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The Power to Detect Trends in Missouri River Fish Populations within the Pallid Sturgeon Population Assessment Program

Open-File Report 2010–1020

U.S. Department of the Interior
U.S. Geological Survey

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Conversion Factors and Abbreviations

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
mile, nautical (nmi)	1.852	kilometer (km)
yard (yd)	0.9144	meter (m)
	Area	
square foot (ft^2)	929.0	square centimeter (cm^2)
square foot (ft^2)	0.09290	square meter (m^2)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F=(1.8\times°C)+32$$

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$°C=(°F-32)/1.8$$

The Power to Detect Trends in Missouri River Fish Populations within the Pallid Sturgeon Population Assessment Program

By Janice L. Bryan[1], Mark L. Wildhaber[1], Dan Gladish[2], Scott Holan[2], Mark Ellerseick[2]

Executive Summary

As with all large rivers in the United States, the Missouri River has been altered, with approximately 32.5 percent of the main stem length impounded and 32.5 percent channelized. These physical alterations to the environment have had effects on the fisheries, but studies examining the effects of alterations have been localized and for short periods of time. In response to the U.S. Fish and Wildlife Service biological opinion, the U.S. Army Corps of Engineers initiated monitoring of the fish community of the Missouri River in 2003. The goal of the Pallid Sturgeon Population Assessment Program is to provide information to detect changes in populations and habitat preferences with time for pallid sturgeon (*Scaphirhynchus albus*) and native target species in the Missouri River Basin. To determine statistical power of the Pallid Sturgeon Population Assessment Program, a power analysis was conducted using a normal linear mixed model with variance component estimates based on the first 3 years of data (2003 to 2005). In cases where 3 years of data were unavailable, estimates were obtained using those data. It was determined that at least 20 years of data, sampling 12 bends with 8 subsamples per bend, would be required to detect a 5 percent annual decline in most of the target fish populations. Power varied between Zones. Zone 1 (upstream from Lake Sakakawea) did not have any species/gear type combinations with adequate power, whereas Zone 3 (downstream from Gavins Point Dam) had 19 species/gear type combinations with adequate power. With a slight increase in the sampling effort to 12 subsamples per bend, the Pallid Sturgeon Population Assessment Program has adequate power to detect declines in shovelnose sturgeon (*S. platorynchus*) throughout the entire Missouri River because of large catch rates. The lowest level of non-occurrence (in other words, zero catches) at the bend level for pallid sturgeon was 0.58 using otter trawls in Zone 1. Consequently, the power of the pallid sturgeon models was not as high as other species at the current level of sampling, but an increase in the sampling effort to 16 subsamples for each of 24 bends for 20 years would generate adequate power for the pallid sturgeon in all Zones. Since gear types are selective in their species efficiency, the strength of the Pallid Sturgeon Population Assessment Program approach is using multiple gears that have statistical power to detect population trends at the same time in different fish species within the Missouri River. As often is the case with monitoring studies involving endangered species, the data used to conduct the analyses exhibit some departures from the parametric model assumptions; however, preliminary simulations indicate that the results of this study are appropriate.

Introduction

The Missouri River is 3,768 kilometers (km) or 2,341 miles (mi) long (Hesse and others, 1989) and drains one sixth of the contiguous United States[1,371,000 square kilometers (km^2), fig. 1]. The drainage basin includes 10 states and part of 2 Canadian provinces; 70.3 percent of the basin drains the semi-arid Great Plains physiographic province (see Galat and others, 2005a and references therein). As with all large rivers in the United States, the Missouri River has been altered, with approximately 32.5 percent of the main stem length impounded and 32.5 percent channelized [1960 river miles for the Missouri River, U. S. Army Corps of Engineers (USACE); 1999 National Hydrography Dataset, U. S. Geological Survey (USGS) and U. S. Environmental Protection Agency]. The Missouri River sustains the largest reservoir system in the United States with six large main stem reservoirs in the Dakotas and Montana. The lower 1,212 km has no main stem reservoirs, but the lower 1,176 km riverine channel has been extensively modified and channelized.

In the lower Missouri River, physical riverine habitat alterations and flood plain land use practices (Hesse and others, 1989; Pinter, 2005) have changed the riverine habitat diversity and channel geometry (Hesse and Sheets, 1993), and

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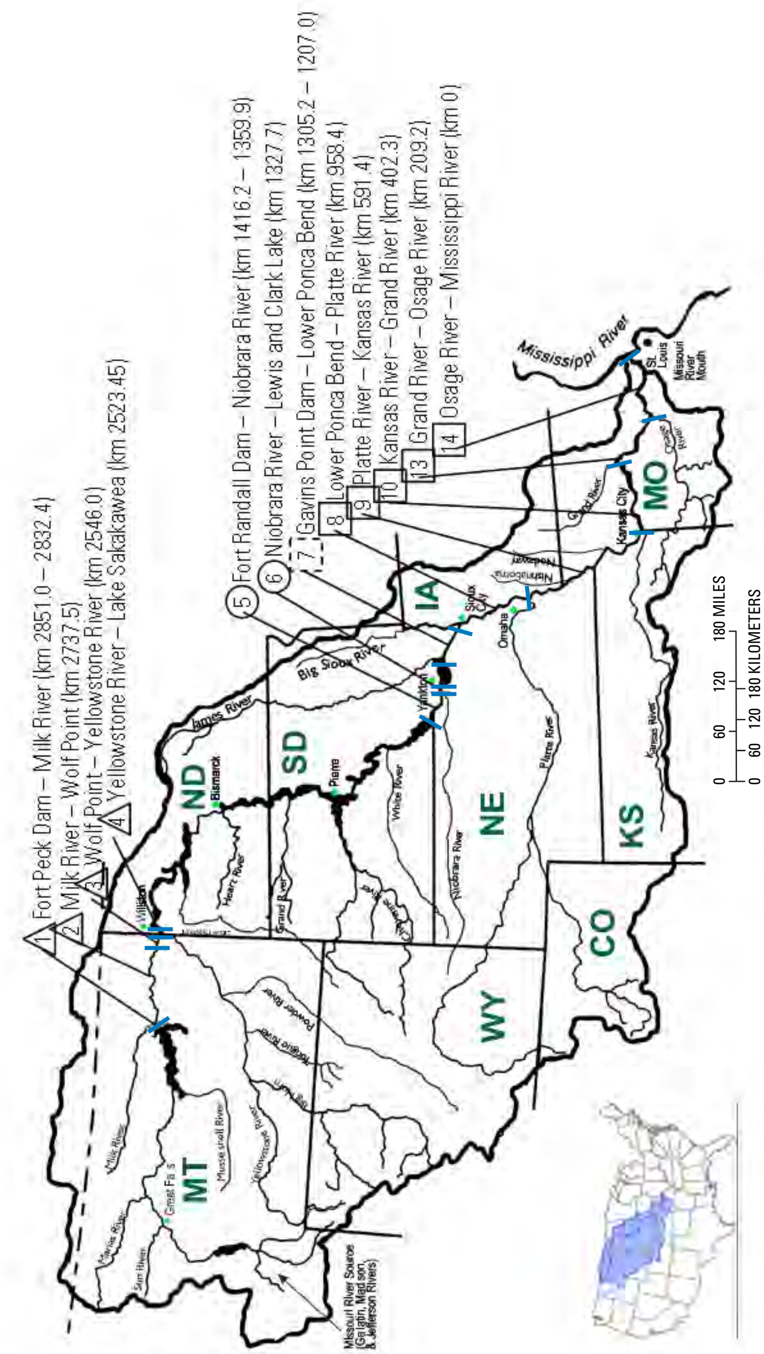

Figure 1. The Zones (triangles = Zone 1, circles = Zone 2, all squares = Zone 3, only solid lined squares = Zone 4) and Segments designated in the Pallid Sturgeon Population Assessment Program on the Missouri River. Blue lines indicate segment boundaries.

the natural wetted channel (Hallberg and others, 1979). The main stem channelization also has created higher river elevation (Pinter and Heine, 2005), which has increased flood levels 3 to 4 m (meters) in the last century (Criss and Shock, 2001; Pinter and Heine, 2005; Ehlmann and Criss, 2006). Upper main stem reservoirs also have altered discharge variation (Galat and Lipkin, 2000; Pegg and others, 2003), and reduced suspended sediment concentration from 25 to 80 percent (Meade, 1995, ~25 percent reduction; Blevins, 2006, 70–80 percent reduction).

These physical alterations to the environment have had biological consequences including a decrease in fish populations (Pflieger and Grace, 1987; Hesse and Sheets, 1993; and Hesse, 1996), a decrease in Missouri River Basin native flora and fauna (Whitmore and Keenlyne, 1990), and benthic insect production decrease of 61 percent in a backwater area downstream from the Niobrara River confluence (Mestl and Hesse, 1993).

Coupled with these physical and biological changes in the Missouri River are the chemical contaminants (Petty and others, 1995, 1998; Meade, 1995) and the introduction of nonnative species (currently 20 percent of fish species for the entire basin, Galat and others, 2005b). These circumstances have culminated in the American Rivers© organization listing the Missouri River in the top 10 of America's most endangered rivers for 8 consecutive years (1994–2002).

In response to the U.S. Fish and Wildlife Service (USFWS) 2000 biological opinion (USFWS, 2000) the USACE initiated monitoring of the fish community of the Missouri River based on the design of the Missouri River Benthic Fishes Study (MRBFS) (Berry and others, 2005) as a 'Reasonable and Prudent Alternative' element in the 2000 and 2003 Biological opinion (USFWS, 2000, 2003). As stated in the guiding document for the Pallid Sturgeon Population Assessment Program (PSPAP), the goal of the PSPAP is to provide the information needed to detect changes in populations and habitat preferences with time for pallid sturgeon (*Scaphirhynchus albus*) and native target species in the Missouri River Basin (written commun. M.R. Drobish 2005a). Through the PSPAP, selected Federal and state agencies (Missouri Department of Conservation; Montana Fish, Wildlife, and Parks; Nebraska Game and Parks Commission; South Dakota Game, Fish and Parks; USFWS), with guidance from the USGS, sampled river segments from the lower Missouri River (1,305.2 km) beginning in 2003, and by 2005 the program included segments above and below the main stem reservoirs. The PSPAP focuses on 10 Missouri River benthic community species (table 1). These species represent the Missouri River native benthic fish community and/or are species of conservation concern.

To produce the most efficient and effective sampling possible in the PSPAP, a power analysis was suggested by the Sustainable Ecosystem Institute (SEI) in their independent science review (SEI, 2004). In cooperation with the USACE, we conducted a power analysis; the purpose being to determine the most efficient sampling (bends) and subsampling (gear deployments within a bend) efforts in combination given the current level of variation. Previous studies have examined the power to detect trends with time using a mixed model approach. Typically, testing for trends proceeds using a t-test on the fixed effect for trend with the proper variance term obtained from the model (Sims and others, 2006, and the references therein). In contrast, for this study an Analysis of Variance (ANOVA) F-test was conducted under a different model formulation.

To take advantage of the PSPAP sampling design (table 2), the power analysis that was conducted uses a standard ANOVA formulation with multiple fixed effects (year, season, and segment) and nested random effects (gear deployment within bend) and results in a F-test for the main effect because

Table 1. Ten fish species of interest in the Pallid Sturgeon Population Assessment Program.

[mm, millimeters; >, greater than or equal to; --, species was not divided into length categories]

Common name	Scientific name	Adult length (mm)
Blue Sucker	*Cycleptus elongatus*	> 500[1]
Pallid Sturgeon	*Scaphirhynchus albus*	> 750[2]
Plains Minnow	*Hybognathus placitus*	--
Sand Shiner	*Notropis stramineus*	--
Sauger	*Sander canadensis*	> 250[3]
Shovelnose Sturgeon	*Scaphirhynchus platorynchus*	> 550[4]
Sicklefin Chub	*Macrhybopsis meeki*	--
Speckled Chub	*Macrhybopsis aestivalis*	--
Sturgeon Chub	*Macrhybopsis gelida*	--
Western Silvery Minnow	*Hybognathus argyritis*	--

[1] Pflieger, 1997

[2] Bajer and Wildhaber, 2007

[3] Becker, 1983; Jenkins and Burkhead, 1994

[4] Moos, 1978

Table 2. Organization of the data collected and analyzed for a gear for each species and their maturity state in the Pallid Sturgeon Population Assessment Program.

Universe
- **Year** (levels range 1–3)
- **Season** (2 levels, Fish Community or Sturgeon Season)
- **Segment** (levels range 1–5)
- **Bend** (randomly selected from all bends in each Universe-Year-Season-Segment combination)
  - **Subsample** (multiple throws of a gear evenly distributed within a bend)

of year. Peery (2004) initially examined the power to detect trends for PSPAP. The analysis conducted for that study was based on a logistic regression of presence-absence. As such, the approach taken by Peery estimated the probability to detect changes in population occurrence rather than population size. In addition, Peery (2004) did not consider variation among bends or among gear deployments within a bend during his simulation of data to conduct tests to assess power. Ultimately, it is these limitations of the original power analyses, the availability of additional years of data, and the request of the PSPAP to use classic statistical approaches and measures that led to the development of the power analysis approach used in this report.

Methods

The following summarizes the PSPAP methods relevant to the power analysis. More detail is given in the PSPAP guiding document and standard operating procedures (written commun. M.R. Drobish 2005a, 2005b). Specifically, we divided the Missouri River into four Zones that contain multiple segments because of the general physical characteristics and location of the segments (fig. 1). As was done in the MRBFS (Berry and others, 2005), these segments are defined by changes in “physical attributes such as degrading or aggrading stream bed, flow fluctuations, natural hydrograph, stream gradient, geology, water temperature, turbidity, substrate, discrete habitat changes (tributary or tributary affect) and modifications (presence of restoration projects)” (written commun. M.R. Drobish 2005a). Zones were defined as follows: Zone 1, the upper section (segments 1–4); Zone 2, the inter-reservoir section (segments 5 and 6); Zone 3, the lower section (segments 7, 8, 9, 10, 13, 14); and Zone 4, the channelized section (segments 8, 9, 10, 13, 14). Zone 3 was created so as to include the affect of the unchannelized section (segment 7) in the Lower Missouri River. For this report, each Zone is analyzed separately. Because of the lag in data collection in Zone 1, the analysis includes only 2005 data from segment 4 for Zone 1.

From this point forward, the term “year” will be used to reference the sampling year which, dependent on temperature restrictions (see below), began on October 31 of the preceding calendar year and ended on October 30 of the present calendar year (for example, without temperature restrictions, the 2005 sampling year would have begun on October 31, 2004 and ended on October 30, 2005). The first year to have both seasons sampled occurred in 2003. For this analysis, data collected from 2003 to 2005 (January 2003 to October 2005) were used. In 2003, data collection started in January for the sturgeon season. In 2003 and 2004, data were collected in segments 5, 6, 9, 13, and 14 only. In 2005, segments 4 through 10, 13, and 14 were sampled.

Annual sampling was evenly distributed into two seasons: fish community and sturgeon. These seasons are defined by water temperature and June 30th. When water temperatures are less than 12.8 ^{o}C (degrees Celcius), the sample was collected in the sturgeon season. Fish community season starts July 1st and continues through October 31st (written commun. M.R. Drobish 2005a). During the fall, these two seasons may overlap because of local water temperatures in the river.

In this program, a river bend is the experimental unit, or scale, at which the measurements are replicated [in MRBFS the experimental unit was the macrohabitat not the bend (Berry and others, 2005)]. A river bend is defined as “beginning at the origin of each channel crossover and will include the adjacent downstream outside bend/inside bend complex” (written commun. M.R. Drobish 2005a). This includes any islands, secondary channels, and tributary mouths. For each year and segment, a random subset of bends is selected for sampling.

Gear Type

Within each bend, different habitats are sampled using specific standard gear types. Only the standard gears that were deployed consistently throughout 2003 to 2005 were used in this study; active gears were bag seine (BS), otter trawl (OT), and trammel net (TN), and passive gears were gill net (GN) and mini-fyke net (MF; see written commun. M.R. Drobish 2005b). Active gears actively fished while deployed (they were moving toward the fish; OT, TN, and BS). Passive gears passively fished while deployed (the fish moved toward the net; GN and MF). Hoop nets or benthic trawls were not included in the analysis because of the inconsistent use of these gears throughout the years and seasons. In Zone 2, all GN and TN were dyed green, and were included in the analysis since each Zone is a separate analysis.

Following Berry and others, (2005) and Arab and others, (2008), the unit of measure for the active gears was catch per unit area (CPUA). In this report, CPUA for each active gear deployment was based on the gears’ minimum deployment area. This scalar is unique to each gear type and was used in all models. The minimum deployment area for an OT was 360 m^2 = 4.9 m wide x 75 m minimum deployment distance, a TN was 2,858 m^2 = 38.1 m wide x 75 m minimum deployment distance, and a BS was 10 m^2 = the minimum area sampled using any BS technique. Consequently, the scalar for the OT was 360, TN was 2,858, and the BS was 10. The only exception to these minimum deployment lengths was when either an OT or TN was deployed in a pool habitat where the minimum deployment length was 25 m. This exception occurred only three times; one gear deployment in segment 6 and two deployments in segment 5. Since these last three deployments constituted a small percentage of total gear deployments, they were removed from the analysis to maintain consistency for each gear.

The unit of measure for passive gears was catch per unit effort (CPUE) based on time. The CPUE for each passive gear deployment was based on each gears’ minimum deployment time. For both gears this was 12 hours; consequently, the scalar for MF and GN was 12. Net length was not used in the passive gear scale adjustment because the distance covered for a MF was not recorded until 2006.

All standard active gears were not used consistently between seasons. In Zone 1 the only gear common between the two seasons is the TN. In Zone 2 the only gear common between seasons is the OT. In Zone 3 the TN was common between seasons. Additionally, in Zone 3, the OT was not deployed in 2005, segment 7, sturgeon season. This last set of non-deployments was because of logistics, not because it was not standard; consequently, OT was treated as common between seasons. The only exception to this is when segment 7 was analyzed alone. In Zone 4, the only gears common between both seasons are the OT and TN.

Subsample

Each gear deployment in a bend is a subsample. For each gear, the subsamples were dispersed evenly throughout the bend. If a gear deployment did not meet the minimum deployment requirement stated above, then the gear deployment was not used in the analysis. This occurred for two gears only: 5 OT deployments and 30 TN deployments; see appendix A (at the back of this report) for details about additional data removal before any of the analyses done for this report as a consequence of quality assurance/quality control work that was necessary.

Analysis

Each analysis was performed separately for all fish collected in each species. If a maturity size is defined (table 1) then additional analyses were performed separately for adults and juveniles for each species. Following Berry and others (2005), no analyses were conducted on *Hybognathus spp.* [plains minnow (*H. placitus*), and western silvery minnow (*H. argyritis*)] because of difficulties in identifying individual species, and because individual species tend to be zoogeographically separated.

Within each zone and species, the same set of criteria used by Berry and others (2005) was used to filter the data for the different levels of analysis. This series of criteria were applied to the data to provide a consistent decision process on how to proceed with the statistical analysis of the data for each species. In addition, imposing these criteria helps provide a set of data that are closer to satisfying the parametric model assumptions (for example, normality and homoskedastic variance), though some departures from the assumptions still remain. These criteria were applied to all gear deployments that had non-missing response variables (no missing information). These were as follows.

1. One fish had to be collected for a given zone, year, season, or gear to be included in the analysis.
2. Data from a gear were not used if the catch was < 5 percent of the total catch. For example, in Zone 4 shovelnose sturgeon (*S. platorynchus*) collections were 2 and 5 respectively for BS and MF; values were < 5 percent of the total catch of 19,678 shovelnose sturgeon, so these gears were excluded from analyses of shovelnose sturgeon in Zone 4.
3. Data from a gear were not used if the presence of that species did not exceed 5 percent of the total number of bends sampled. This only occurred in Zone 2 for blue sucker (*Cycleptus elongatus*) collected in TN, where only 2 out of 55 bends sampled had at least one blue sucker.
4. Data were excluded if the catch in a year by one gear was < 10 percent of the total number of fish collected for that species for all years by that gear.
5. Data were excluded if the catch in a season by a gear was < 5 percent of the total number of fish collected for that species and gear for both seasons.

For only the analyses that examined each individual segment, data were excluded if no fish were collected in that segment [only occurred when no speckled chub (*Macrhybopsis aestivalis*) were collected in Zone 1 and no sicklefin chub (*M. meeki*), sturgeon chub (*M. gelida*), speckled chub, and blue sucker-juvenile were collected in Zone 2] or the total number of fish collected for a species in that segment by a gear was < 5 percent of the total number of fish collected in that segment.

Model Description and Power Calculation

The PSPAP sampling design has a nested structure with multiple subsamples within each bend. In particular, for each species, the model consisted of three fixed effects (year, season, and segment). Additionally, within each year, season, and segment combination, a random sample of river bends is selected from the entire zone. Further, within each river bend, multiple gear deployments (subsamples) were distributed randomly across the area within a bend. To calculate the power for each of the different combinations of segments, seasons, and gears, separate analyses for each combination were performed. The data used for these analyses constitute a subset of the original dataset and the models contain only factors that have more than one level. For example, if interest lies in the power of individual segments in Zone 4, then there would be five models considered that contained only factors that have more than one level in each segment. In these cases the appropriate modifications were made to the procedure.

To calculate the power of lower and higher levels of effort than was observed in the original data requires knowledge of the population variances associated with the random effects because of bend and subsample. Ultimately, these values are inferred based on estimates obtained from the data, and are considered known when calculating power.

To accommodate the study design, the power analysis we conducted is based on the normal linear mixed model given by

$$Y_{ijklm} = \mu + \alpha_i + \beta_j + \gamma_k + \alpha\beta_{ij} + \alpha\gamma_{ik} + \beta\gamma_{jk} + \alpha\beta\gamma_{ijk} + D_{ijkl} + S_{ijklm} \quad (1)$$

where

- Y_{ijklm} is the catch per unit (area or effort) for year *i*, season *j*, segment *k*, bend *l*, and subsample *m*;
- μ is the overall mean for all years, seasons, segments, bends, and subsamples;
- α_i is the fixed effect due to year *i* (i=1,…,a);
- β_j is the fixed effect due to season *j* (j=1,…,b);
- γ_k is the fixed effect due to segment *k* (k=1,…,c);
- D_{ijkl} is the random effect due to bend *l* (l=1,…,d); and
- S_{ijklm} is the random effect due to subsample (gear deployment) *m* (m=1,…,s),

with $D_{ijkl} \sim iid\ N(0,\sigma_D^2)$, $S_{ijklm} \sim iid\ N(0,\sigma_S^2)$ mutually independent; see Kuehl (2000) for a comprehensive discussion. Equivalently this model can be expressed as a mixed means model (Moser, 1996; Littell and others, 2006) and is given by

$$Y_{ijklm} = \mu_{ijk} + D_{ijkl} + S_{ijklm} \quad (2)$$

where μ_{ijk} denotes the fixed portion of the model, and where D_{ijkl} and S_{ijklm} are random effects defined in the same manner as above.

The focus for this study is on testing the main effect because of year. As such, the appropriate hypothesis test in cell means notation is given by

H_0: $\bar{\mu}_{1..} = \ldots = \bar{\mu}_{a..}$

H_a: at least one inequality.

Under the null hypothesis the test statistic follows a central *F* distribution with $a - 1$ numerator degrees of freedom (ndf) and $abc(d\text{-}1)$ denominator degrees of freedom (ddf). Conversely, under the alternative hypothesis, for which the power is calculated, the test statistic follows a non-central *F* distribution with (a-1) ndf, $abc(d$-1) ddf and non-centrality parameter Φ, where Φ is given by

$$\Phi = \frac{bcds}{\sigma_S^2 + s\sigma_D^2} \sum_{i=1}^{a} (\bar{\mu}_{i..} - \bar{\mu}_{...})^2 \quad (3)$$

Power is defined to be the probability of rejecting the null hypothesis given that the alternative is true. That is, we determine the probability that our test statistic is greater than the critical value of the test under significance level α, denoted $F_{(1-\alpha;a-1,abc(d-1))}$ under the non-central *F* distribution with the appropriate degrees of freedom [for example power = $P(F>F_{(1-\alpha;a-1,abc(d-1))}|\Phi)$].

To calculate this power, the number of years, *a*, needs to be specified as well as the value of $\bar{\mu}_{i..}$, for each *i*. Since the goal is to obtain a power estimate when there is a given percent decrease in the population from one year to the next, the alternative hypothesis is defined by:

$$\bar{\mu}_{i..} = (1 - \Delta)^{i-1}\bar{\mu}_{1..} \quad (4)$$

for $i = 2, \ldots, a$ and $0 < \Delta < 1$. Hence, for each year *i*, the mean $\bar{\mu}_{i..}$ was decreased from the previous year's mean $\bar{\mu}_{i-1..}$ by a constant percentage. Note that choosing the alternative hypothesis in terms of a decreasing mean rather than an increasing mean is of greater biological interest and yields a conservative power estimate (that is, given the same number of years, decreasing the mean rather than increasing the mean results in a smaller non-centrality parameter). To specify a biologically meaningful estimate, the initial mean $\bar{\mu}_{1..}$ was calculated from the data. In that vein, estimating the first year is slightly problematic in that the original data are unbalanced; that is, each year-season-segment combination does not contain the same number of bends, and each bend does not contain the same number of subsamples (as opposed to a balanced design, in which this is the case). To estimate the first year allowing for each bend to have the same affect on the mean, an annual mean was calculated in a nested manner by first averaging subsamples within a bend, then bend means within a segment, then segment means within a season, and season means within a year before averaging years. Though this estimate does not constitute a statistically optimal estimate, it does provide a biologically meaningful initial specification under the alternative hypothesis.

As an exploratory measure, the variance components for all models initially were estimated using Restricted Maximum Likelihood Estimation (REML) using the “unbound” option (Proc Mixed in SAS version 9.1.3; Littell and others, 2006). Models having a negative bend variance component estimate were noted and then re-estimated using standard REML estimation methods (that is, the variance components have a bounded parameter space and are restricted to be greater than or equal to zero). The re-estimated value was then used in the power calculation. The exploratory analysis conducted here argues for the collection of additional data to be analyzed in conjunction with the existing data in the hope that increased information will produce positive bend variance component estimates, even when the parameter space is unbounded (Kuehl, 2000). Even though the variance component estimates used in our analysis were estimated using REML, any model results having an initially negative bend variance component estimate (from the exploratory phase of the analysis) should be interpreted with caution (as clearly denoted in the accompanying tables and figures).

Current target levels of effort for the PSPAP are 12 bends with 8 subsamples per bend for each year, season, and segment combination [referenced as 12/8 or number of bends/number of subsamples per bend for the rest of the document, (written commun. M.R. Drobish 2005a)]. However, in the data used for the power analysis, these levels fluctuated slightly between years and segments (table 3, at the back of this report); consequently, for this analysis, the current target levels of effort and those above and below the current levels were of interest. The levels of bend effort tested were 6, 12, 18, 24, and subsample effort levels of 4, 8, 12, and 16. Different monitoring lengths of 5, 10, and 20 years also were examined, as was the power to detect different population rates of decline over the years. Three compounding rates of decline were studied; 1, 3, and 5 percent. So a 1, 3, and 5 percent annual rate of decline for 10 years would be 8.6, 24, and 37 percent decline between the 1st and 10th year, respectively (20 years = 17.4, 43.9, and 62.3 percent). Other topics of interest that were examined include how many years are required under the current level of effort to achieve adequate power; how many bends are required using 5 years for each season and segment at 8 subsamples per bend (a maximum of 60 bends were tested because the average number of bends per segment in Zone 4 was 56.2); and how large of an annual decline would be necessary using the current level of effort to detect a change in 5 years. For all tests the α-level was 0.05 and power of 0.80 was considered adequate.

Results

Each individual species and size category was susceptible to certain gear types with large percentages of non-occurrence (zero catches, figs. 2–24 part a, tables 4–7, at the back of this report); therefore, the high incidence of zeros for the species/gear combinations required the removal of 237 species/gear/year/season combinations from the analysis because of our deletion criteria (appendix B, figs. 2–24, part b, at the back of this report). There were 182 models out of 550 models that had a negative bend variance component estimate (based on preliminary exploratory analysis) and were recalculated using standard REML estimation, (this restricts variance component estimates to be greater than or equal to zero) (table 8, at the back of this report). Because of the frequency of zeros in the data, the distributions were not normally distributed; however, based on preliminary simulation results, it was determined that power increased as the number of zeros decreased and, therefore, the assumption of normality was violated to a lesser degree (J. Bryan, USGS, unpub. Data, 2008). Consequently, this indicates the power estimates presented are conservative.

At the current level of 12 bends and 8 subsamples (designated hereinafter as bend/subsample), only the sturgeon chub models have adequate power to detect a 5 percent decline per year in 5 years (appendix C at the back of this report). At the current level of 12/8, the only species to have adequate power to detect a 5 percent decline in 10 years with any of the models were sturgeon chub (Zone 3 and 4) and shovelnose sturgeon (Zone 3 and 4; tables 9, 12, 15, and 18, appendix D at the back of this report). Since most of the species did not reach an adequate power of 0.80 until 20 years at a 5 percent level of annual decline (appendix E at the back of this report), only these latter results will be discussed. The monitoring program is designed to monitor entire populations; consequently, only the power of the gear types for each species/Zone combination will be discussed. The results for each gear type in each individual season and segment are presented in appendix F (at the back of this report) for reference. All power graphs are presented with different combinations of bend and subsample levels that were tested.

Zone 1

None of the species/gear combinations, out of the 28 examined, had adequate power under or at the current 12/8 level (tables 9–11, figs. 25–39, at the back of this report). Sixteen species/gear combinations did not have adequate power at the 24/16 level. Twelve species/gear combinations had adequate power between the 12/8 and 24/16 levels. None of the species/gear combinations will achieve adequate power in five years with a 60/8 level. In 5 years, only the shovelnose sturgeon, and sicklefin chub models will have adequate power to detect less than a 45 percent annual population decline (an annual decline of 45 percent over 5 years is a population decline of 90 percent). Sixteen species/gear combinations did not have adequate power until after 50 years at a 12/8 level.

Blue Sucker-All

- The OT and TN had adequate catch to meet our criteria and calculate power values (fig. 2, table B–1, at the back of this report).
- Neither the OT nor TN reached adequate power at the 24/16 level of effort (table 9, fig. 25).
- Neither the OT nor TN reached adequate power at the 60/8 level of monitoring for 5 years (table 10).
- Using either gear, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 10).
- Using either gear, it would take more than 100 years to reach adequate power at the current 12/8 level (table 11).

Blue Sucker-Adult

- The TN had adequate catch to meet our criteria and calculate power values (fig. 3, table B–2, at the back of this report).
- The TN did not have adequate power at the 24/16 level of effort (table 9, fig. 26).
- The TN did not have adequate power at the 60/8 level of monitoring for 5 years (table 10).

- Using TN, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 10).
- Using TN, it would take more than 100 years to reach adequate power at the current 12/8 level (table 11).

Blue Sucker-Juvenile

- The OT had adequate catch to meet our criteria and calculate power values (fig. 4, table B–3, at the back of this report).
- The OT did not have adequate power at the 24/16 level of effort (table 9, fig. 27).
- The OT did not have adequate power at the 60/8 level of monitoring for 5 years (table 10).
- Using OT, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 10).
- Using OT, it would take more than 100 years to reach adequate power at the current 12/8 level (table 11).

Pallid Sturgeon-All

- The OT and TN had adequate catch to meet our criteria and calculate power values (fig. 5, table B–4, at the back of this report).
- The OT did not have adequate power at the 24/16 level of effort; however, the TN had adequate power at the 18/16 level of effort (table 9, fig. 28).
- Neither the OT nor TN reached adequate power at the 60/8 level of monitoring for 5 years (table 10).
- Using either gear, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 10).
- Using TN, it would take 35 to 40 years to reach adequate power at the current 12/8 level; however, using OT would take more than 100 years (table 11).

Pallid Sturgeon-Adult

- The TN had adequate catch to meet our criteria and calculate power values (fig. 6, table B–5, at the back of this report).
- The TN did not have adequate power at the 24/16 level of effort (table 9, fig. 29).
- The TN did not have adequate power at the 60/8 level of monitoring for 5 years (table 10).
- Using TN, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 10).
- Using TN, it would take more than 100 years to reach adequate power at the current 12/8 level (table 11).

Pallid Sturgeon-Juvenile

- The OT and TN had adequate catch to meet our criteria and calculate power values (fig. 7, table B–6, at the back of this report).
- The TN had adequate power at the 18/16 level of effort; however, the OT did not have adequate power at the 24/16 level of effort (table 9, fig. 30).
- Neither the OT nor TN reached adequate power at the 60/8 level of monitoring for 5 years (table 10).
- Using either gear, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 10).
- Using TN, it would take 35 to 40 years to reach adequate power at the current 12/8 level; however, using OT would take more than 100 years (table 11).

Sand Shiner-All

- The MF had adequate catch to meet our criteria and calculate power values (fig. 8, table B–7, at the back of this report).
- The MF did not have adequate power at the 24/16 level of effort (table 9, fig. 31).
- The MF did not have adequate power at the 60/8 level of monitoring for 5 years (table 10).
- Using MF, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 10).
- Using MF, it would take more than 100 years to reach adequate power at the current 12/8 level (table 11).

Sauger-All

- The BS, MF, OT and TN had adequate catch to meet our criteria and calculate power values (fig. 9 and 10, table B–8, at the back of this report).

- The TN had adequate power at the 12/12 level. The BS had adequate power at the 24/16; however, the OT and MF did not have adequate power at the 24/16 level of effort (table 9, fig. 32).
- None of the three gears reached adequate power at the 60/8 level of monitoring for 5 years (table 10).
- Using any of the gears, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 10).
- Using BS, MF, and TN, it would take 50 to 75, 35 to 40, and 25 to 30 years, respectively, to reach adequate power at the current 12/8 level; however, if using OT, it would take more than 100 years (table 11).

Sauger-Adult

- The MF and TN had adequate catch to meet our criteria and calculate power values (fig. 11 and 12, table B–9, at the back of this report).
- The TN had adequate power at the 12/16 level; however the MF did not have adequate power at the 24/16 level of effort (table 9, fig. 33).
- Neither the TN nor the MF reached adequate power at the 60/8 level of monitoring for 5 years (table 10).
- Using TN or MF, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 10).
- Using TN, it would take 25 to 30 years to reach adequate power at the current 12/8 level; however, the MF would take more than 100 years to reach adequate power (table 11).

Sauger-Juvenile

- The BS, MF, and OT had adequate catch to meet our criteria and calculate power values (fig. 13 and 14, table B–10, at the back of this report).
- The BS and MF had adequate power at the 24/16 and 24/12 level of effort, respectively; however, the OT did not have adequate power at the 24/16 level of effort (table 9, fig. 34).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 10).
- Using any gear, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 10).
- -Using BS and MF, it would take 50 to 75 and 30 to 35 years, respectively, to reach adequate power at the current 12/8 level; however, using OT would take more than 100 years (table 11).

Shovelnose Sturgeon-All

- The OT and TN had adequate catch to meet our criteria and calculate power values (fig. 15 and 16, table B–11, at the back of this report).
- The OT had adequate power at the 24/12 level of effort and the TN had adequate power at the 12/12 level of effort (table 9, fig. 35).
- Neither the OT nor TN reached adequate power at the 60/8 level of monitoring for 5 years (table 10).
- Using TN, it would take a 35 to 40 percent annual population decline in 5 years to reach adequate power at the current 12/8 level; however, using the OT, it would take more than a 45 percent annual population decline in 5 years (table 10).
- Using OT, it would take 30 to 35 years to reach adequate power at the current 12/8 level, and using the TN would take 20 to 25 years (table 11).

Shovelnose Sturgeon-Adult

- The OT and TN had adequate catch to meet our criteria and calculate power values (fig. 17 and 18, table B–12, at the back of this report).
- The TN had adequate power at the 18/12 level of effort; however, the OT did not have adequate power at the 24/16 level of effort (table 9, fig. 36).
- Neither the OT nor TN reached adequate power at the 60/8 level of monitoring for 5 years (table 10).
- Using TN or OT, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 10).
- Using TN, it would take 25 to 30 years to reach adequate power at the current 12/8 level; however, using OT would take more than 100 years (table 11).

Shovelnose Sturgeon-Juvenile

- The TN and OT had adequate catch to meet our criteria and calculate power values (fig. 19 and 20, table B–13, at the back of this report).

- The TN had adequate power at the 12/16 level of effort; however, the OT did not have adequate power at the 24/16 level of effort (table 9, fig. 37).
- Neither the OT nor TN reached adequate power at the 60/8 level of monitoring for 5 years (table 10).
- Using TN or OT, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 10).
- Using OT or TN, it would take 35 to 40 or 25 to 30 years, respectively, to reach adequate power at the current 12/8 level (table 11).

Sicklefin Chub-All

- The OT had adequate catch to meet our criteria and calculate power values (fig. 21, table B–14, at the back of this report).
- The OT had adequate power at the 12/8 level of effort (table 9, fig. 38).
- The OT did not reach adequate power at the 60/8 level of monitoring for 5 years (table 10).
- Using OT, it would take a 25 to 30 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 10).
- Using OT, it would take 15 to 20 years to reach adequate power at the current 12/8 level (table 11).

Speckled Chub-All

- None of the gears had adequate catch to meet our criteria and calculate power values (fig. 22 and 23, table B–15, at the back of this report).

Sturgeon Chub-All

- The MF and OT had adequate catch to meet our criteria and calculate power values (fig. 24, table B–16, at the back of this report).
- The OT and MF did not have adequate power at the 24/16 level of effort (table 9, fig. 39).
- Neither the OT nor MF reached adequate power at the 60/8 level of monitoring for 5 years (table 10).
- Using either gear, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 10).
- Using OT or MF, it would take more than 100 years to reach adequate power at the current 12/8 level (table 11).

Zone 2

Seven species/gear combinations, out of the 29 examined, had adequate power under or at the current 12/8 level (tables 12–14, figs. 40–51, at the back of this report). They were the sauger-all (Sander canadensis), sauger-adult, shovelnose sturgeon-all, and shovelnose sturgeon-adult. Fifteen species/gear combinations did not have adequate power at the 24/16 level. Six species/gear combinations had adequate power between the 12/8 and 24/16 levels. None of the species/gear combinations will achieve adequate power in 5 years with a 60/8 level. In 5 years, only the sauger-all, sauger-adult, shovelnose sturgeon-all, and shovelnose sturgeon-adult models will have adequate power to detect less than a 45 percent annual population decline. Thirteen species/gear combinations did not have adequate power until after 50 years at a 12/8 level.

Blue Sucker-All

- The OT and GN had adequate catch to meet our criteria and calculate power values (fig. 2, table B–1).
- Neither the OT nor GN reached adequate power at the 24/16 level of effort (table 12, fig. 40).
- Neither the OT nor GN reached adequate power at the 60/8 level of monitoring for 5 years (table 13).
- Using either gear, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 13).
- Using either gear, it would take more than 100 years to reach adequate power at the current 12/8 level (table 14).

Blue Sucker-Adult

- The OT and GN had adequate catch to meet our criteria and calculate power values (fig. 3, table B–2).
- Neither the OT nor GN reached adequate power at the 24/16 level of effort (table 12, fig. 41).
- Neither the OT nor GN reached adequate power at the 60/8 level of monitoring for 5 years (table 13).
- Using either gear, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 13).

- Using either gear, it would take more than 100 years to reach adequate power at the current 12/8 level (table 14).

Blue Sucker-Juvenile

- None of the gears had adequate catch to meet our criteria and calculate power values (fig. 4, table B–3).

Pallid Sturgeon-All

- The GN, OT and TN had adequate catch to meet our criteria and calculate power values (fig. 5, table B–4).
- -The TN had adequate power at the 24/16 level of effort; however neither the GN nor OT reached adequate power at the 24/16 level of effort (table 12, fig. 42).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 13).
- Using any gear, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 13).
- Using TN, it would take 40 to 45 years to reach adequate power at the current 12/8 level; however, if using OT or GN, it would take 75 to 100 years (table 14).

Pallid Sturgeon-Adult

- The GN had adequate catch to meet our criteria and calculate power values (fig. 6, table B–5).
- The GN did not have adequate power at the 24/16 level of effort (table 12, fig. 43).
- The GN did not have adequate power at the 60/8 level of monitoring for 5 years (table 13).
- Using GN, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 13).
- Using GN, it would take more than 100 years to reach adequate power at the current 12/8 level (table 14).

Pallid Sturgeon-Juvenile

- The GN, OT and TN had adequate catch to meet our criteria and calculate power values (fig. 7, table B–6).
- The TN had adequate power at the 24/16 level of effort; however the GN and OT did not have adequate power at the 24/16 level of effort (table 12, fig. 44).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 13).
- Using any gear, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 13).
- Using OT and TN, it would take 75 to 100 years and 35 to 40 years, respectively to reach adequate power at the current 12/8 level; however, using the GN it would take more than 100 years (table 14).

Sand Shiner-All

- The BS and MF had adequate catch to meet our criteria and calculate power values (fig. 8, table B–7).
- The MF had adequate power at the 18/12 level of effort; however, the BS did not have adequate power at the 24/16 level of effort (table 12, fig. 45).
- Neither the BS nor MF had adequate power at the 60/8 level of monitoring for 5 years (table 13).
- Using MF, it would take a 40 to 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level; however using BS would take more than a 45 percent annual population decline (table 13).
- Using MF, it would take 25 to 30 years to reach adequate power at the current 12/8 level; however, using the BS would take more than 100 years (table 14).

Sauger-All

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 9 and 10, table B–8).
- The GN and TN had adequate power at the 18/8 and 6/16 level of effort, respectively; however, the OT did not have adequate power at the 24/16 level of effort (table 12, fig. 46).
- None of the three gears reached adequate power at the 60/8 level of monitoring for 5 years (table 13).
- Using the TN, it would take a 30 to 35 percent annual decline in 5 years to reach adequate power at the current 12/8 level, but using OT or GN would take more than a 45 percent annual population decline (table 13).

- Using GN, OT, or TN, it would take 20 to 25, 35 to 40, and 15 to 20 years, respectively, to reach adequate power at the current 12/8 level (table 14).

Sauger-Adult

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 11 and 12, table B–9).
- The GN and TN had adequate power at the 18/8 and 6/16 level of effort, respectively; however, the OT did not have adequate power at the 24/16 level of effort (table 12, fig. 47).
- -None of the three gears reached adequate power at the 60/8 level of monitoring for 5 years (table 13).
- Using the TN, it would take a 30 to 35 percent annual decline in 5 years to reach adequate power at the current 12/8 level, but using OT or GN would take more than a 45 percent annual population decline (table 13).
- Using GN, OT, or TN, it would take 20 to 25, 50 to 75, and 15 to 20 years, respectively, to reach adequate power at the current 12/8 level (table 14).

Sauger-Juvenile

- The BS, MF, and OT had adequate catch to meet our criteria and calculate power values (fig. 13 and 14, table B–10).
- The OT had adequate power at the 18/12 level of effort, respectively. The BS and MF did not have adequate power at the 24/16 level of effort (table 12, fig. 48).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 13).
- Using any gear, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 13).
- Using OT, it would take 30 to 35 years to reach adequate power at the current 12/8 level, but using the BS or MF would take more than 100 years (table 14).

Shovelnose Sturgeon-All

- The GN, OT and TN had adequate catch to meet our criteria and calculate power values (fig. 15 and 16, table B–11).
- The GN and OT had adequate power at the 12/8 level of effort and the TN had adequate power at the 6/12 level of effort (table 12, fig. 49).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 13).
- Using GN or OT, it would take a 30 to 35 percent annual population decline in 5 years to reach adequate power at the current 12/8 level, but using TN would take 20 to 25 percent (table 13).
- Using TN, it would take 10 to 15 years to reach adequate power at the current 12/8 level and using the GN or OT it would take 15 to 20 years (table 14).

Shovelnose Sturgeon-Adult

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 17 and 18, table B–12).
- The GN, OT, and TN had adequate power at the 12/12, 12/8, and 6/12 level of effort, respectively (table 12, fig. 50).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 13).
- Using GN, OT, or TN, it would take a 35 to 40, 30 to 35, and 20 to 25 percent annual population decline in 5 years to reach adequate power at the current 12/8 level, respectively (table 13).
- Using GN, OT, or TN, it would take 20 to 25, 15 to 20, and 10 to 15 years to reach adequate power at the current 12/8 level, respectively (table 14).

Shovelnose Sturgeon-Juvenile

- The GN had adequate catch to meet our criteria and calculate power values (fig. 19 and 20, table B–13).
- The GN did not have adequate power at the 24/16 level of effort (table 12, fig. 51).
- The GN did not reach adequate power at the 60/8 level of monitoring for 5 years (table 13).
- Using GN, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 13).
- Using GN, it would take more than 100 years to reach adequate power at the current 12/8 level (table 14).

Sicklefin Chub-All

- None of the gears had adequate catch to meet our criteria and calculate power values (fig. 21, table B–14).

Speckled Chub-All

- None of the gears had adequate catch to meet our criteria and calculate power values (fig. 22 and 23, table B–15).

Sturgeon Chub-All

- None of the gears had adequate catch to meet our criteria and calculate power values (fig. 24, table B–16).

Zone 3

Nineteen species/gear combinations, out of the 46 examined, had adequate power under or at the current 12/8 level (tables 15–17, figs. 52–67, at the back of this report). The only species/gear combinations not to have adequate power at the 12/8 level were blue sucker-juvenile, pallid sturgeon-all, pallid sturgeon-adult, and pallid sturgeon-juvenile. Fifteen species/gear combinations did not have adequate power at the 24/16 level. Twelve species/gear combinations had adequate power between the 12/8 and 24/16 levels. Only the shovelnose sturgeon and sturgeon chub will achieve adequate power in 5 years with a bend/subsample level lower than 60/8. In 5 years, only the pallid sturgeon model will not have adequate power to detect less than a 45 percent annual population decline. Fifteen species/gear combinations did not have adequate power until after 50 years at a 12/8 level.

Blue Sucker-All

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 2, table B–1).
- The GN, OT, and TN reached adequate power at the 18/16, 18/12, and 6/18 level of effort, respectively (table 15, fig. 52).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 16).
- Using TN, it would take a 20 to 25 percent annual population decline in 5 years to reach adequate power at the current 12/8 level and a GN or OT would require more than a 45 percent decline (table 16).
- Using the GN, OT, or TN, it would take 20 to 25, 25 to 30, or 15 to 20 years to reach adequate power at the current 12/8 level (table 17).

Blue Sucker-Adult

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 3, table B–2).
- The GN, OT, and TN reached adequate power at the 18/8, 24/12, and 12/8 level of effort, respectively (table 15, fig. 53).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 16).
- Using GN or OT, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level and the TN would require a 25 to 30 percent decline (table 16).
- Using the GN, OT, or TN, it would take 25 to 30, 30 to 35, or 15 to 20 years to reach adequate power at the current 12/8 level, respectively (table 17).

Blue Sucker-Juvenile

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 4, table B–3).
- The GN, OT, and TN reached adequate power at the 18/16, 12/12, and 12/16 level of effort, respectively (table 15, fig. 54).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 16).
- Using any gear, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level, respectively (table 16).
- Using the TN or OT, it would take 20 to 25 years to reach adequate power at the current 12/8 level; using GN would take 40 to 45 years (table 17).

Pallid Sturgeon-All

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 5, table B–4).
- The GN and TN had adequate power at the 18/16 and 24/16 level of effort, respectively; but the OT did not reach adequate power at the 24/16 level of effort (table 15, fig. 55).

- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 16).
- Using any gear, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 16).
- Using GN, TN, and OT, it would take 35 to 40, 50 to 75, and more than 100 years to reach adequate power at the current 12/8 level, respectively (table 17).

Pallid Sturgeon-Adult

For this group, the deletion criteria removed all gear deployments in the fish community season (appendix B). Consequently, the overall gear analysis is equivalent to the sturgeon season analysis.

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 6, table B–5).
- None of the gears reached adequate power at the 24/16 level of effort (table 15, fig. 56).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 16).
- Using any gear, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 16).
- Using any of the gears, it would take more than 100 years to reach adequate power at the current 12/8 level (table 17).

Pallid Sturgeon-Juvenile

- The GN, OT and TN had adequate catch to meet our criteria and calculate power values(fig. 7, table B–6).
- The TN had adequate power at the 24/16 level of effort, but the GN and OT did not have adequate power at the 24/16 level of effort (table 15, fig. 57).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 16).
- Using any gear, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 16).
- Using TN, it would take 50 to 75 years to reach adequate power at the current 12/8 level, but the GN or OT would take more than 100 years (table 17).

Sand Shiner-All

- The BS and MF had adequate catch to meet our criteria and calculate power values (fig. 8, table B–7).
- The BS had adequate power at the 6/16 level of effort and the MF had adequate power at the 24/12 level of effort (table 15, fig. 58).
- Neither the BS nor MF had adequate power at the 60/8 level of monitoring for 5 years (table 16).
- Using BS, it would require a 20 to 25 percent annual population decline in 5 years to reach adequate power at the current 12/8 level and the MF would require more than a 45 percent annual population decline (table 16).
- Using BS, it would take 15 to 20 years to reach adequate power at the current 12/8 level and the MF would take 30 to 35 years (table 17).

Sauger-All

- All five gears had adequate catch to meet our criteria and calculate power values (fig. 9 and 10, table B–8).
- The BS and GN had adequate power at the 12/4 and 12/8 level of effort, respectively; but the MF, OT, and TN did not have adequate power at the 24/16 level of effort (table 15, fig. 59).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 16).
- Using BS or GN, it would take a 10 to 15 or 30 to 35 percentannual population decline in 5 years to reach adequate power at the current 12/8 level, respectively, but the MF, OT, or TN would take more than a 45 percent annual decline (table 16).
- Using BS or GN, it would take 10 to 15 or 15 to 20 years to reach adequate power at the current 12/8 level, respectively. The MF or TN would take 50 to 75 years, and the OT would take more than 100 years (table 17).

Sauger-Adult

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 11 and 12, table B–9).
- The GN had adequate power at the 12/8 level of effort, but the OT and TN did not have adequate power at the 24/16 level of effort (table 15, fig. 60).

- None of the three gears reached adequate power at the 60/8 level of monitoring for 5 years (table 16).
- Using the GN, it would require a 30 to 35 percent annual population decline in 5 years to reach adequate power at the current 12/8 level, but the OT or TN would require more than a 45 percent annual decline (table 16).
- Using GN or TN, it would take 15 to 20 or 45 to 50 years to reach adequate power at the current 12/8 level, respectively, but the OT would take more than 100 years (table 17).

Sauger-Juvenile

- The BS, MF, and OT had adequate catch to meet our criteria and calculate power values (fig. 13 and 14, table B–10).
- The BS had adequate power at the 6/8 level of effort, but the MF and OT did not have adequate power at the 24/16 level of effort (table 15, fig. 61).
- None of the three gears reached adequate power at the 60/8 level of monitoring for 5 years (table 16).
- Using BS, it would take a 10 to15 percent annual population decline in 5 years to reach adequate power at the current 12/8 level, respectively, but using MF and OT would take more than a 45 percent annual decline (table 16).
- Using BS or MF, it would take 10 to 15 or 50 to 75 years to reach adequate power at the current 12/8 level, but the OT would take more than 100 years (table 17).

Shovelnose Sturgeon-All

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 15 and 16, table B–11).
- All gears had adequate power at the 6/4 level of effort (table 15, fig. 62).
- The GN, OT, and TN reached adequate power at the 35 to 40/8, 30 to 35/8, 45 to 50/8 level of monitoring for 5 years, respectively (table 16).
- Using GN or OT, it would take a 5 to 10 percent annual population decline in 5 years to reach adequate power at the current 12/8 level; the TN would require a 10 to 15 percent annual decline (table 16).
- Using any gear, it would take 5 to 10 years to reach adequate power at the current 12/8 level (table 17).

Shovelnose Sturgeon-Adult

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 17 and 18, table B–12).
- All gears had adequate power at the 6/4 level of effort (table 15, fig. 63).
- The GN and OT reached adequate power at the 15 to 20/8 level of monitoring for 5 years and the TN reached adequate power at the 20 to 25/8 level (table 16).
- Using any gear, it would take a 10 to 15 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 16).
- Using GN or OT, it would take 5 to 10 years to reach adequate power at the current 12/8 level, and the TN would take 10 to 15 years (table 17).

Shovelnose Sturgeon-Juvenile

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 19 and 20, table B–13).
- All gears had adequate power at the 6/4 level of effort (table 15, fig. 64).
- The GN, OT, and TN reached adequate power at the 30 to 35/8, 25 to 30/8, and 50 to 55/8 level of monitoring for 5 years, respectively (table 16).
- Using GN or OT, it would take a 5 to 10 percent annual population decline in 5 years to reach adequate power at the current 12/8 level, the TN would require a 10 to 15 percent decline (table 16).
- Using any gear, it would take 5 to 10 years to reach adequate power at the current 12/8 level (table 17).

Sicklefin Chub-All

- The MF and OT had adequate catch to meet our criteria and calculate power values (fig. 21, table B–14).
- The OT had adequate power at the 6/16 level of effort, but the MF did not have adequate power at the 24/16 level of effort (table 15, fig. 65).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 16).
- Using OT, it would take a 20 to 25 percent annual population decline in 5 years to reach adequate power

at the current 12/8 level, but the MF would take more than a 45 percent annual decline (table 16).

- Using OT, it would take 15 to 20 years to reach adequate power at the current 12/8 level, but using the MF it would take more than 100 years (table 17).

Speckled Chub-All

- The BS, MF, and OT had adequate catch to meet our criteria and calculate power values (fig. 22 and 23, table B–15).
- The MF and OT had adequate power at the 18/16 and 6/8 level of effort, respectively, but the BS did not have adequate power at the 24/16 level of effort (table 15, fig. 66).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 16).
- Using OT, it would require a 15 to 20 percent annual population decline in 5 years to reach adequate power at the current 12/8 level, respectively, but the BS or MF would take more than a 45 percent annual decline (table 16).
- Using OT, it would take 10 to 15 years to reach adequate power at the current 12/8 level, and the BS and MF would take 30 to 35 years (table 17).

Sturgeon Chub-All

- The OT had adequate catch to meet our criteria and calculate power values (fig. 24, table B–16).
- The OT had adequate power at the 6/4 level of effort (table 15, fig. 67).
- The OT reached adequate power at less than the 5/8 level of monitoring for 5 years (table 16).
- Using OT, it would take a 1 to 3 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 16).
- Using OT, it would take less than 3 years to reach adequate power at the current 12/8 level (table 17).

Zone 4

Sixteen species/gear combinations, out of the 44 examined, had adequate power under or at the current 12/8 level (tables 18–20, fig. 68–83, at the back of this report). Fifteen species/gear combinations did not have adequate power at the 24/16 level. Thirteen species/gear combinations had adequate power between the 12/8 and 24/16 levels. Only the shovelnose sturgeon and sturgeon chub will achieve adequate power in 5 years with a bend/subsample level lower than 60/8. In 5 years, only the pallid sturgeon and blue sucker-juvenile models will not have adequate power to detect less than a 45 percent annual population decline. Fourteen species/gear combinations did not have adequate power until after 50 years at a 12/8 level.

Blue Sucker-All

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 2, table B–1).
- The TN reached adequate power at the 12/8 level of effort and the GN and OT at the 18/16 level of effort (table 18, fig. 68).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 19).
- Using TN, it would require a 25 to 30 percent annual population decline in 5 years to reach adequate power at the current 12/8 level, but the GN and OT would require more than a 45 percent annual population decline (table 19).
- Using the GN, OT, or TN, it would take 25 to 30, 30 to 35, or 15 to 20 years to reach adequate power at the current 12/8 level, respectively (table 20).

Blue Sucker-Adult

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 3, table B–2).
- The GN, OT, and TN reached adequate power at the 24/8, 24/16, and 12/8 level of effort, respectively (table 18, fig. 69).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 19).
- Using TN, it would require a 25 to 30 percent annual population decline in 5 years to reach adequate power at the current 12/8 level, but the GN and OT would require more than a 45 percent annual population decline (table 19).
- Using the GN, OT, or TN, it would take 25 to 30, 35 to 40, or 15 to 20 years to reach adequate power at the current 12/8 level, respectively (table 20).

Blue Sucker-Juvenile

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 4, table B–3).
- The GN, OT, and TN reached adequate power at the 18/16, 12/16, and 18/12 level of effort, respectively (table 18, fig. 70).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 19).
- Using any gear, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 19).
- Using the OT or TN, it would take 25 to 30 years to reach adequate power at the current 12/8 level, and the GN would take 45 to 50 years (table 20).

Pallid Sturgeon-All

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 5, table B–4).
- The GN had adequate power at the 18/16 level of effort, but the OT and TN did not reach adequate power at the 24/16 level of effort (table 18, fig. 71).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 19).
- Using any gear, it would require more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 19).
- Using GN and TN, it would take 35 to 40 and 75 to 100 years to reach adequate power at the current 12/8 level, respectively, but the OT would take more than 100 years (table 20).

Pallid Sturgeon-Adult

For this group, the deletion criteria removed all gear deployments in the fish community season (appendix B). Consequently, the overall gear analysis is equivalent to the sturgeon season analysis.

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 6, table B–5).
- None of the gears reached adequate power at the 24/16 level of effort (table 18, fig. 72).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 19).
- Using any gear, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 19).
- Using any of the gears, it would take more than 100 years to reach adequate power at the current 12/8 level (table 20).

Pallid Sturgeon-Juvenile

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 7, table B–6).
- None of the gears reached adequate power at the 24/16 level of effort (table 18, fig. 73).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 19).
- Using any gear, it would take more than a 45 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 19).
- Using TN it would take 75 to 100 years to reach adequate power at the current 12/8 level, but using GN or OT would take more than 100 years (table 20).

Sand Shiner-All

- The BS and MF had adequate catch to meet our criteria and calculate power values (fig. 8, table B–7).
- The BS had adequate power at the 6/16 level of effort, but the MF did not have adequate power at the 24/16 level of effort (table 18, fig. 74).
- Neither the BS nor MF had adequate power at the 60/8 level of monitoring for 5 years (table 19).
- Using BS, it would require a 25 to 30 percent annual population decline in 5 years to reach adequate power at the current 12/8 level and the MF would require a 40 to 45 percent annual population decline (table 19).
- Using BS, it would take 15 to 20 years to reach adequate power at the current 12/8 level and MF would take 50 to 75 years (table 20).

Sauger-All

- The GN, MF, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 9 and 10, table B–8).
- The GN and MF had adequate power at the 12/12 and 24/16 level of effort, respectively, but the OT and TN

did not have adequate power at the 24/16 level of effort (table 18, fig. 75).

- -None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 19).
- -Using GN, it would require a 35 to 40 percent annual population decline in 5 years to reach adequate power at the current 12/8 level, but using MF, OT, or TN would require more than a 45 percent annual decline (table 19).
- Using GN and MF, it would take 20 to 25 and 40 to 45 years to reach adequate power at the current 12/8 level, respectively, but the OT and TN would take more than 100 years (table 20).

Sauger-Adult

- The GN and TN had adequate catch to meet our criteria and calculate power values (fig. 11 and 12, table B–9).
- The GN had adequate power at the 12/12 level of effort, but the TN did not have adequate power at the 24/16 level of effort (table 18, fig. 76).
- None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 19).
- Using the GN, it would require a 35 to 40 percent annual population decline in 5 years to reach adequate power at the current 12/8 level, but the TN would require more than a 45 percent annual decline (table 19).
- Using GN, it would take 20 to 25 years to reach adequate power at the current 12/8 level, respectively, but using OT would take more than 100 years (table 20).

Sauger-Juvenile

- The BS, MF, and OT had adequate catch to meet our criteria and calculate power values (fig. 13 and 14, table B–10).
- The BS and MF had adequate power at the 6/8 and 24/16 level of effort, respectively, but the OT did not have adequate power at the 24/16 level of effort (table 18, fig. 77).
- -None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 19).
- Using the BS it would take a 10 to 15 percent annual population decline in 5 years to reach adequate power at the current 12/8 level; however, using MF or OT would take more than a 45 percent annual population decline (table 19).
- Using BS or MF, it would take 10 to 15 or 45 to 50 years to reach adequate power at the current 12/8 level, respectively, but the OT would take more than 100 years (table 20).

Shovelnose Sturgeon-All

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 15 and 16, table B–11).
- All gears had adequate power at the 6/4 level of effort (table 18, fig. 78).
- The GN and OT reached adequate power at the 45 to 50/8 and 30 to 35/8 level of monitoring for 5 years, respectively, but the TN did not reach adequate power at the 60/8 level (table 19).
- Using GN or TN, it would take a 10 to 15 percent annual population decline in 5 years to reach adequate power at the current 12/8 level, the OT required a 5 to 10 percent decline (table 19).
- Using GN or OT, it would take 5 to 10 years to reach adequate power at the current 12/8 level, and the TN would take 10 to 15 years (table 20).

Shovelnose Sturgeon-Adult

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 17 and 18, table B–12).
- The GN and OT had adequate power at the 6/4 level of effort, and the TN had adequate power at the 6/8 level of effort (table 18, fig. 79).
- The GN, OT, and TN reached adequate power at the 20 to 25/8, 30 to 35/8, and 25 to 30/8 level of monitoring for 5 years, respectively (table 19).
- Using any gear, it would take a 10 to 15 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 19).
- Using GN, it would take 5 to 10 years to reach adequate power at the current 12/8 level, and the OT or TN would take 10 to 15 years (table 20).

Shovelnose Sturgeon-Juvenile

- The GN, OT, and TN had adequate catch to meet our criteria and calculate power values (fig. 19 and 20, table B–13).
- The GN and OT had adequate power at the 6/4 level of effort, and the TN had adequate power at the 6/8 level of effort (table 18, fig. 80).
- The GN and OT reached adequate power at the 40 to 45/8 and 25 to 30/8 level of monitoring for 5 years, respectively, but the TN did not reach adequate power at the 60/8 level (table 19).
- Using GN or TN, it would take a 10 to 15 percent annual population decline in 5 years to reach adequate power at the current 12/8 level, and the OT would require a 5 to 10 percent decline (table 19).
- Using GN or OT, it would take 5 to 10 years to reach adequate power at the current 12/8 level, and using TN it would take 10 to 15 years (table 20).

Sicklefin Chub-All

- The MF and OT had adequate catch to meet our criteria and calculate power values (fig. 2, table B–14).
- The OT had adequate power at the 12/8 level of effort, but the MF did not reach adequate power at the 24/16 level (table 18, fig. 81).
- -None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 19).
- Using OT, it would take a 25 to 30 percent annual population decline in 5 years to reach adequate power at the current 12/8 level, but the MF would take more than a 45 percent annual decline (table 19).
- Using OT, it would take 5 to 10 years to reach adequate power at the current 12/8 level, but using the MF it would take more than 100 years (table 20).

Speckled Chub-All

- The BS, MF, and OT had adequate catch to meet our criteria and calculate power values (fig. 22 and 23, table B–15).
- The MF and OT had adequate power at the 24/12 and 6/12 level of effort, but the BS did not reach adequate power at the 24/16 level (table 18, fig. 82).
- -None of the gears reached adequate power at the 60/8 level of monitoring for 5 years (table 19).
- Using OT, it would take a 20 to 25 percent annual population decline in 5 years to reach adequate power at the current 12/8 level, respectively; BS or MF would take more than a 45 percent annual decline (table 19).
- Using BS, MF, and OT, it would take 35 to 40, 30 to 35, and 10 to 15 years to reach adequate power at the current 12/8 level, respectively (table 20).

Sturgeon Chub-All

- The OT had adequate catch to meet our criteria and calculate power values (fig. 24, table B–16).
- The OT had adequate power at the 6/4 level of effort (table 18, fig. 83).
- The OT reached adequate power at less than the 5/8 level of monitoring for 5 years (table 19).
- Using OT, it would take a 1 to 3 percent annual population decline in 5 years to reach adequate power at the current 12/8 level (table 19).
- Using OT, it would take less than 3 years to reach adequate power at the current 12/8 level (table 20).

Conclusions

The purpose of monitoring programs is to sustain long-term assessment of populations, and is extensive when monitoring a community of species that includes long-lived rare species. The sampling that occurred from 2003 to 2005 in the Pallid Sturgeon Population Assessment Program is a good example of this type of community population monitoring using multiple gear types that target not only the long-lived, rare fish species, but also gear types that target short-lived, small fish species. Gray and Burlew (2007) estimated sampling would need to occur for 20 to 30 years to detect an annual 5 percent trend in fingernail clams (Family: Sphaeriidae). Purcell and others (2005) determined it would take 10 to 20 years to detect a decline in abundance of 30 to 56 percent in bird communities in oak-woodland sites in California. The current study results are similar to these examples of other long term monitoring. It was determined that at least 20 years at the current sampling effort is required to detect a 5 percent annual decline in most of the target fish populations. These estimates are conservative since preliminary analyses indicate that a decrease in the number of zeros (J. Bryan, USGS, unpub. data 2008) or increase in the number of fish caught will increase power (2006 PSPAP yearly reports show an increase in pallid sturgeon catches after 2005).

There were differences between the previous power analysis conducted by Peery (2004) and the analysis conducted in this study. Peery (2004) used a logistic regression model based on presence-absence. As such, the approach estimates the power to detect changes in population occurrence rather than population size. In addition, the power analyses that were conducted were all at the α-level = 0.10. These differences would explain why Peery (2004) estimated higher power than the results of this study.

In Zone 1 (in this analysis, this is segment 4), the only models that achieved adequate power under the current sampling effort were the sicklefin chub caught in the OT. In this analysis, Zone 1 consisted only of segment 4; consequently, the variance component estimates and power likely will improve once the additions of segments 1–3 (first sampled after 2005) are included in the analysis. With an increase to the 12/12, 18/16 or 24/16 level of effort, the power of the TN was adequate for the pallid and shovelnose sturgeon and sauger, respectively, and the power of the MF and BS model was adequate for the sauger.

Zone 2 (segments 5 and 6) had a moderate number of models that achieved adequate power. At the current sampling level, the power of the GN and OT models was adequate for shovelnose sturgeon. The power of the TN models was adequate for sauger and shovelnose sturgeon. With an increase to the 24/16 level of effort, the power of the TN model was adequate for the pallid sturgeon. With an increase to the 18/12 level of effort, the power of the MF model was adequate for the sand shiner (*Notropis stramineus*).

Zone 3 (segments 7, 8, 9, 10, 13, and 14) had the most species/gear combinations that achieved adequate power under the current sampling effort for 20 years. This is not unexpected since Zone 3 is the largest zone that was examined. Under the current sampling level, the power of the OT models was adequate for shovelnose sturgeon and all three chub species. The power of the TN models was adequate for blue sucker and shovelnose sturgeon. The power of the GN models was adequate for sauger and shovelnose sturgeon. Lastly, the power of the BS models was adequate for the sand shiner and sauger. With an increase of effort to the 18/16 level, the power of the GN model was adequate for the pallid sturgeon and blue sucker.

Zone 4 (segments 8, 9, 10, 13, and 14) had fewer models that achieved adequate power than Zone 3. Under the current sampling level, the power of the OT models was adequate for shovelnose sturgeon and all three chub species. The power of the TN models was adequate for blue sucker and shovelnose sturgeon. The power of the GN models was adequate for shovelnose sturgeon. Lastly, the power of the BS model was adequate for the sand shiner and sauger. With an increase of effort to the 18/16 level, the power of the GN model was adequate for the pallid sturgeon and blue sucker.

The lowest level of non-occurrence (zero catches) at the bend level for pallid sturgeon was 0.58 using OT in Zone 1. Because of the low numbers of fish, the power of the pallid sturgeon models were not as high as other species at the current level of sampling, but an increase in the sampling effort to 24 bends/16 subsamples for 20 years would generate adequate power for the pallid sturgeon in all Zones using TN and OT (18/16 if using GN and TN for Zone 1, 3, and 4). However, using only one gear type would eliminate other species of interest, for example, the smaller fish species such as all three chub species, sand shiners, and some juvenile classes. If using GN, OT, and TN and increasing the level of effort to 24/16, the only species that doesn't have adequate power is the sand shiner in all zones and sauger-juvenile in Zone 1, 3, and 4 (the blue sucker models would need a higher level of effort to have adequate power using only the GN, OT, and TN). These results indicate the value of multiple gear types to monitor the fish community in the Missouri River, which is intuitive since certain species are more susceptible to specific gear types.

Another aspect of using multiple gears to sample a fish community is the ability to combine active gears or passive gears in multi-gear models. For this report these power calculations were not generated because of time constraints; however, with additional data, higher catch rates, and the use of multi-gear models, the power of the Pallid Sturgeon Population Assessment Program to detect trends in fish populations in the Missouri River will likely improve, though reassessment is recommended.

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Figures 2–83

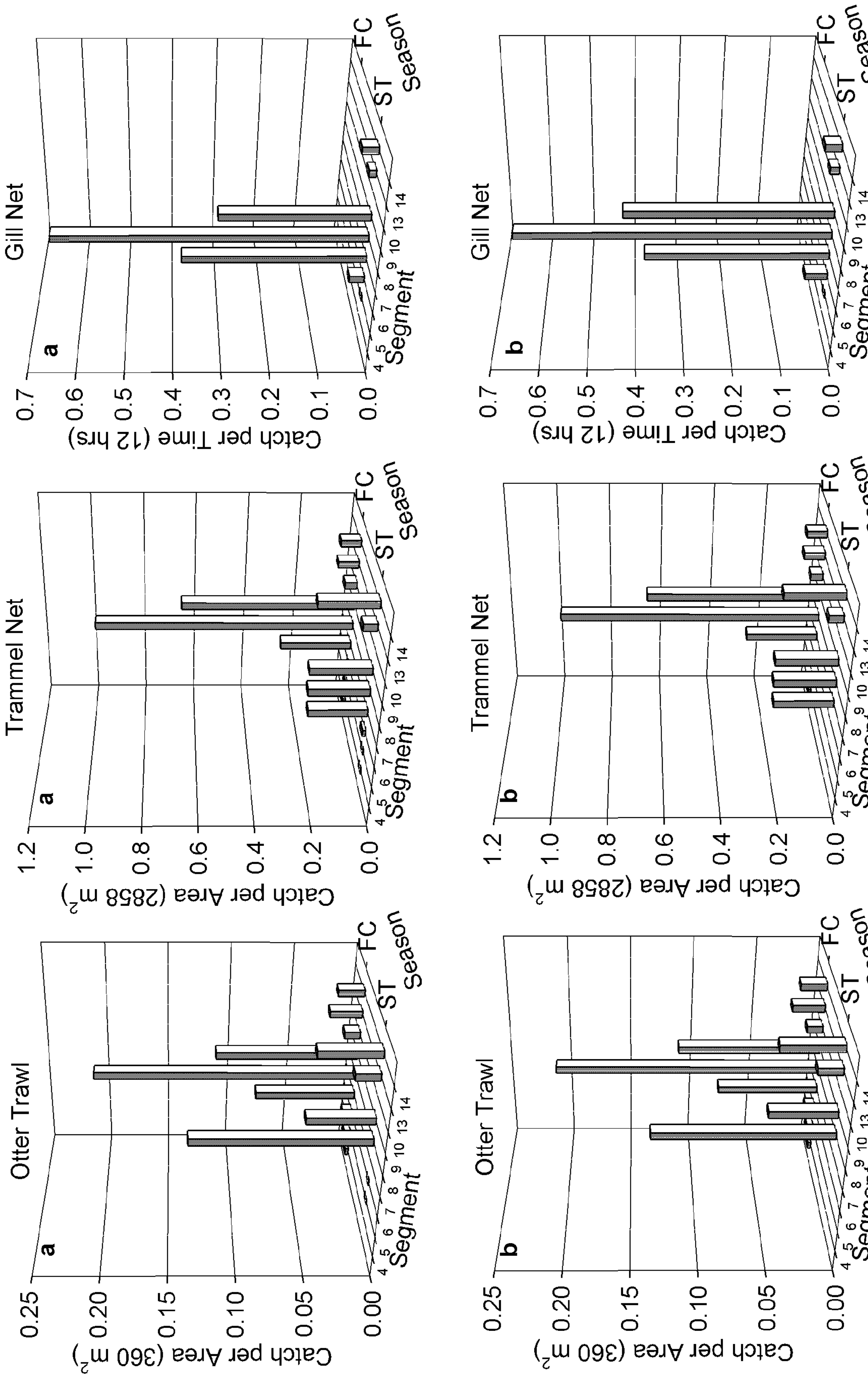

Figure 2. Blue sucker-all catch per unit before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

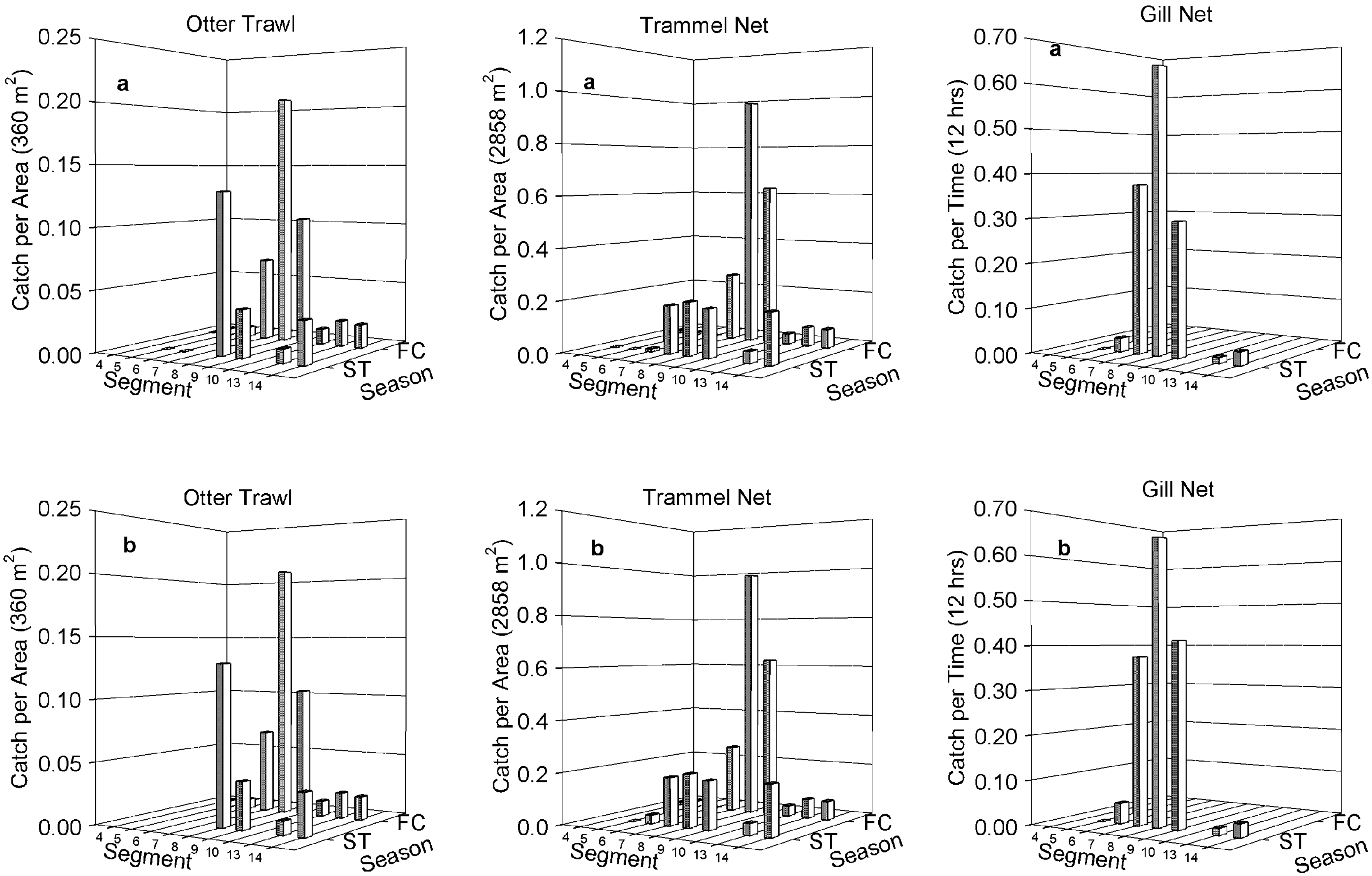

Figure 3. Blue sucker-adult catch per unit before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

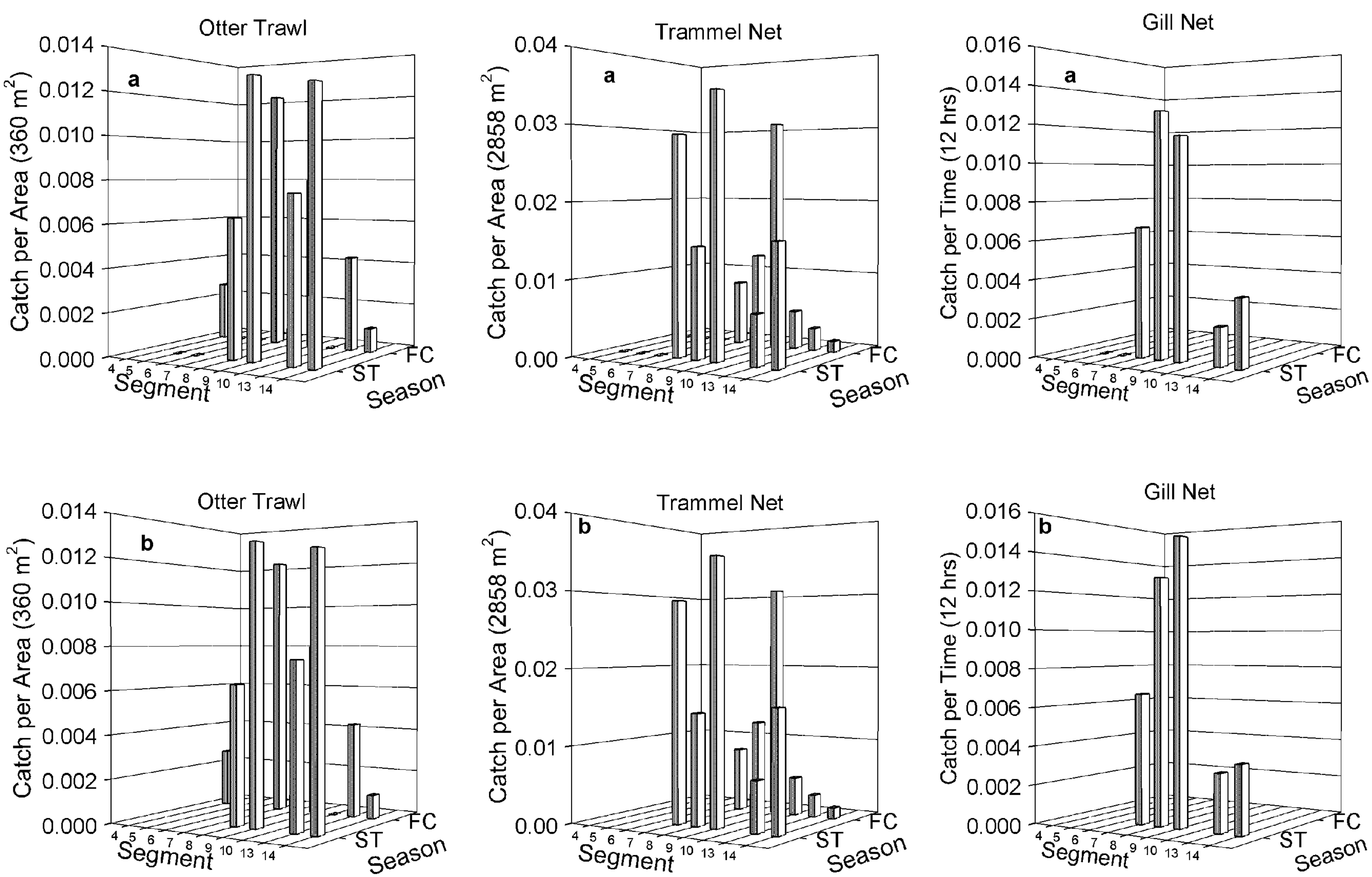

Figure 4. Blue sucker-juvenile catch per unit before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

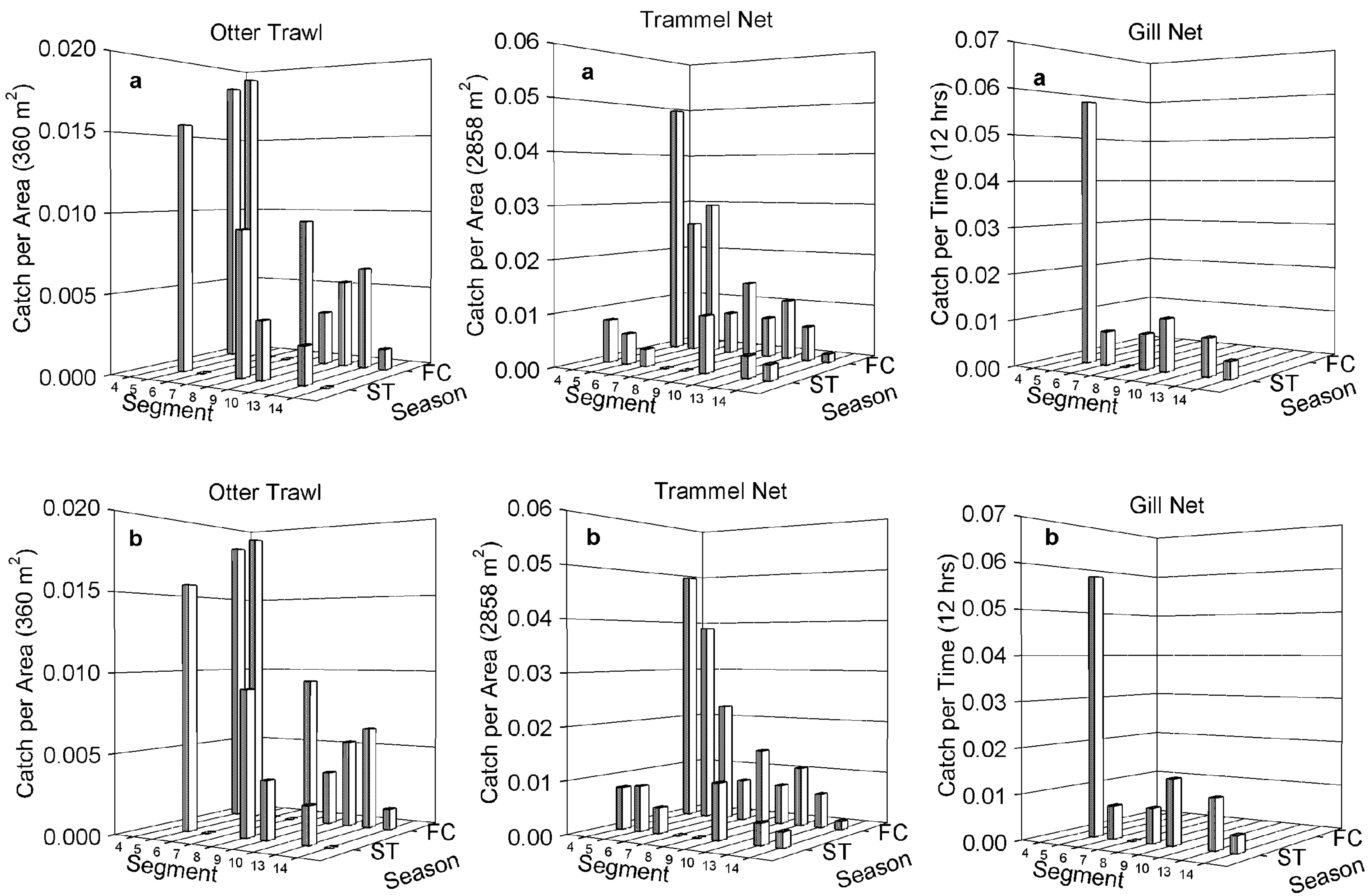

Figure 5. Pallid stugeon-all catch per unit before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

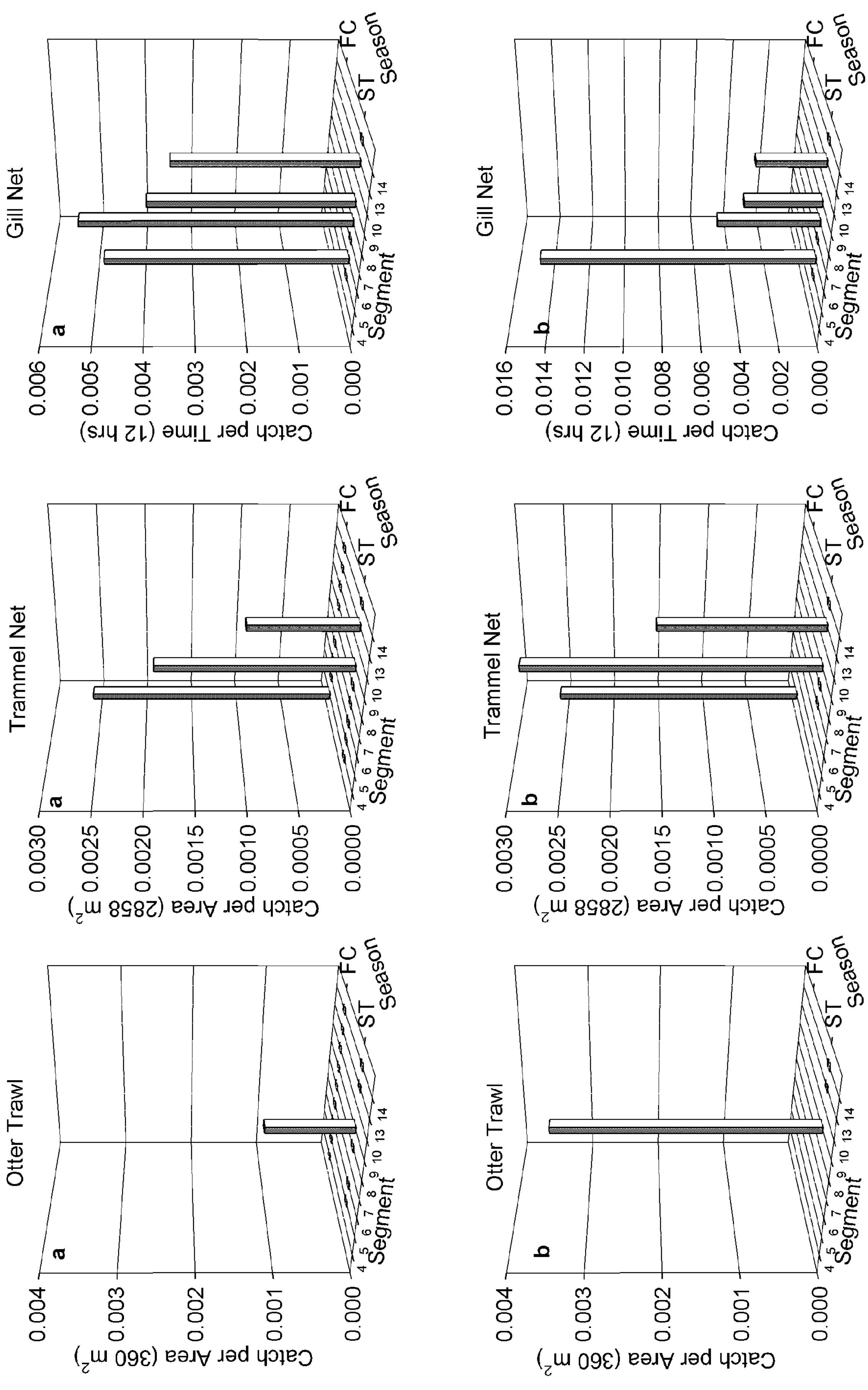

Figure 6. Pallid stugeon-adult catch per unit before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

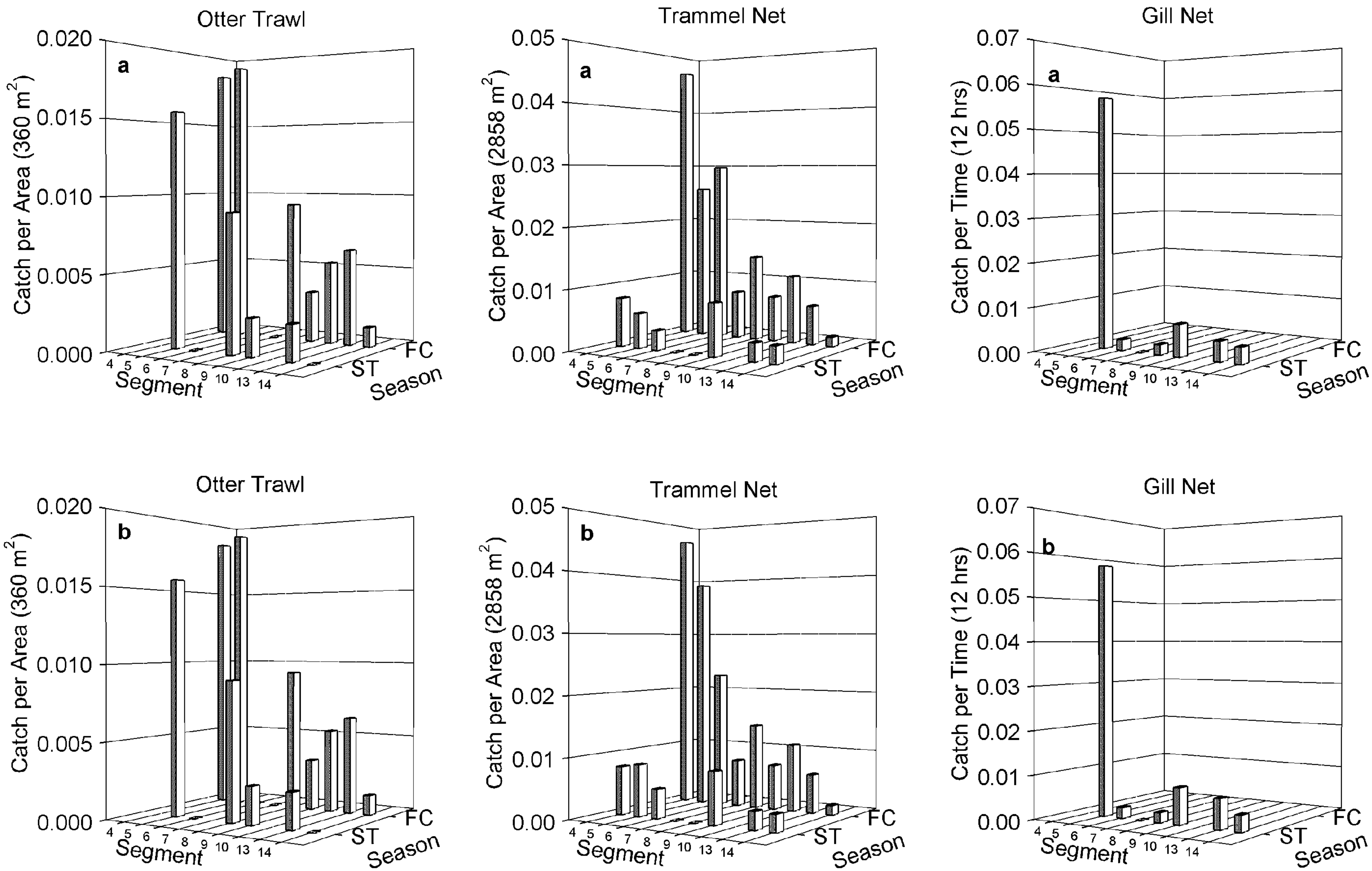

Figure 7. Pallid sturgeon-juvenile catch per unit before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

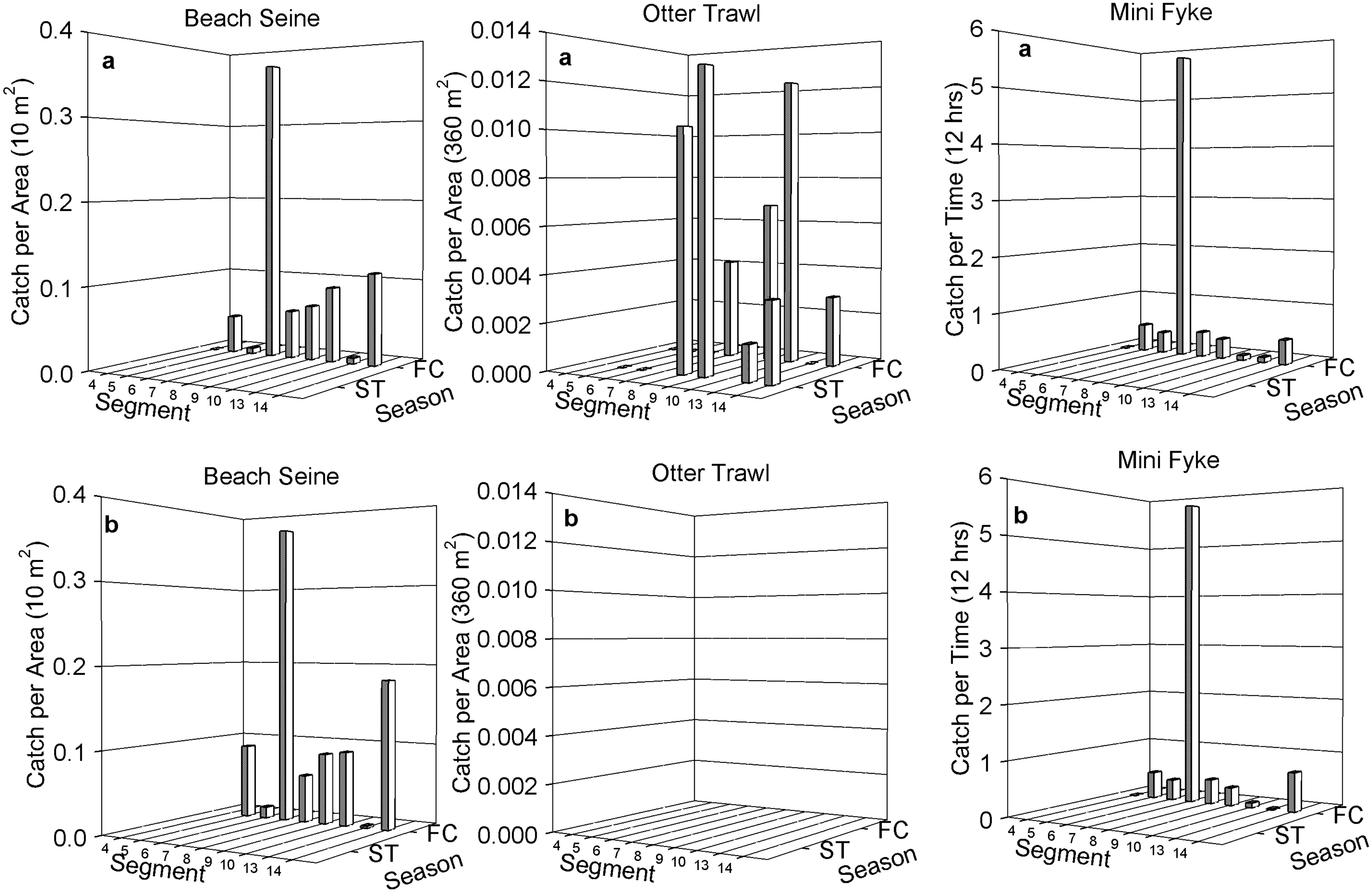

Figure 8. Sand shiner-all catch per unit before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

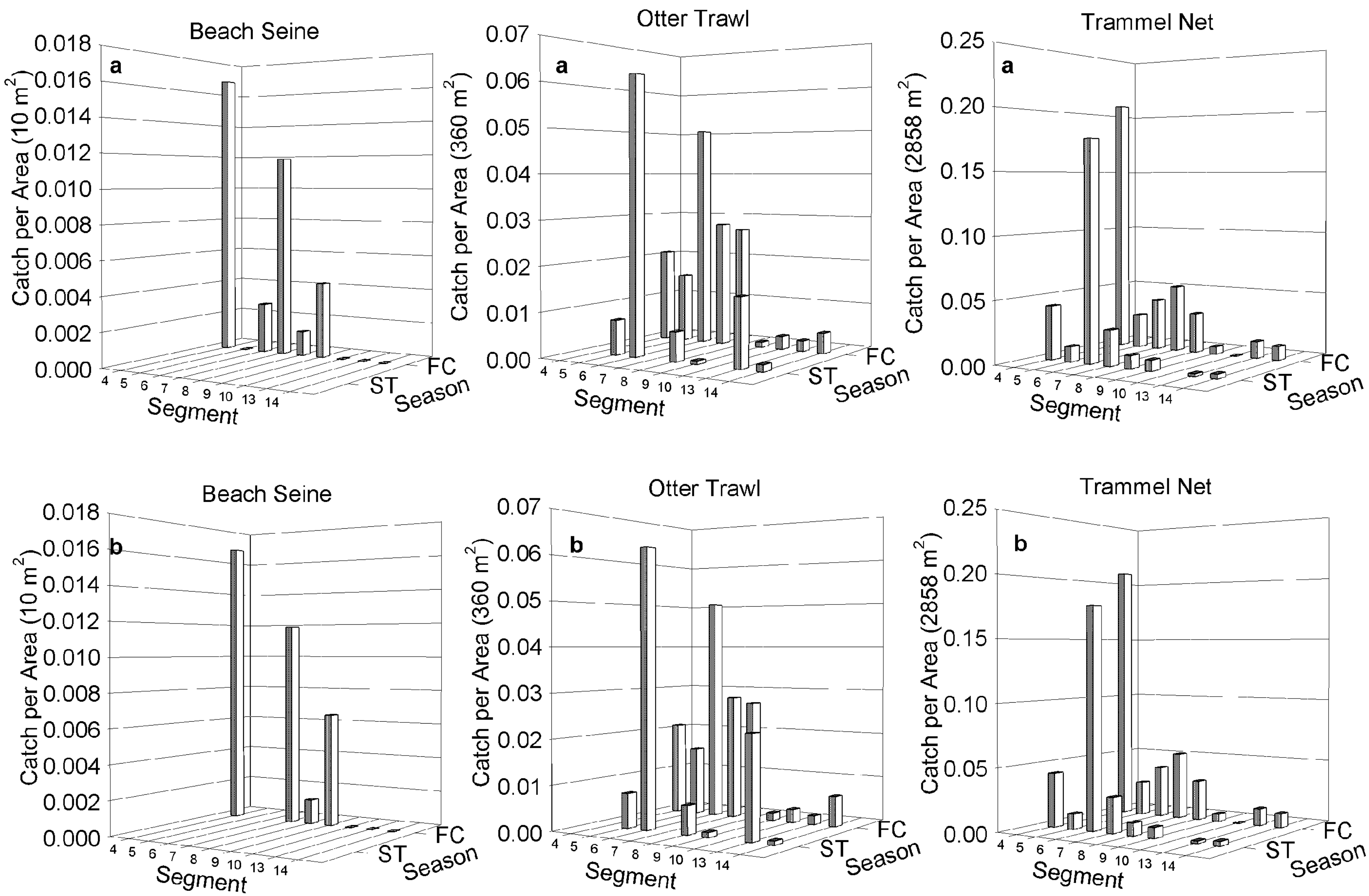

Figure 9. Sauger-all catch per unit for the active gears before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

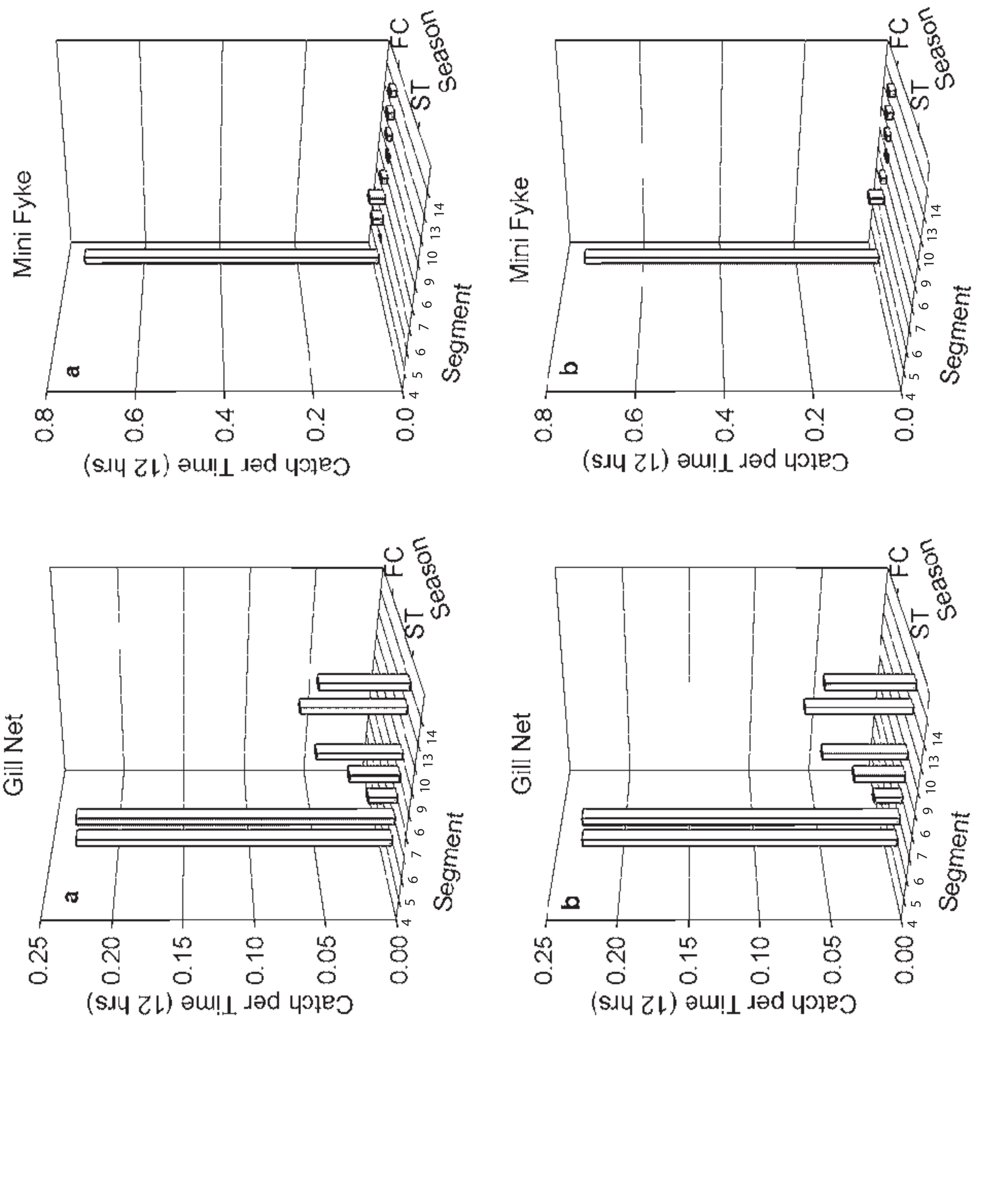

Figure 10. Sauger-all catch per unit for the passive gears before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

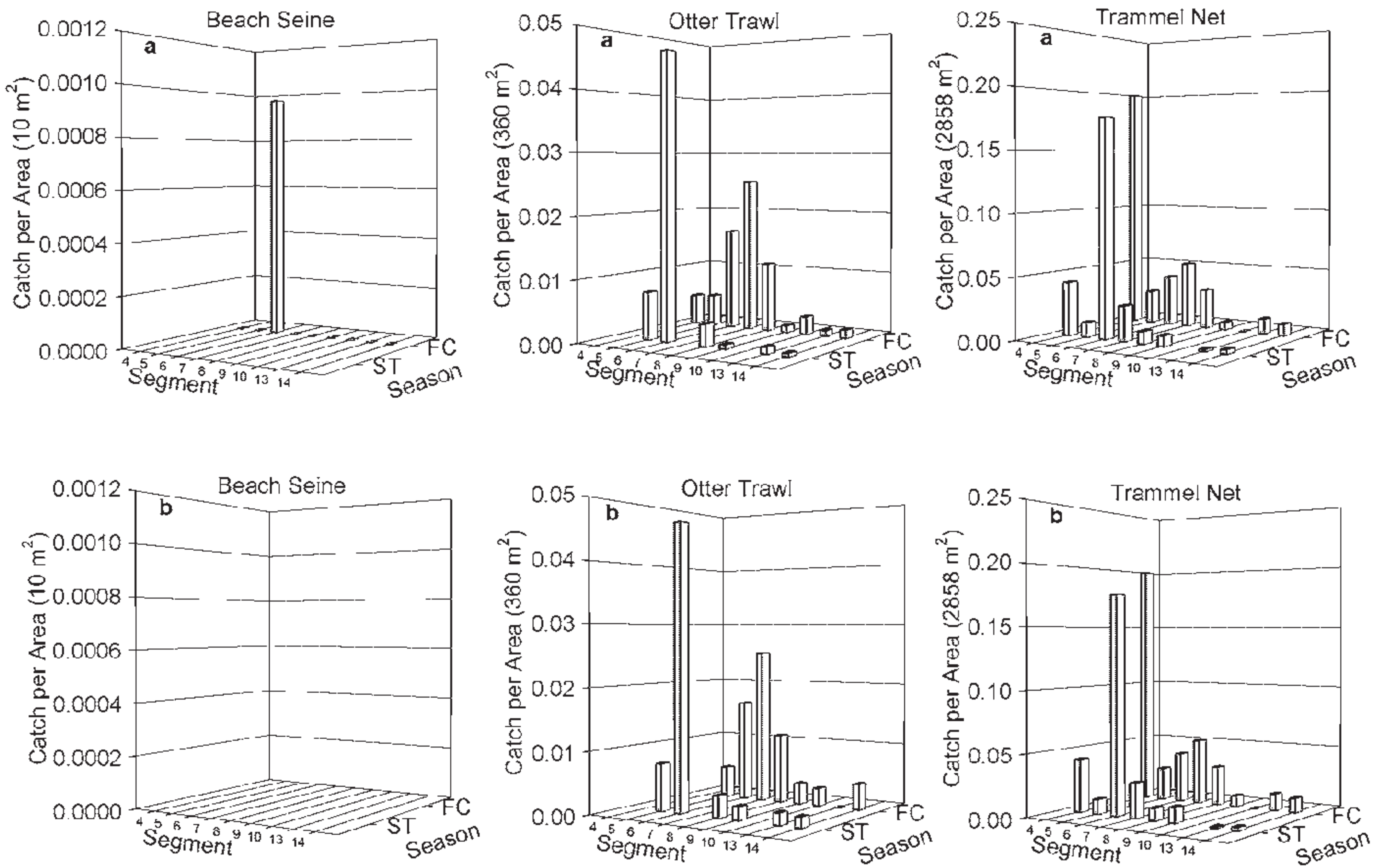

Figure 11. Sauger-adult catch per unit for active gears before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

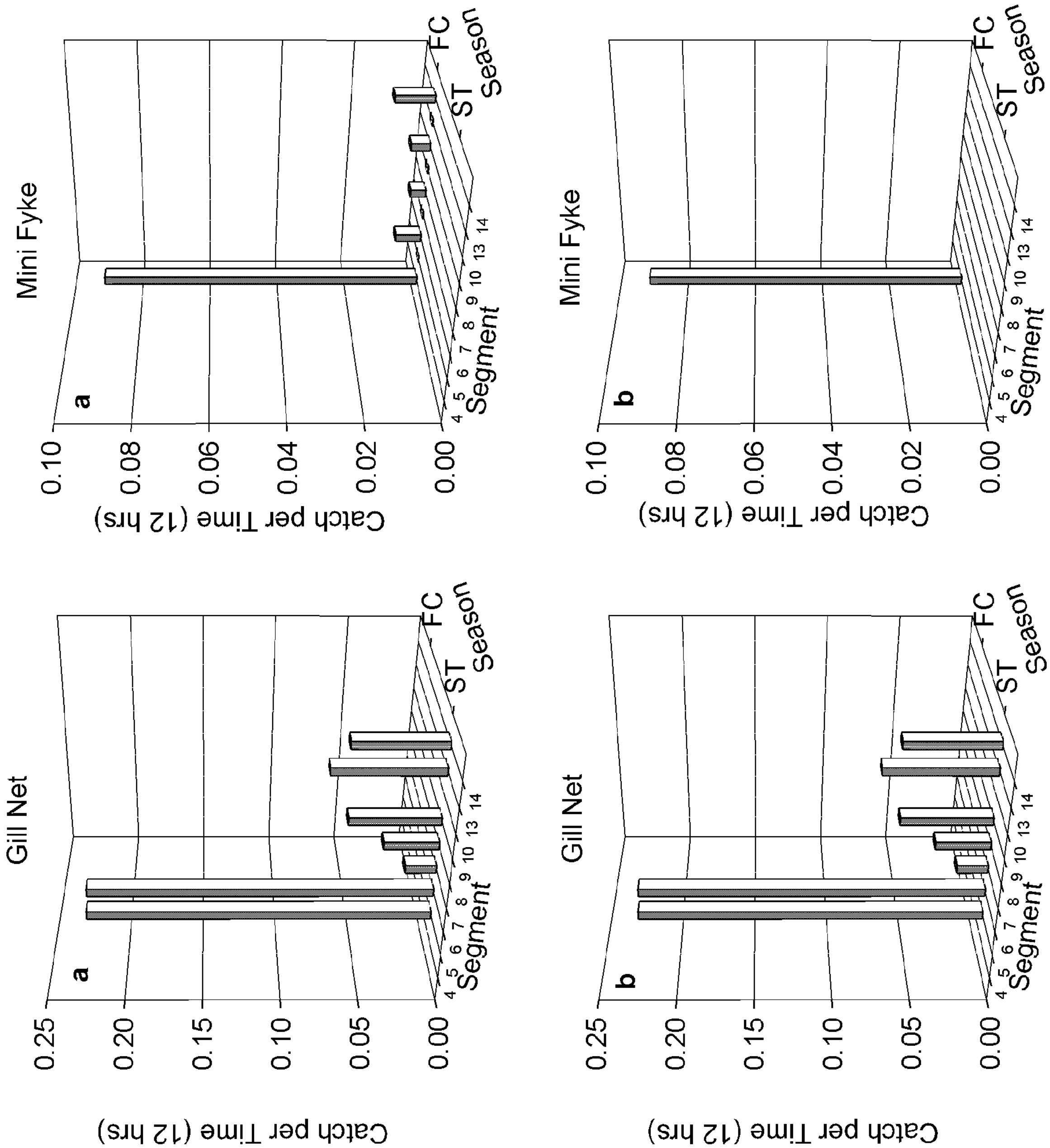

Figure 12. Sauger-adult catch per unit for passive gears before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

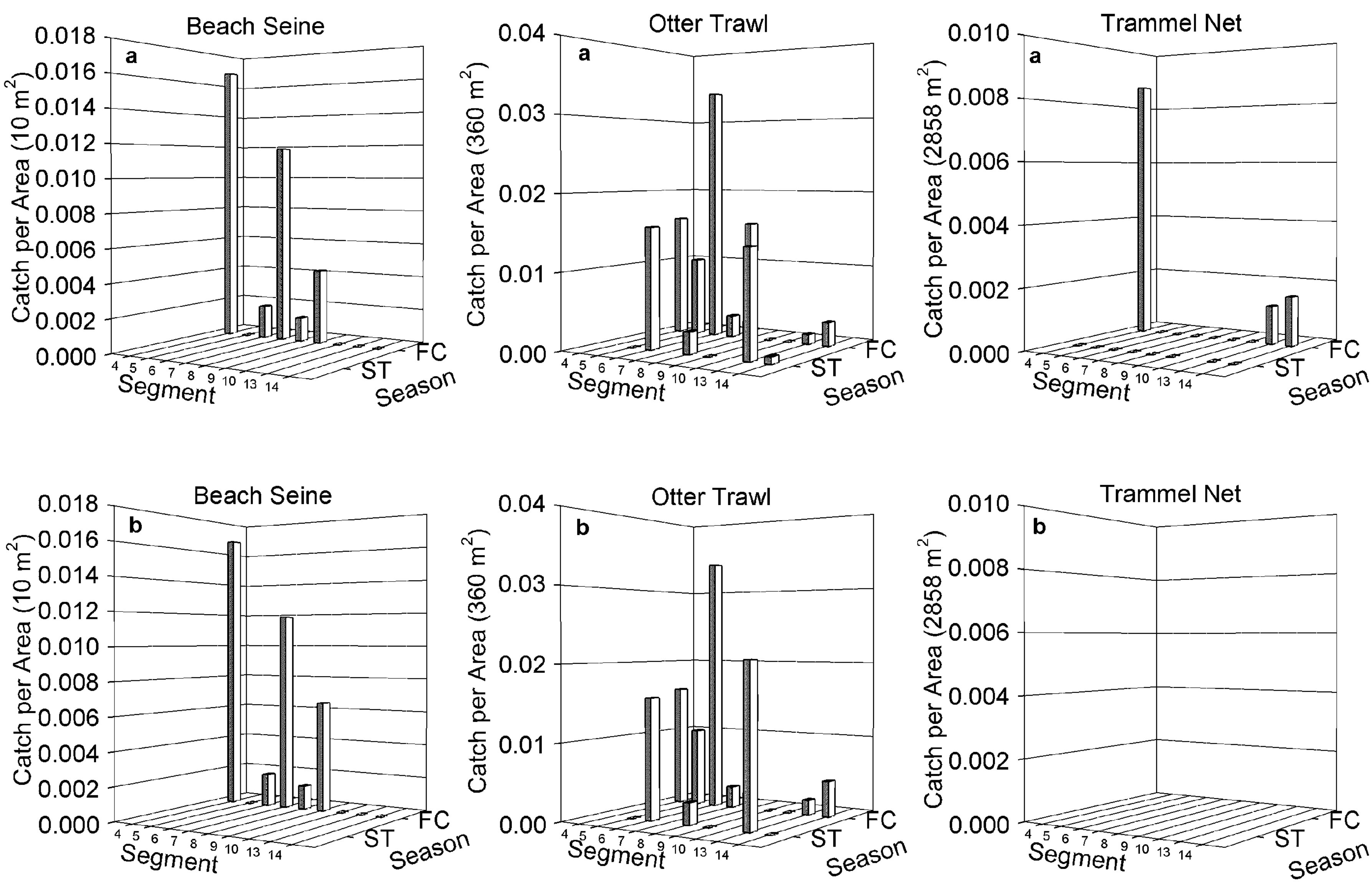

Figure 13. Sauger-juvenile catch per unit for the active gears before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

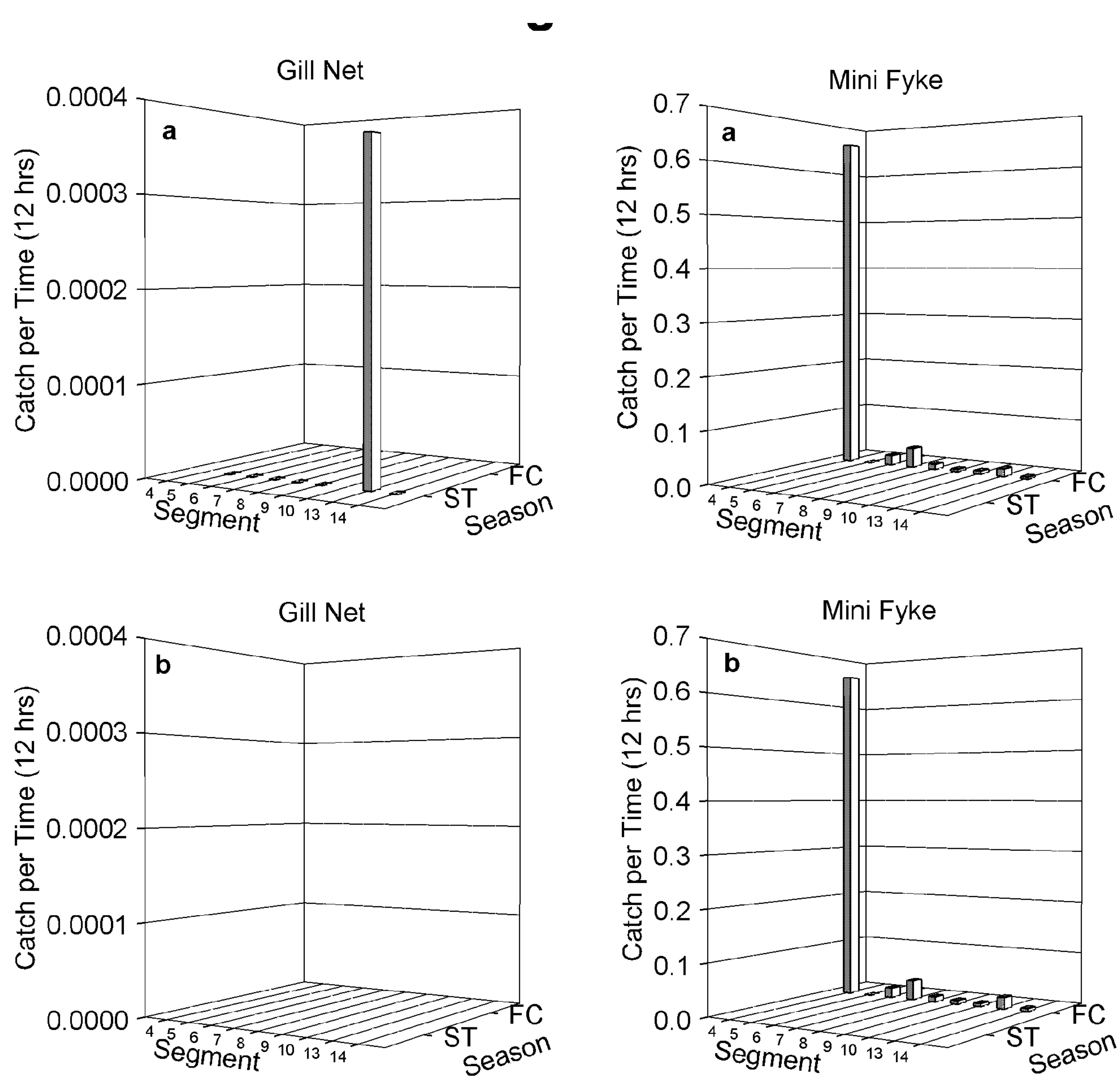

Figure 14. Sauger- juvenile catch per unit for the passive gears before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

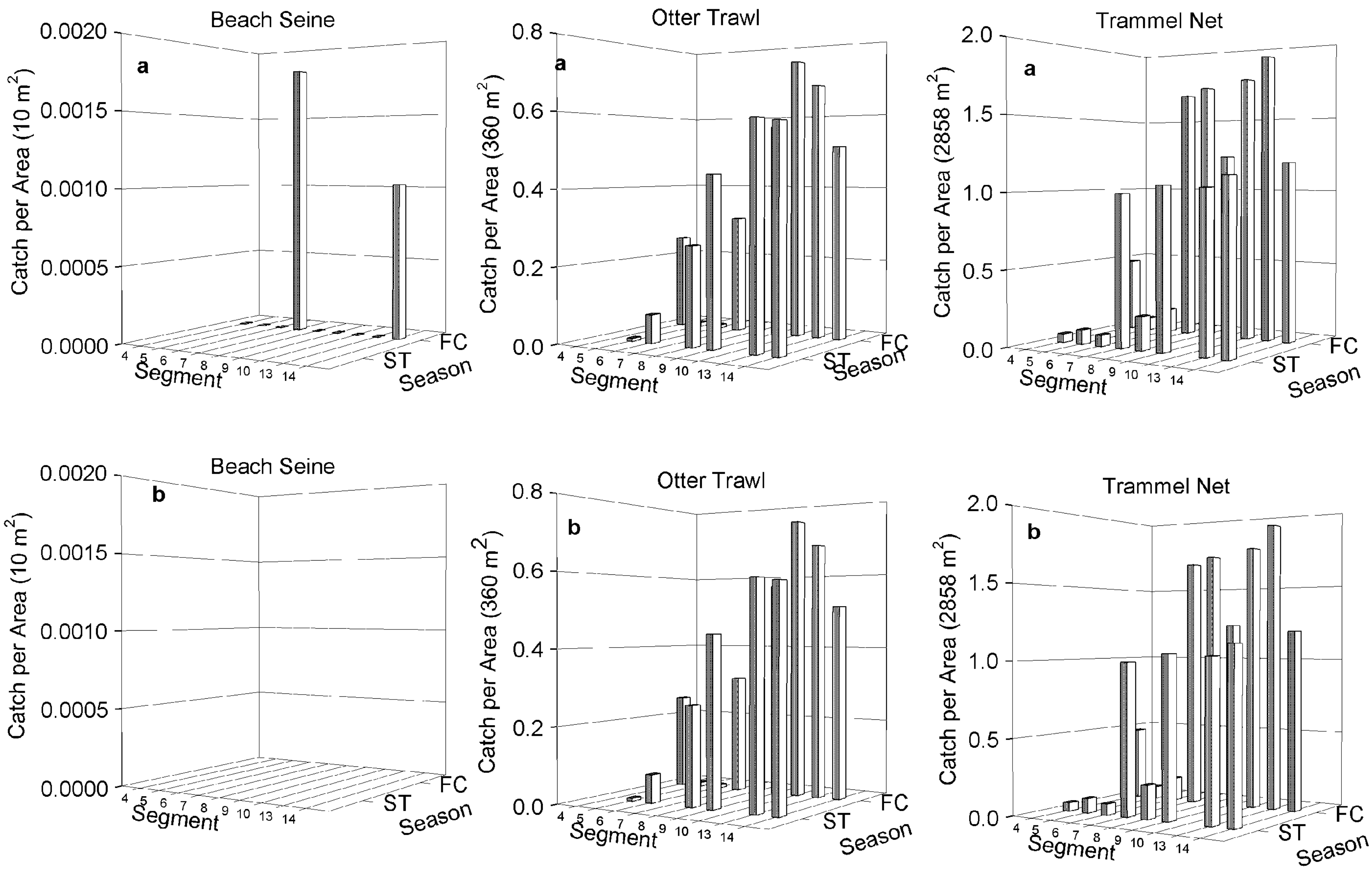

Figure 15. Shovelnose sturgeon-all catch per unit for active gears before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

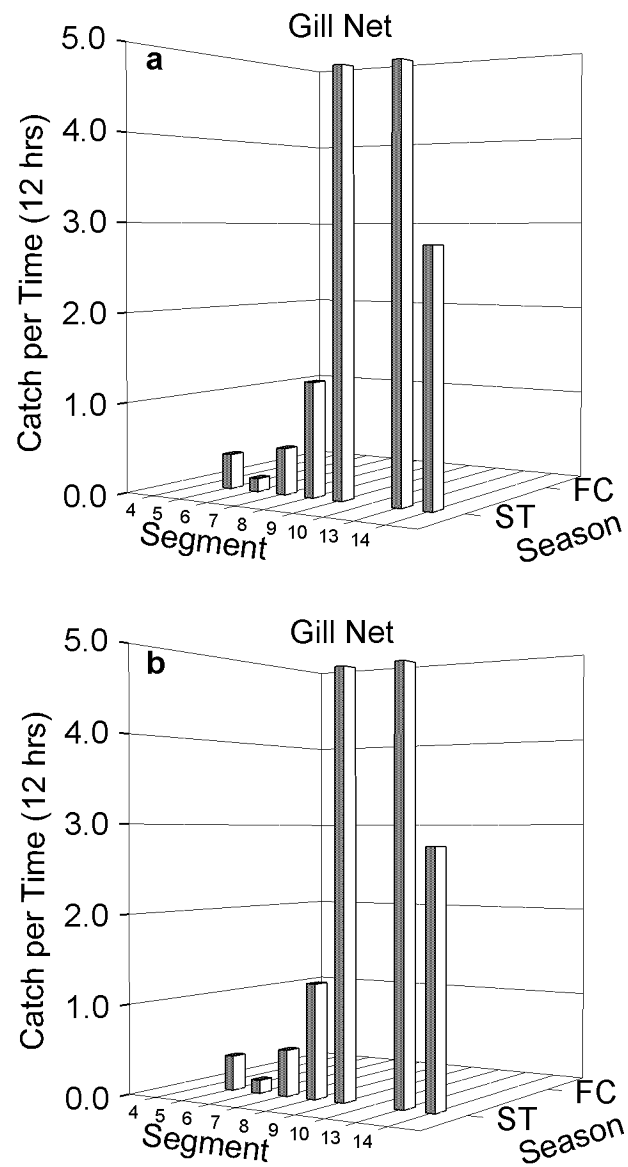

Figure 16. Shovelnose sturgeon-all catch per unit for passive gears before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

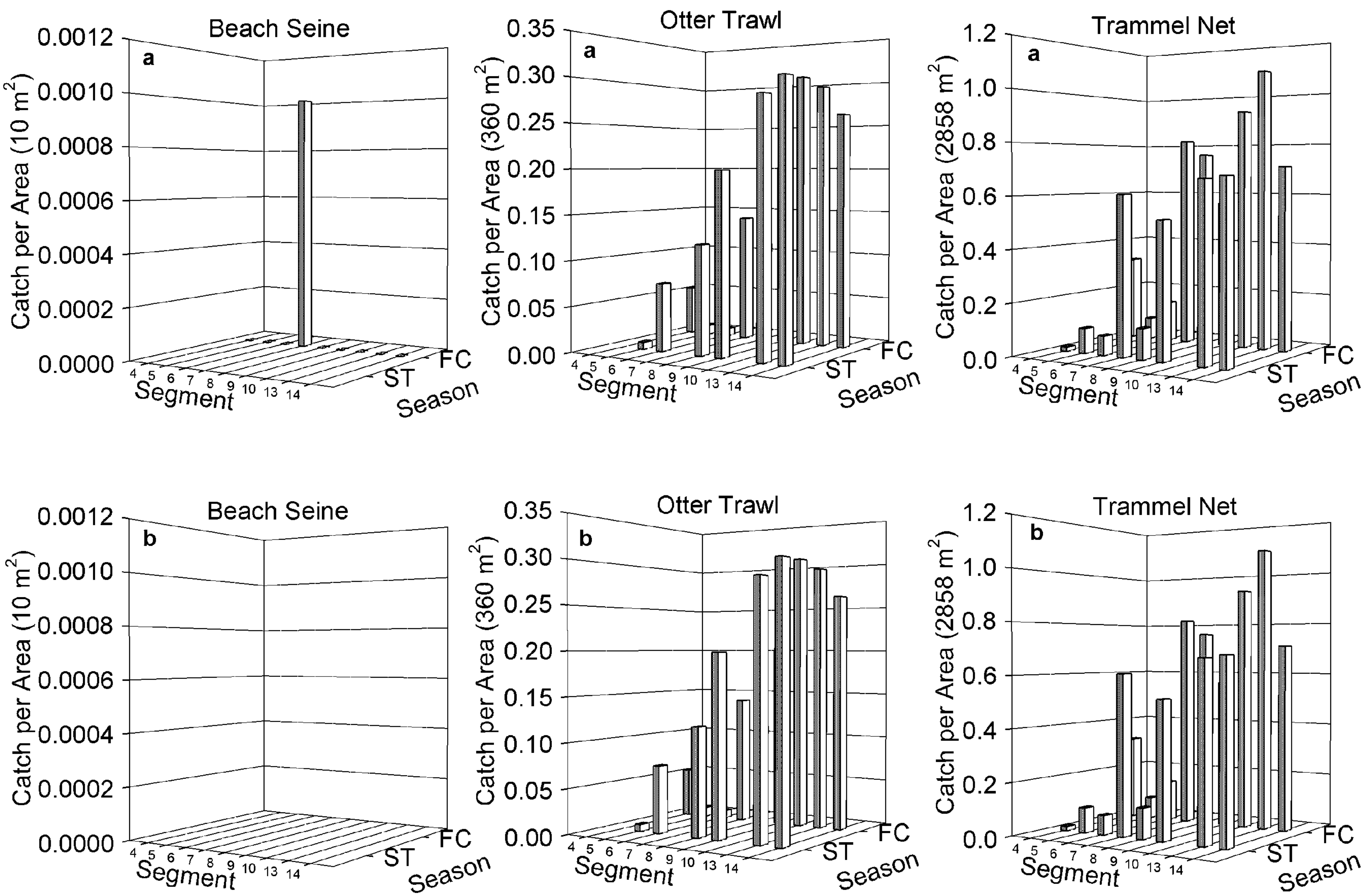

Figure 17. Shovelnose sturgeon-adult catch per unit for active gears before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

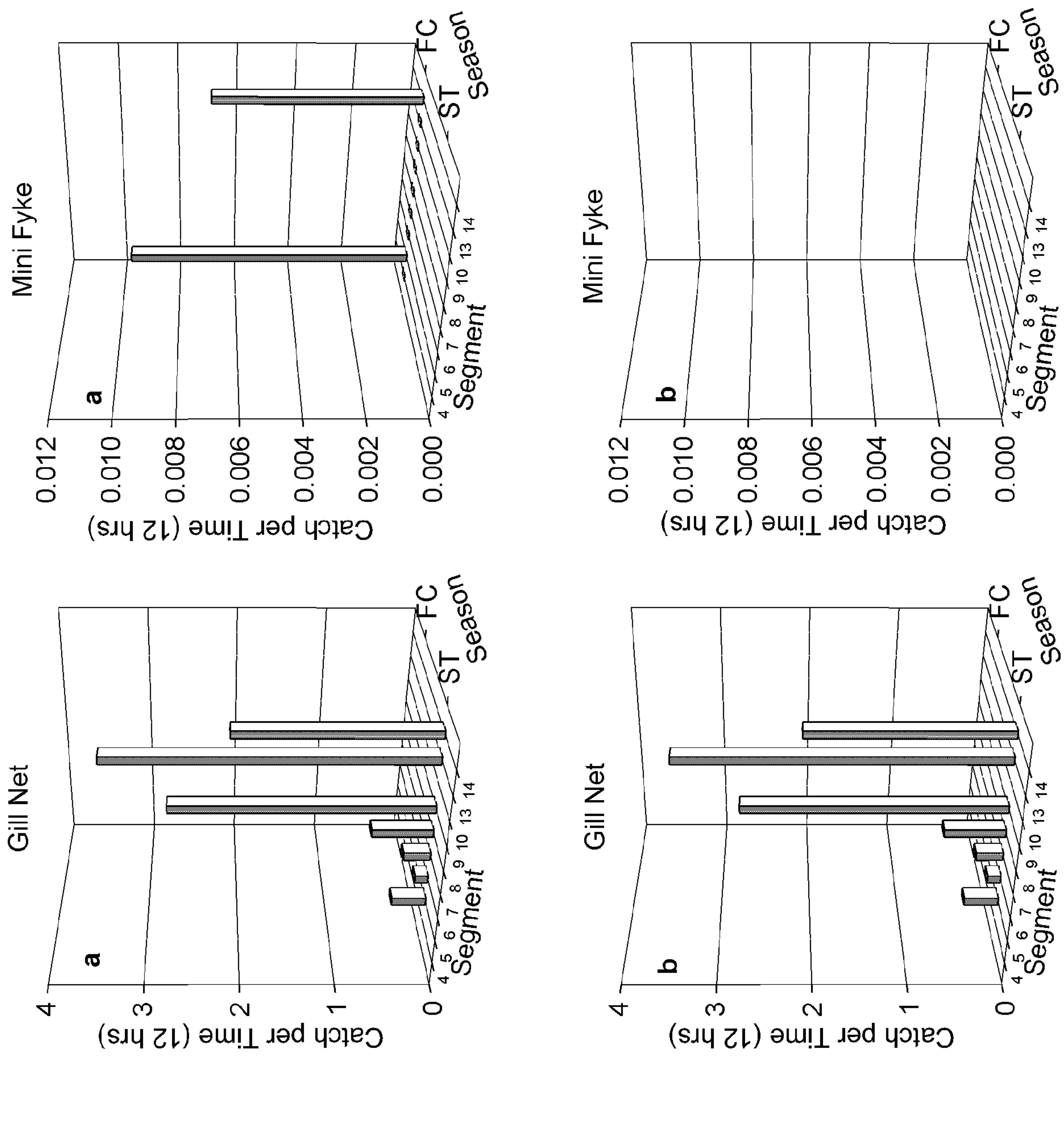

Figure 18. Shovelnose sturgeon-adult catch per unit for passive gears before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

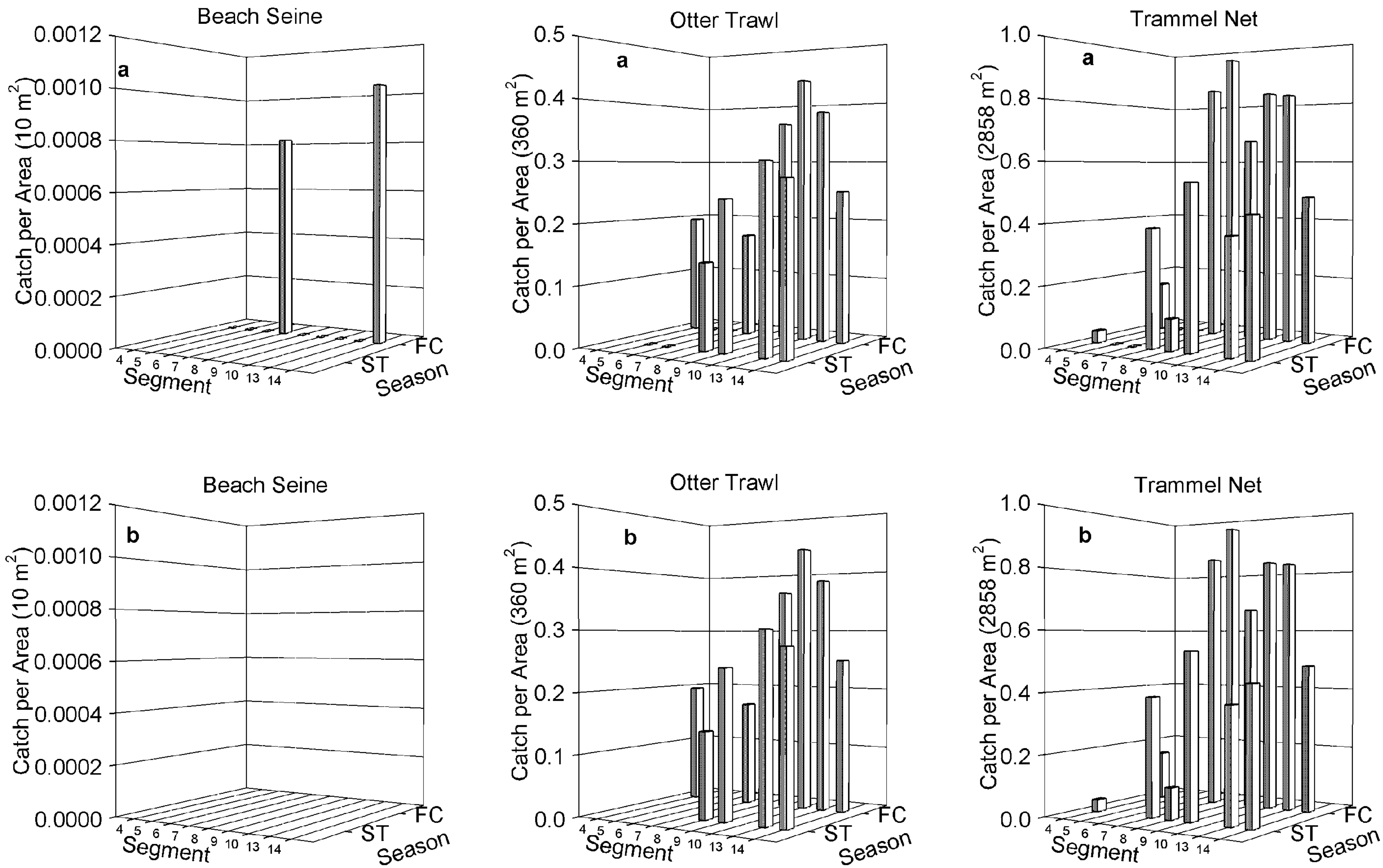

Figure 19. .Shovelnose sturgeon-juvenile catch per unit for active gears before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

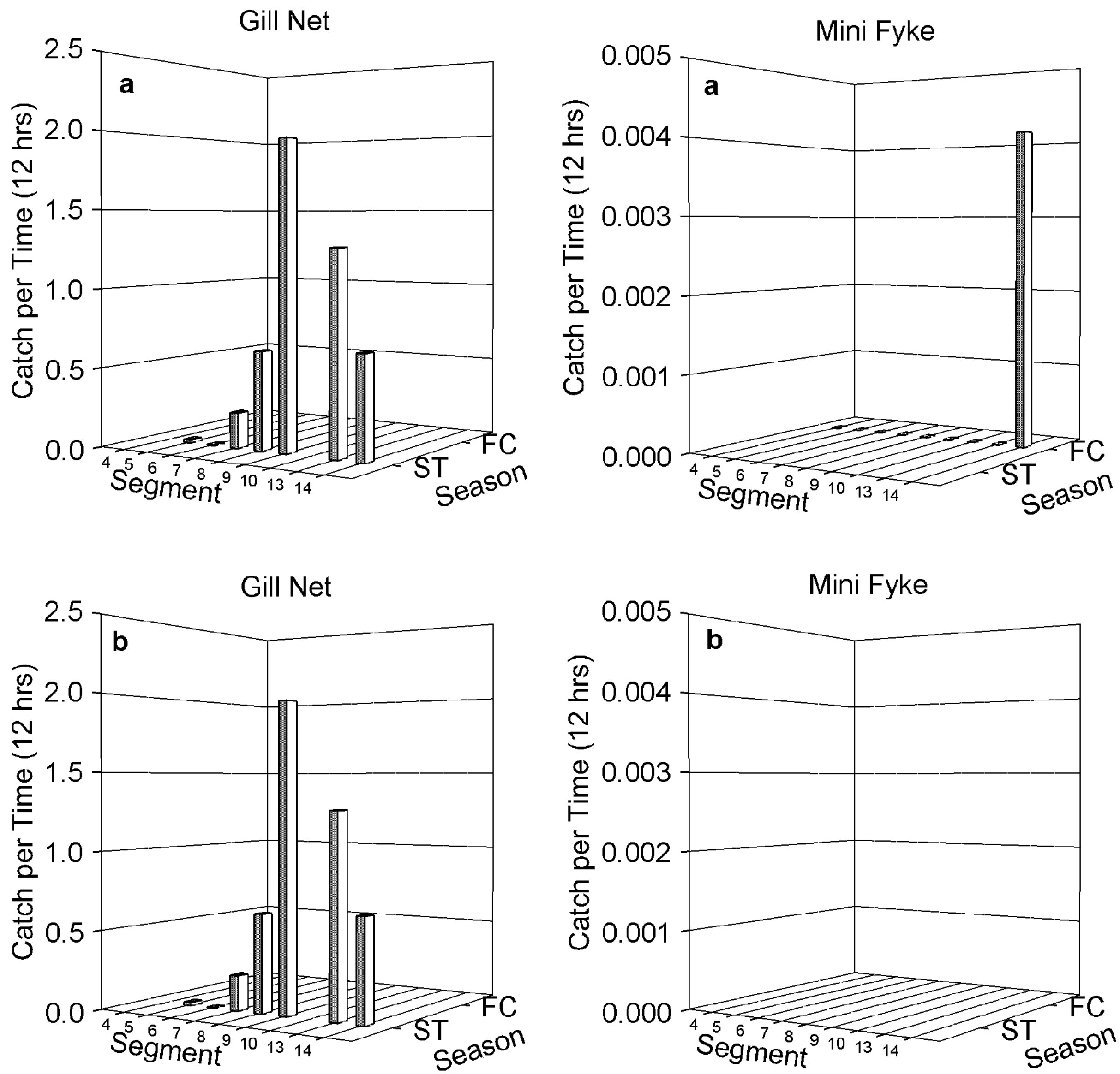

Figure 20. Shovelnose sturgeon-juvenile catch per unit for passive gears before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

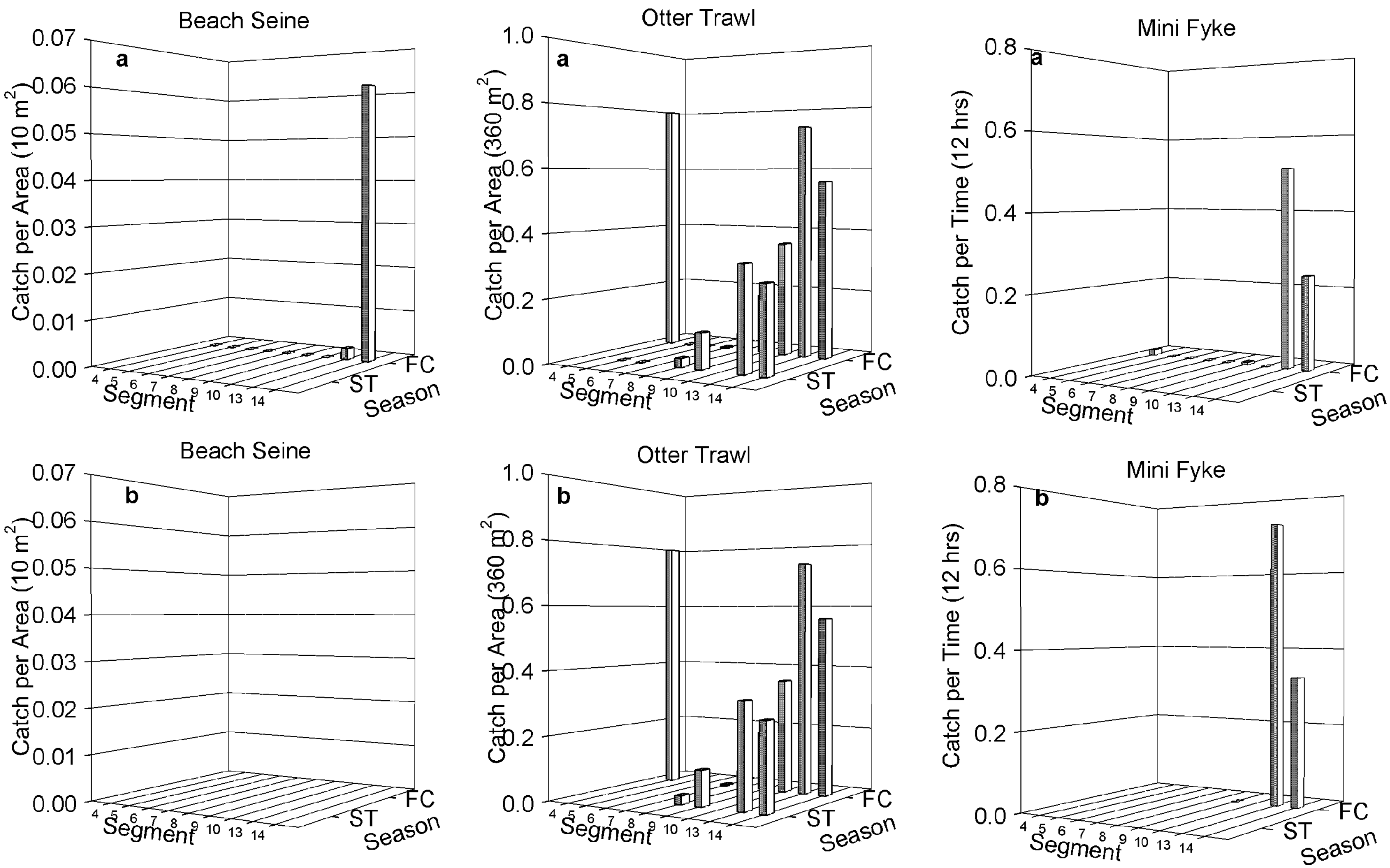

Figure 21. Sicklefin chub-all catch per unit before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

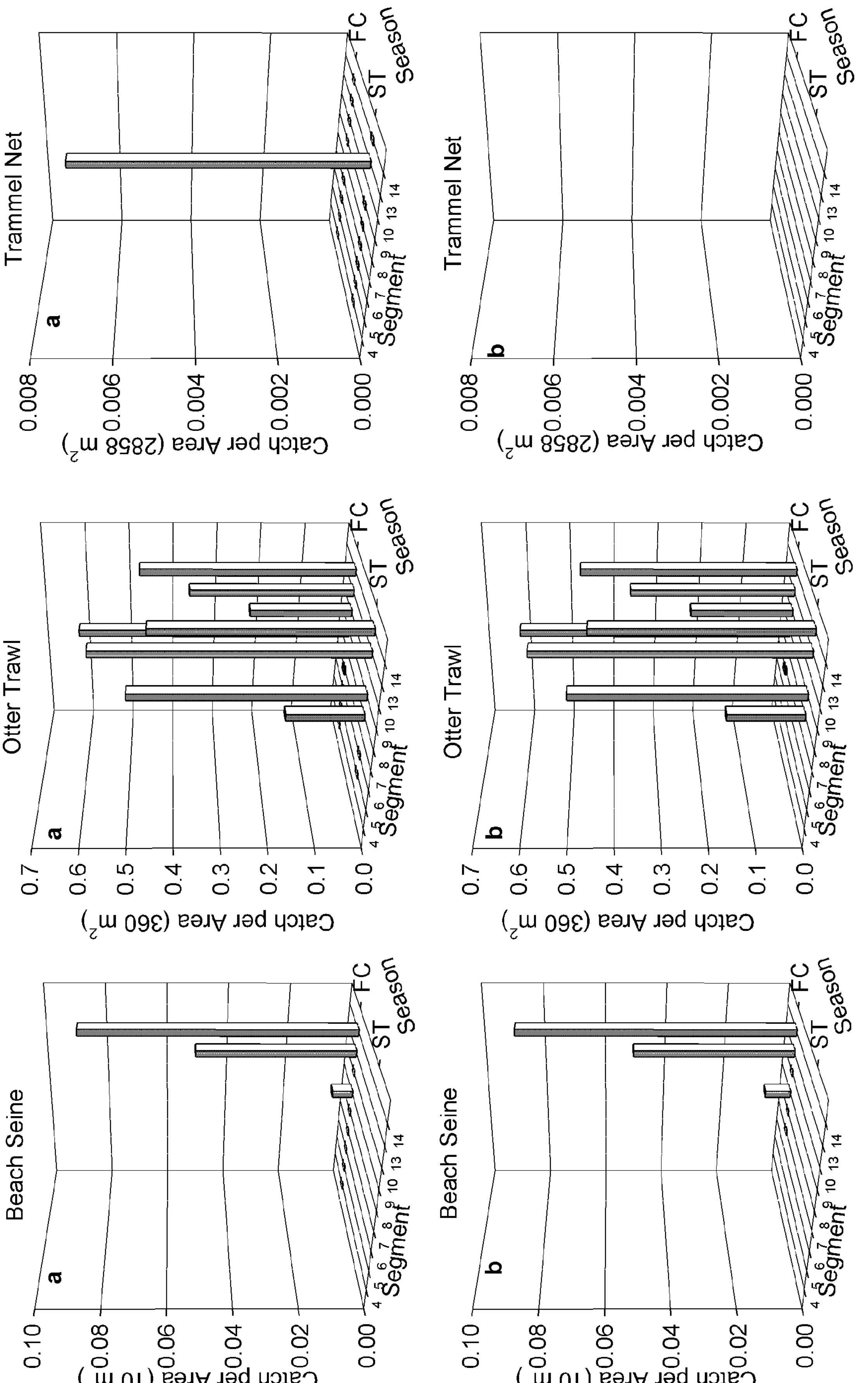

Figure 22. Speckled chub-all catch per unit for active gears before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

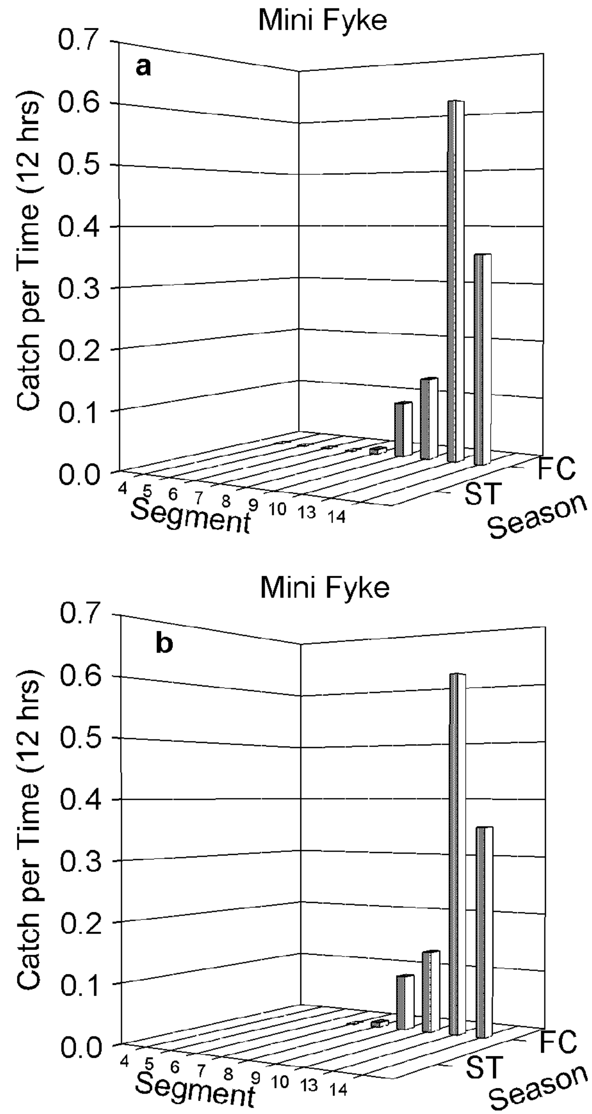

Figure 23. Speckled chub-all catch per unit for passive gear before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

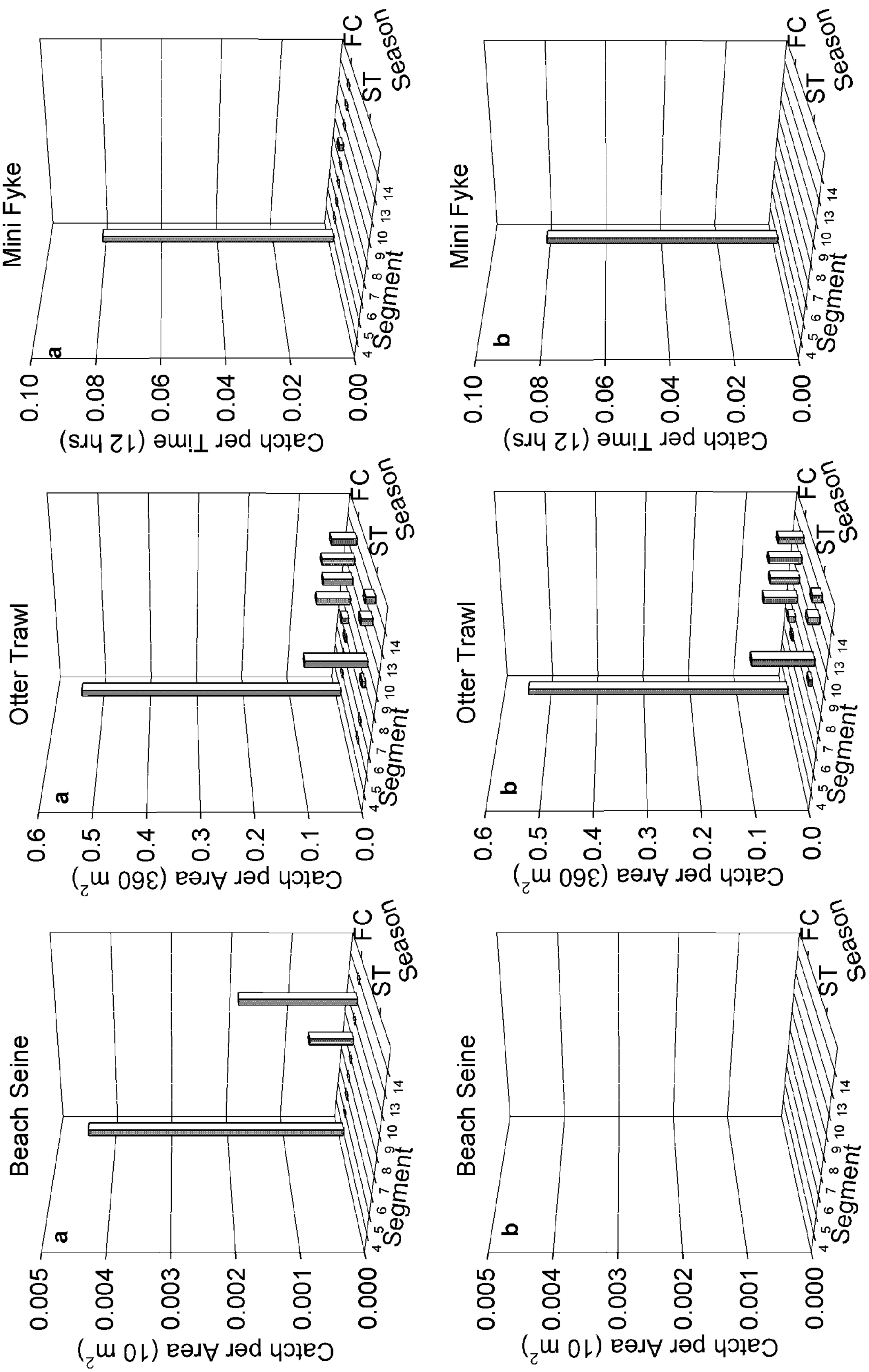

Figure 24. Sturgeon chub-all catch per unit before (a) and after (b) data were removed because of criteria (defined in methods). A 'ST' stands for sturgeon season and 'FC' stands for fish community season.

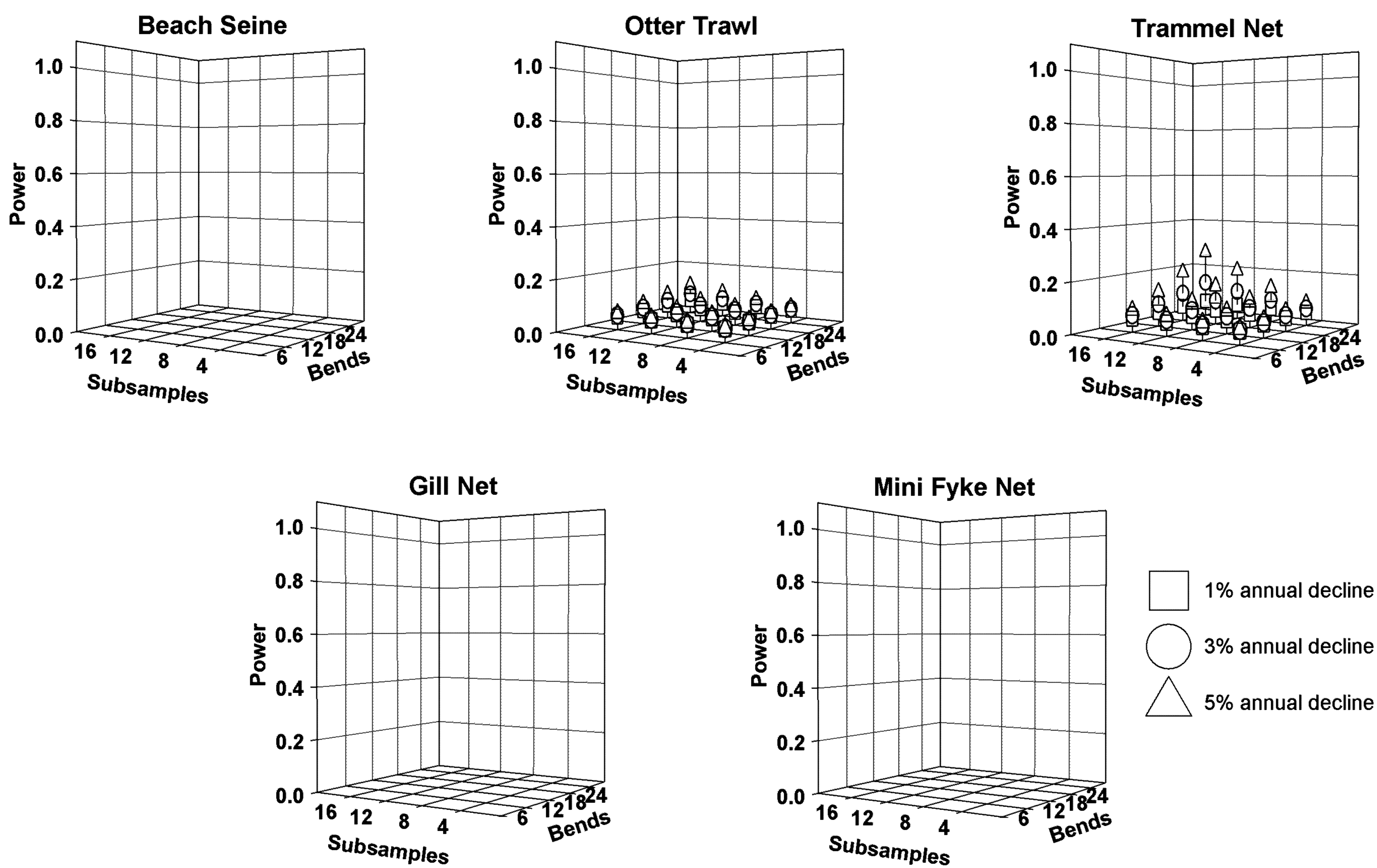

Figure 25. Twenty-year power curves for blue sucker-all from Zone 1 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

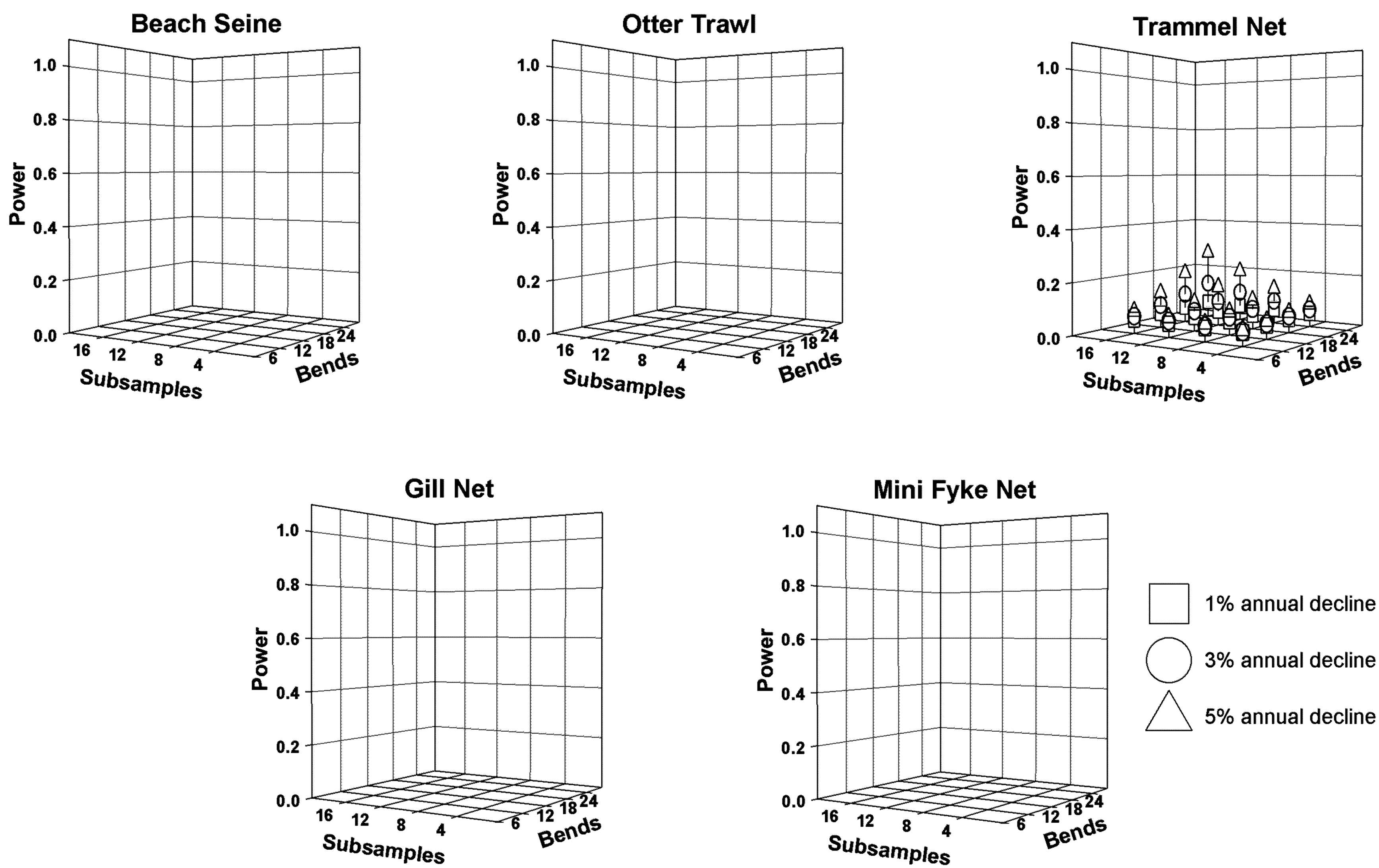

Figure 26. Twenty-year power curves for blue sucker-adult from Zone 1 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

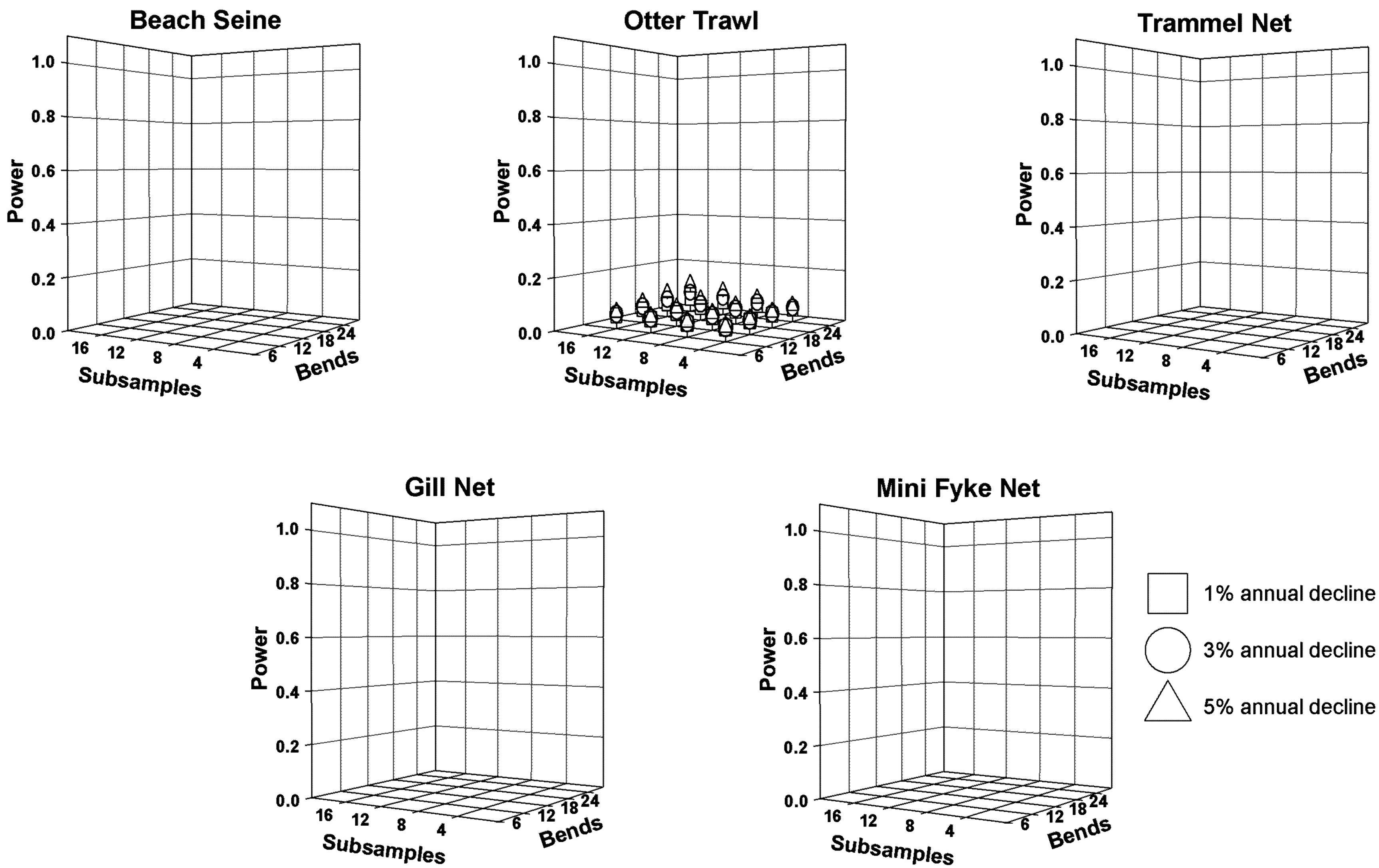

Figure 27. Twenty-year power curves for blue sucker-juvenile from Zone 1 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

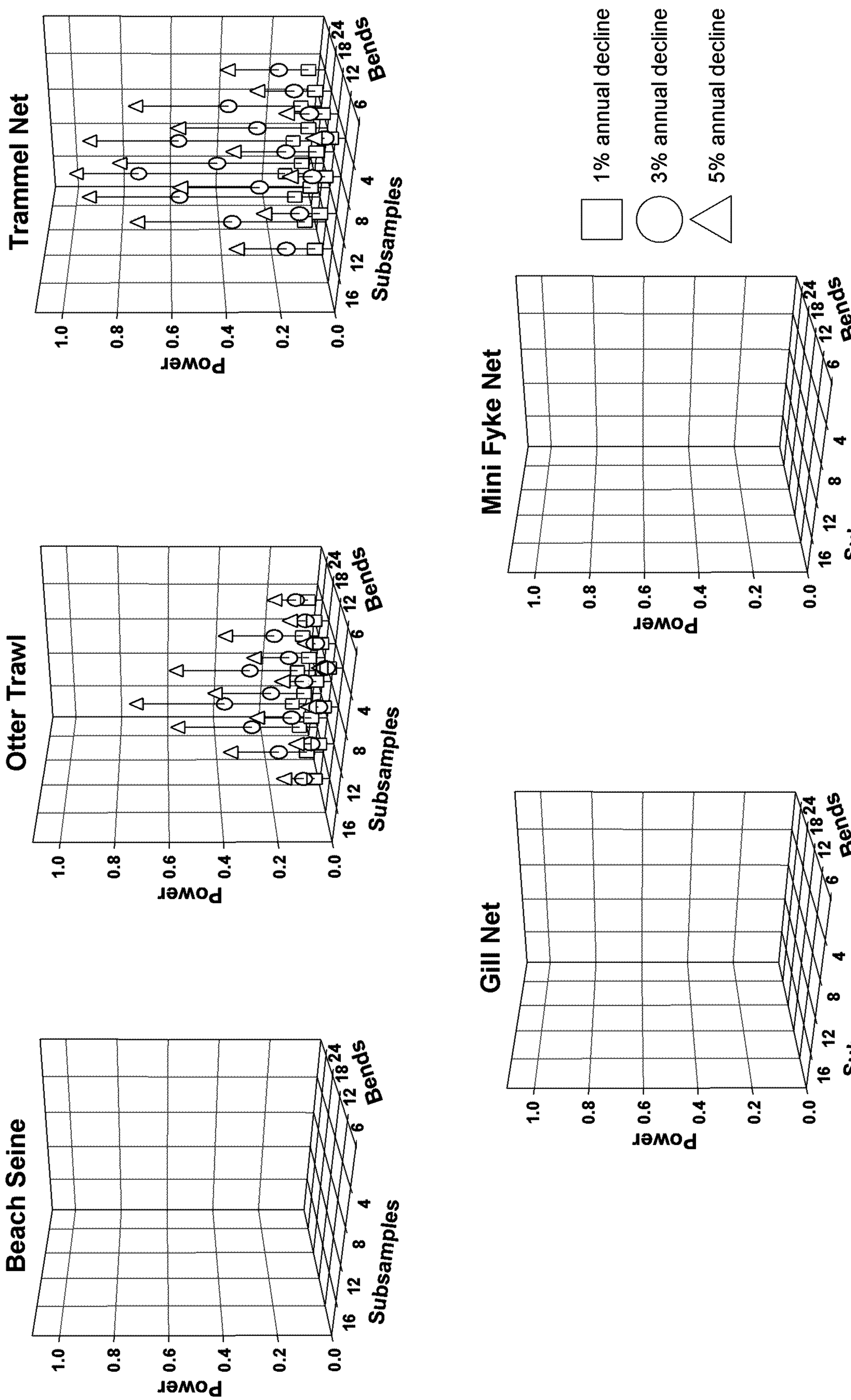

Figure 28. Twenty-year power curves for pallid sturgeon-all from Zone 1 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

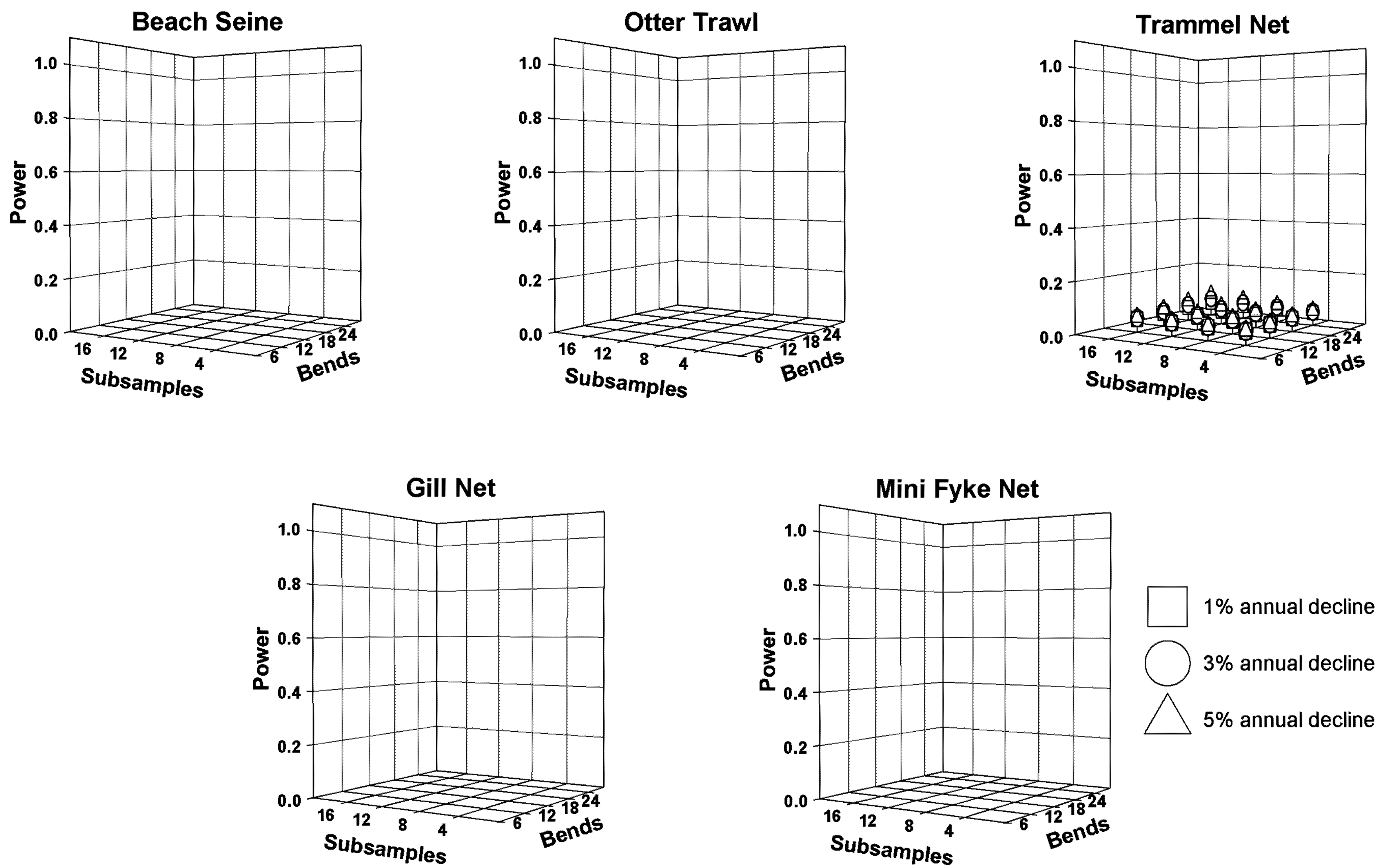

Figure 29. Twenty-year power curves for pallid sturgeon-adult from Zone 1 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

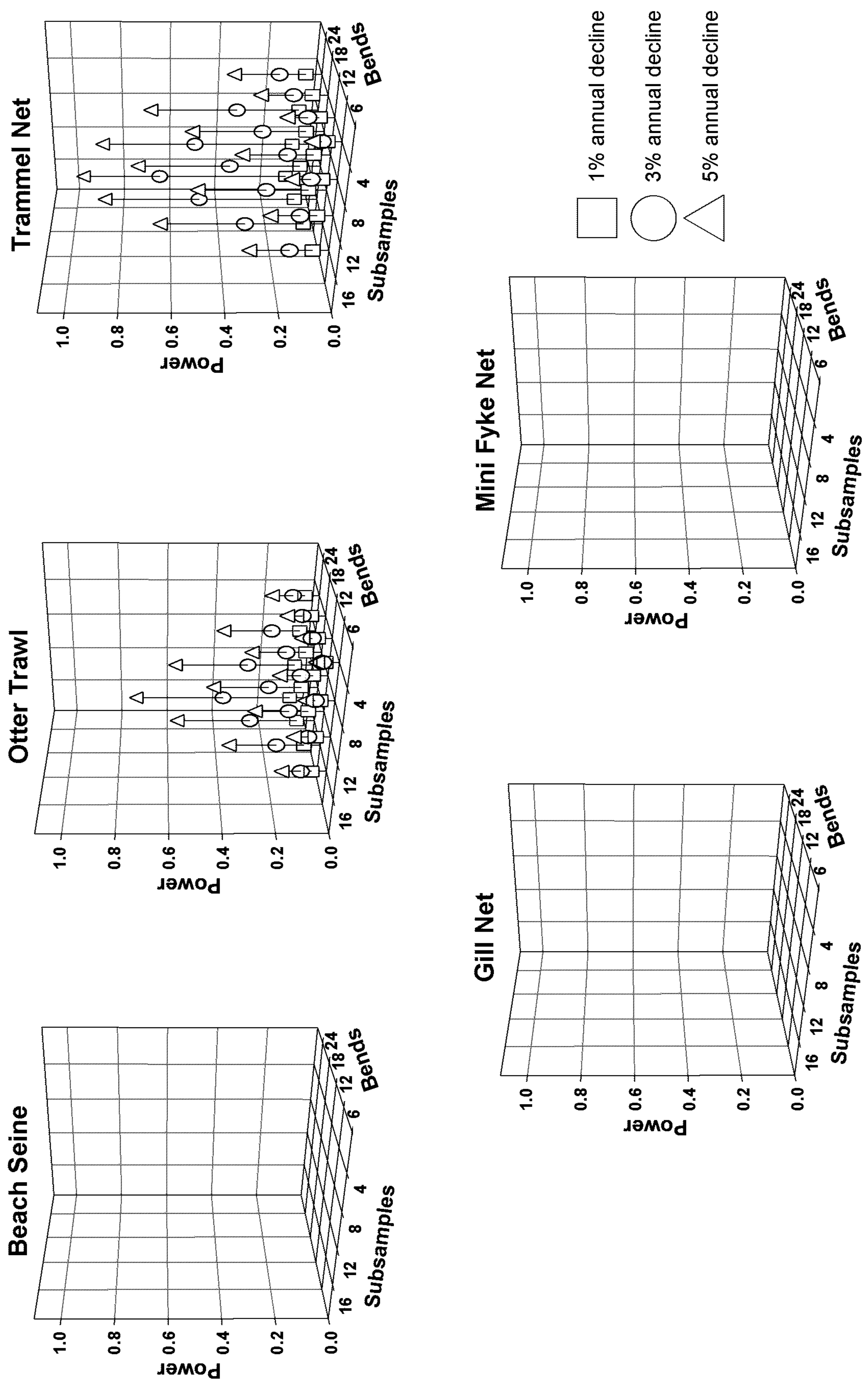

Figure 30. Twenty-year power curves for pallid sturgeon-juvenile from Zone 1 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

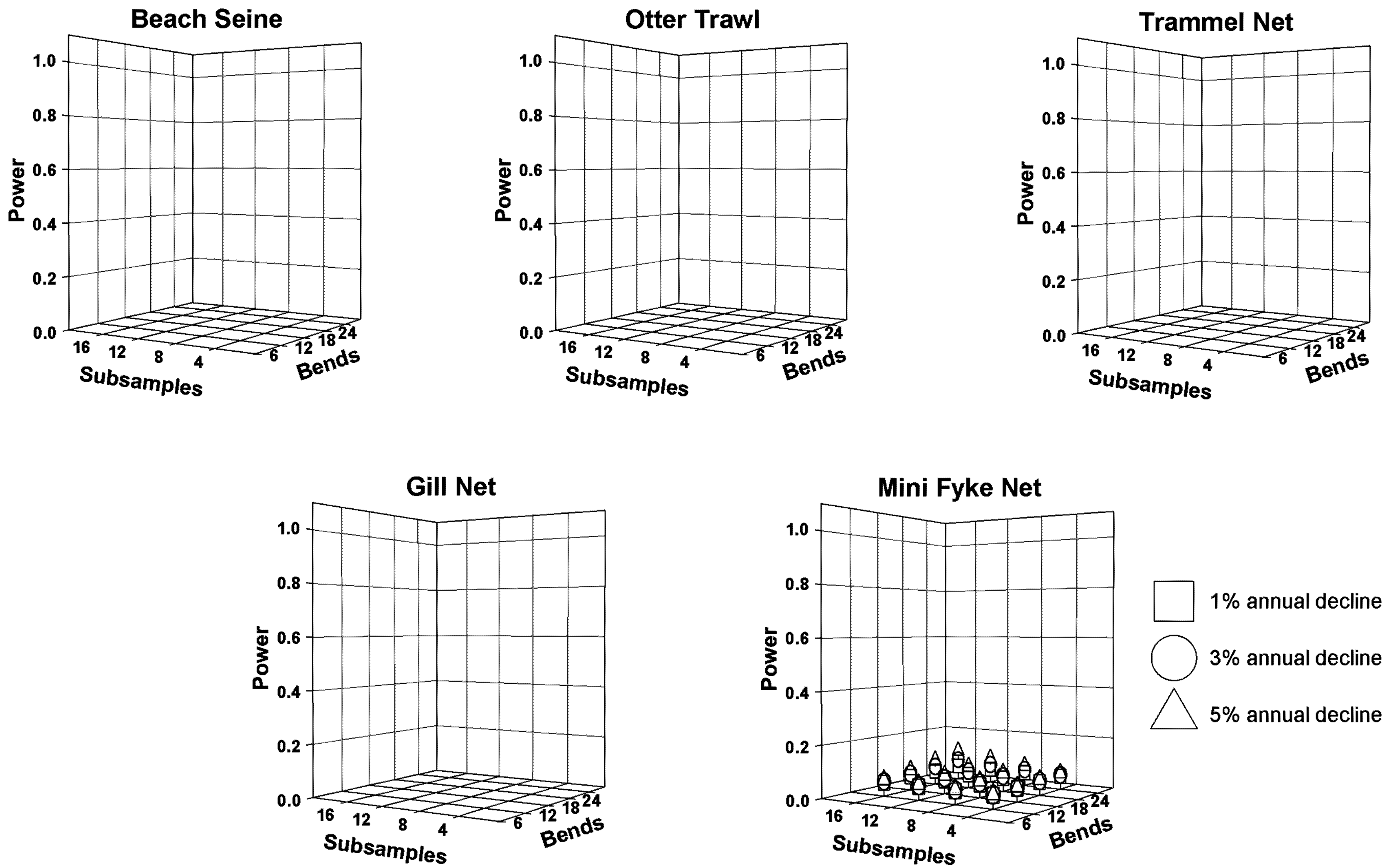

Figure 31. Twenty-year power curves for sand shiner-all from Zone 1 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

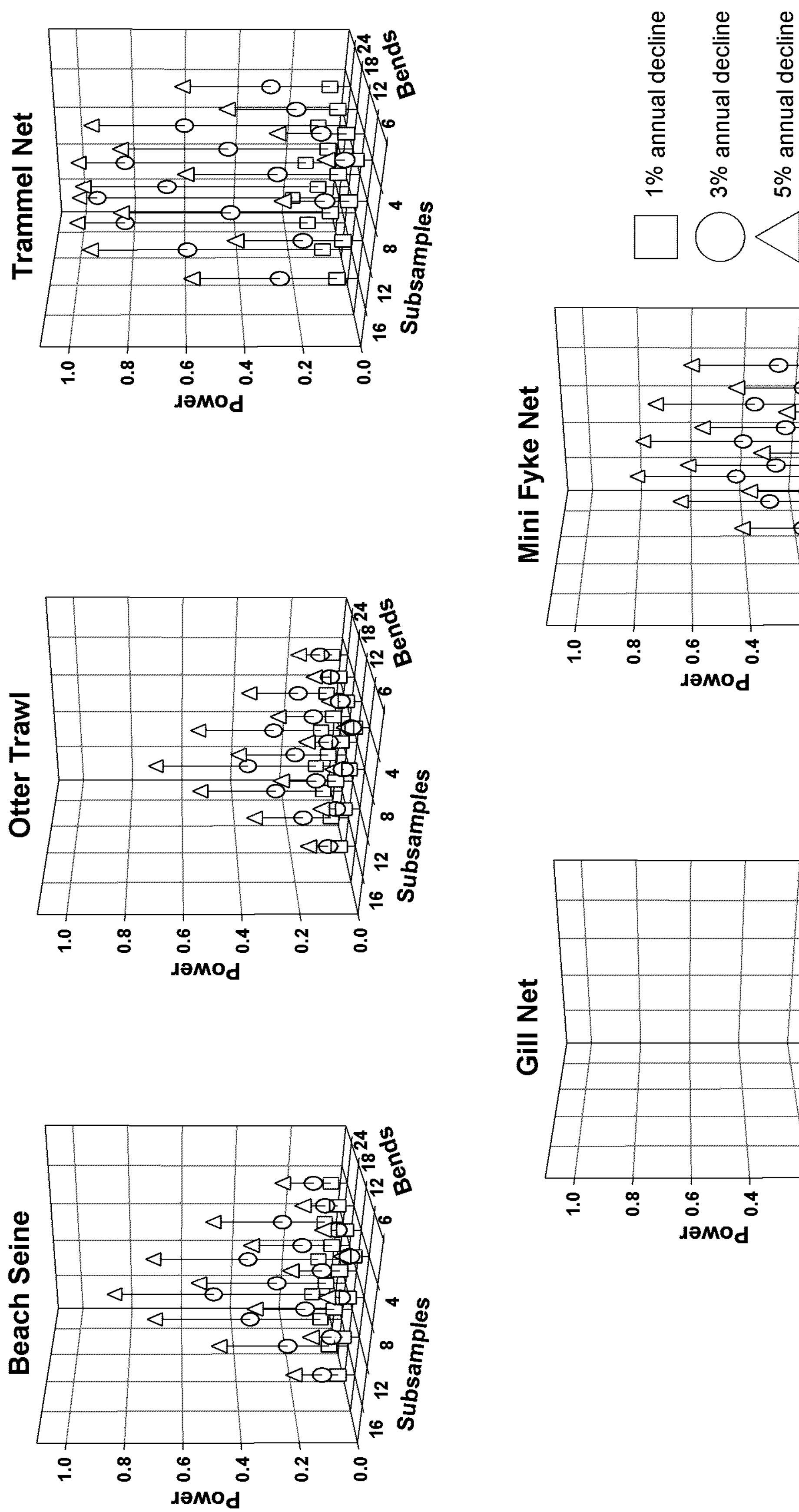

Figure 32. Twenty-year power curves for sauger-all from Zone 1 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

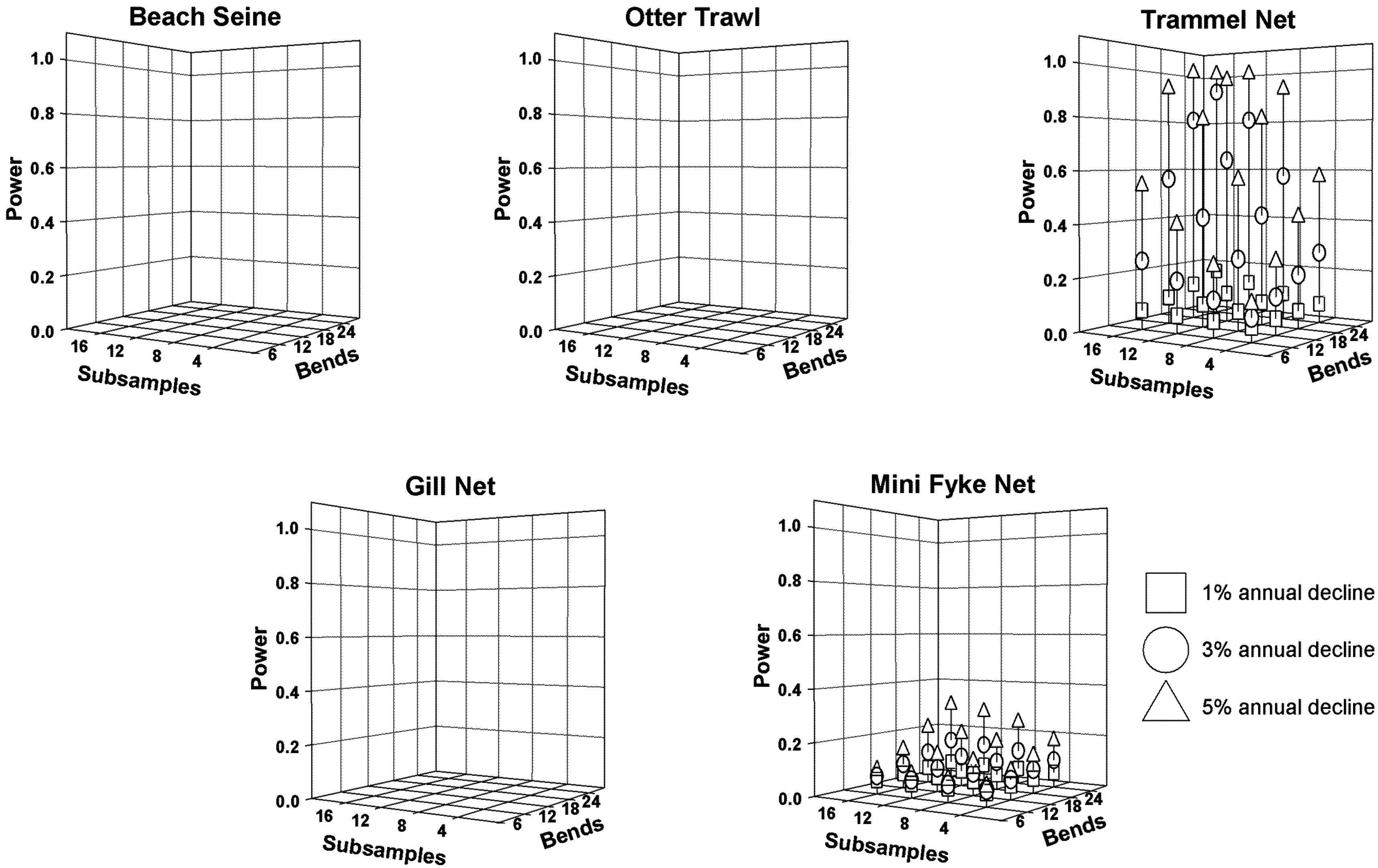

Figure 33. Twenty-year power curves for sauger-adult from Zone 1 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

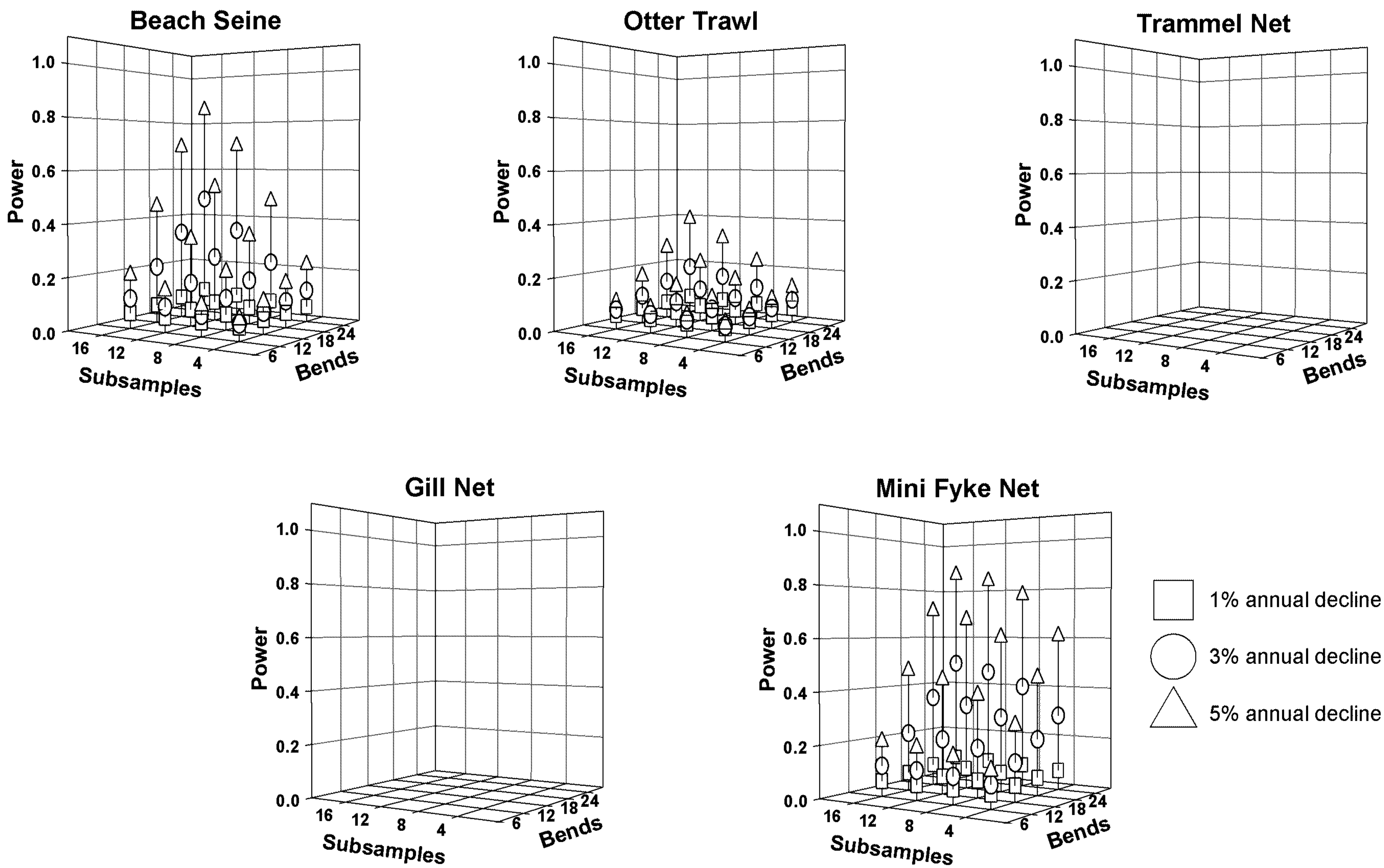

Figure 34. Twenty-year power curves for sauger-juvenile from Zone 1 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

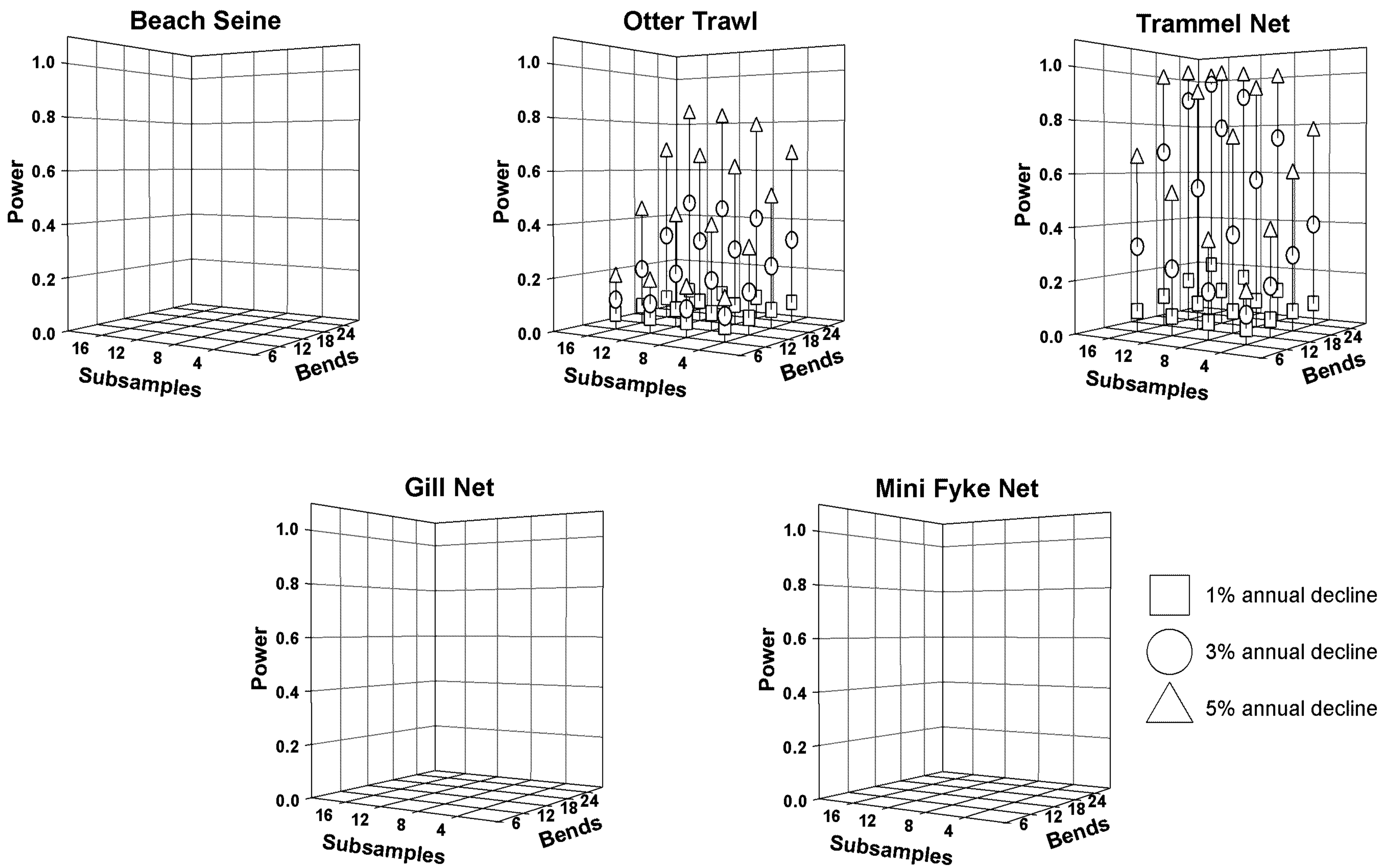

Figure 35. Twenty-year power curves for shovelnose sturgeon-all from Zone 1 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

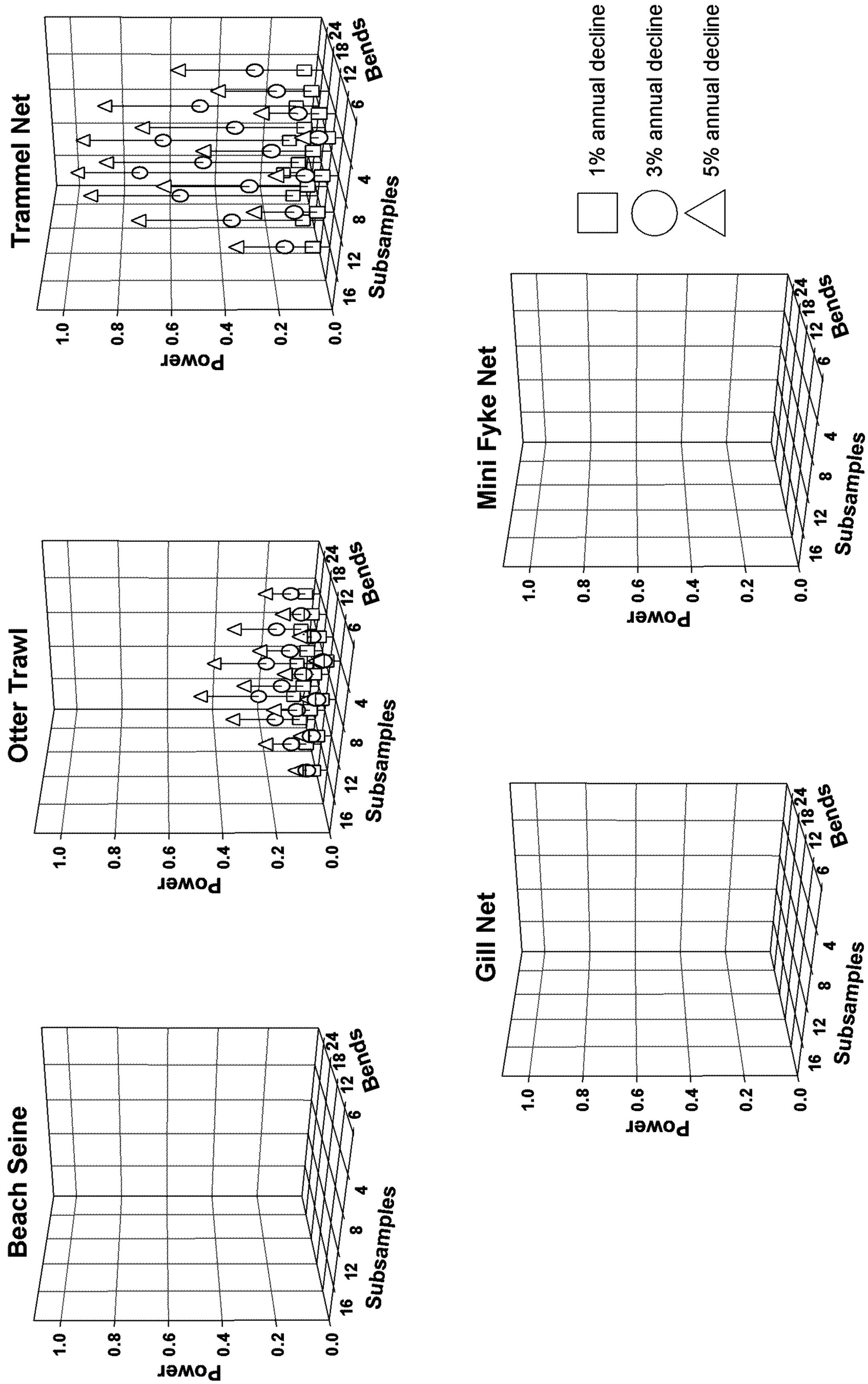

Figure 36. Twenty-year power curves for shovelnose sturgeon-adult from Zone 1 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

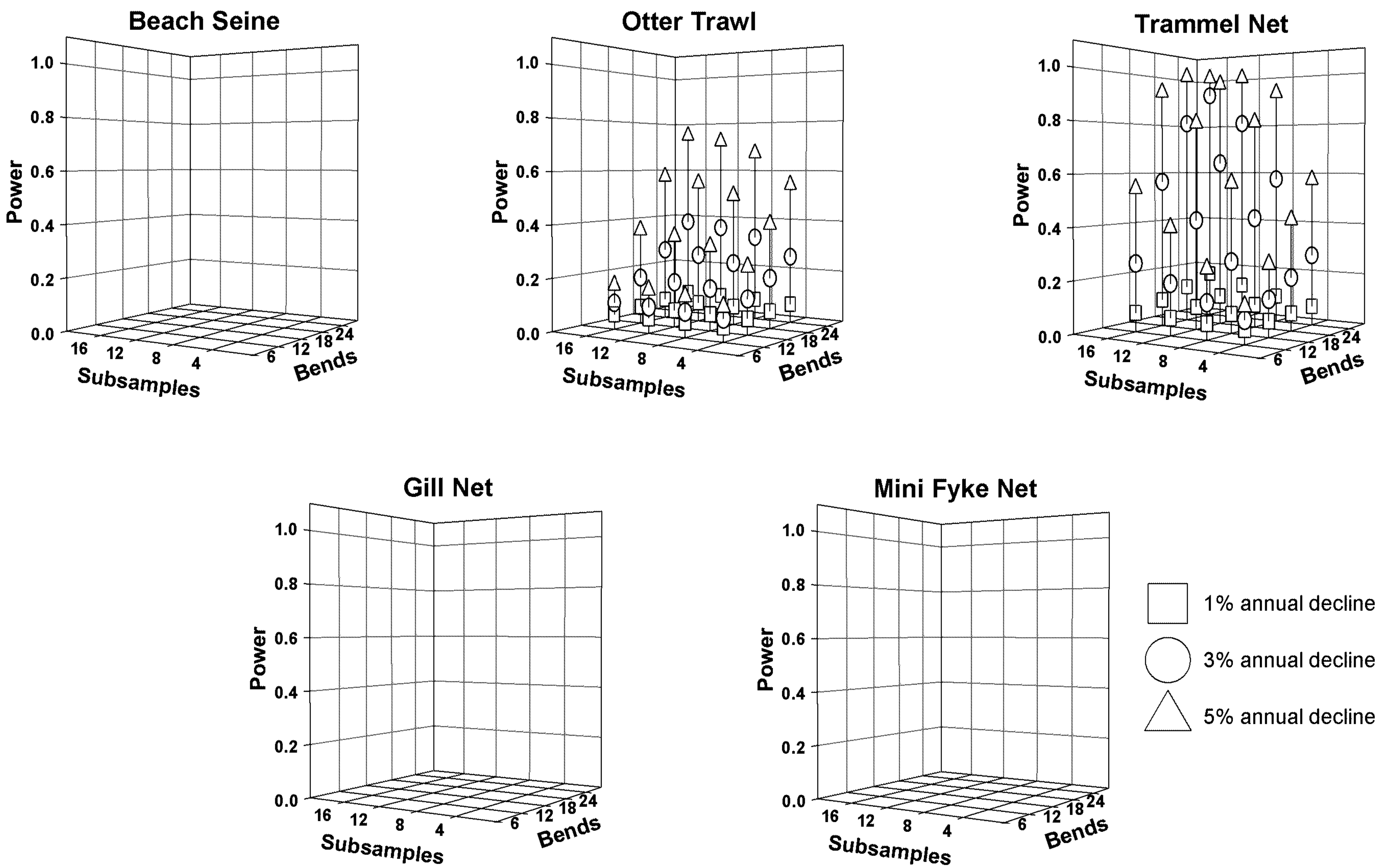

Figure 37. Twenty-year power curves for shovelnose sturgeon-juvenile from Zone 1 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

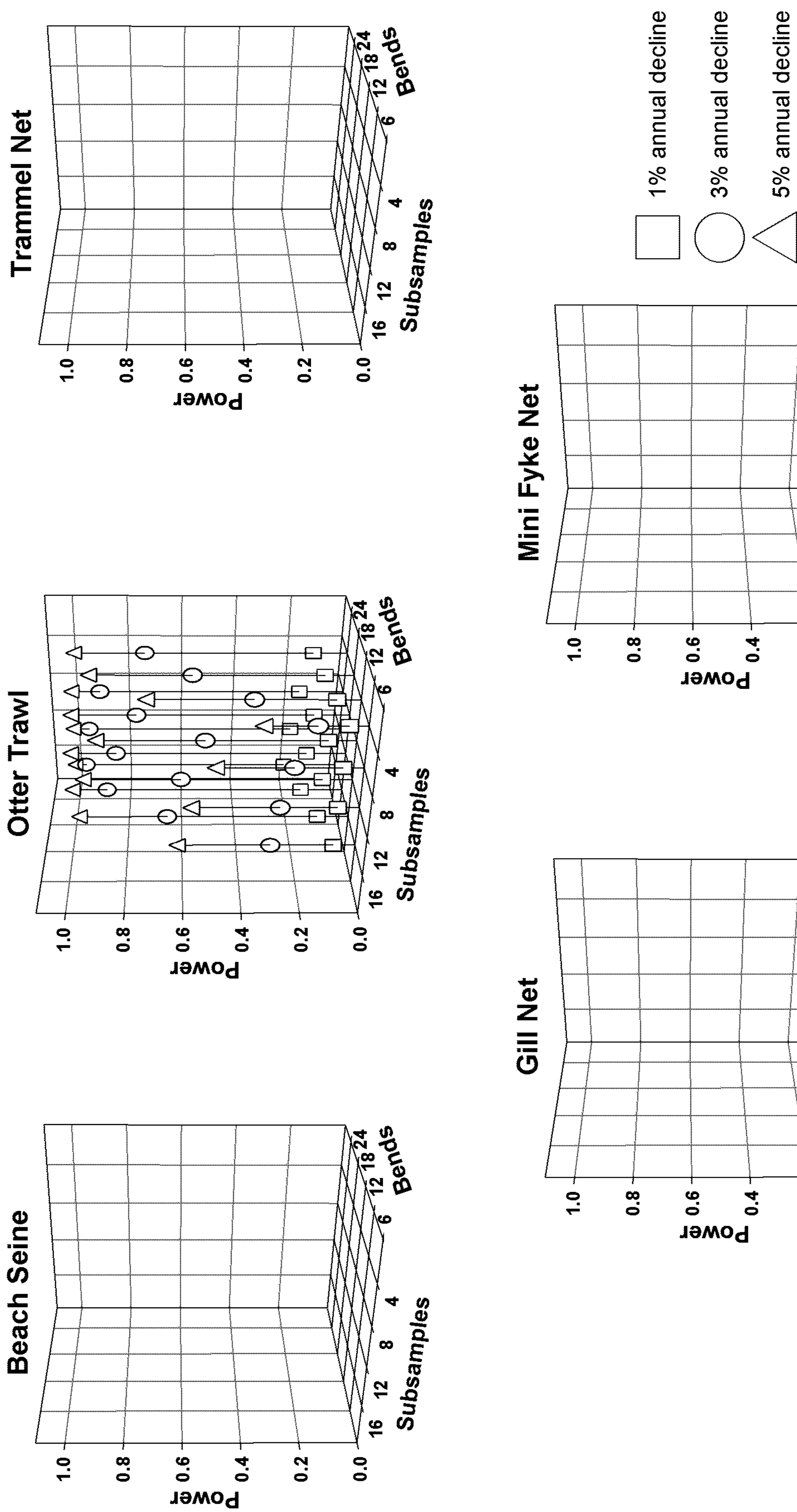

Figure 38. Twenty-year power curves for sicklefin chub-all from Zone 1 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

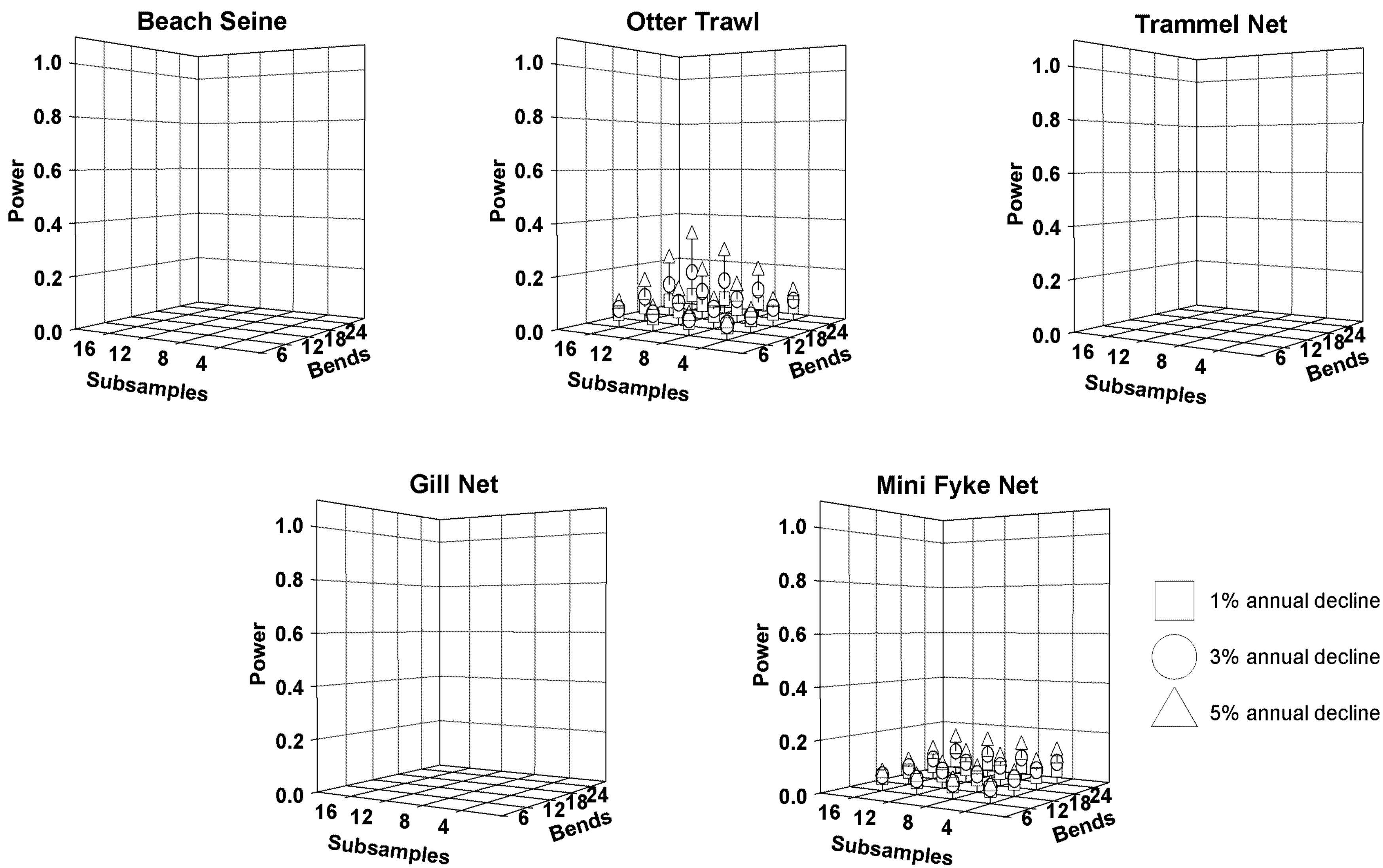

Figure 40. Twenty-year power curves for sturgeon chub-all from Zone 1 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

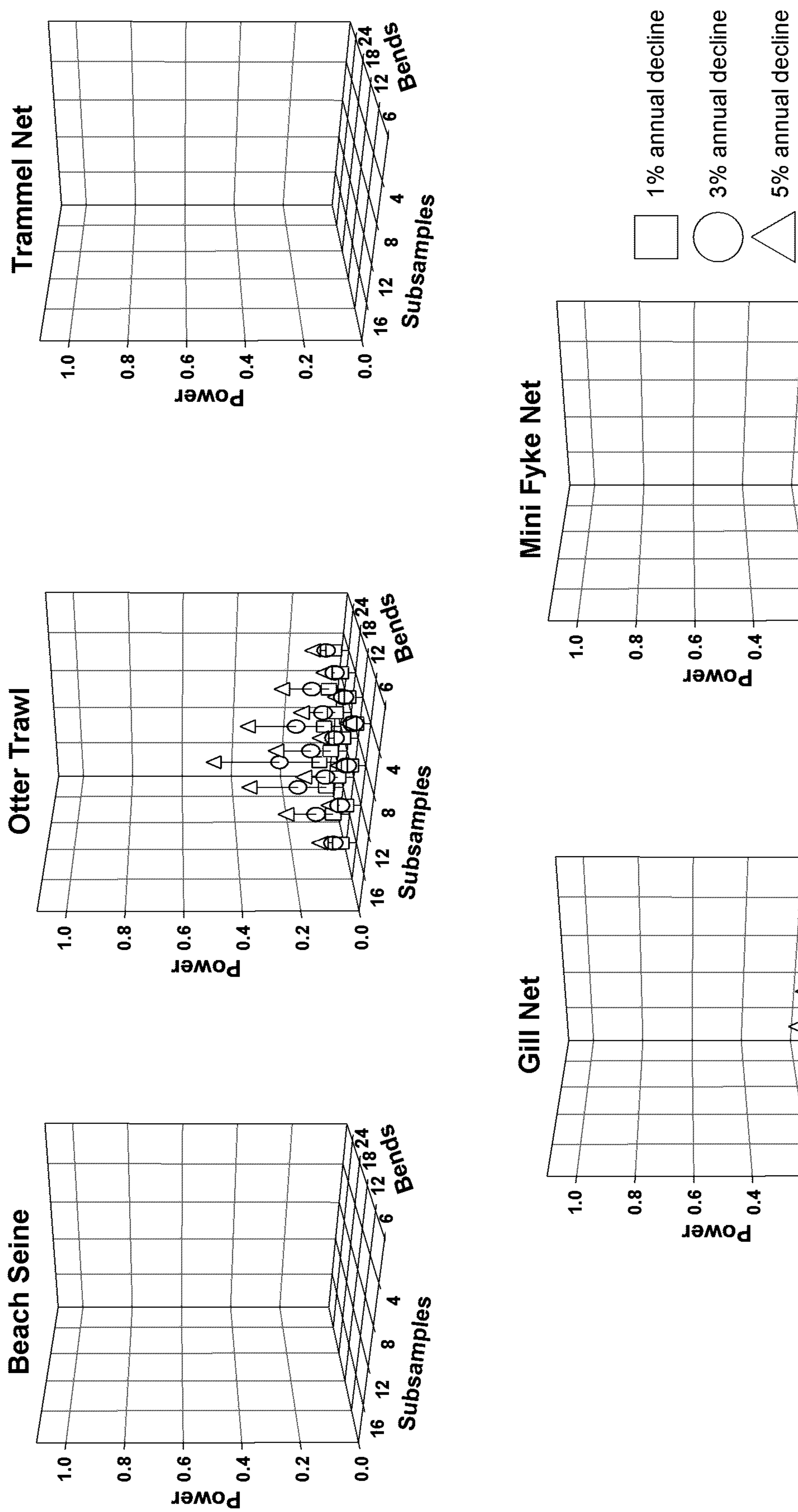

Figure 40. Twenty-year power curves for blue sucker-all from Zone 2 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

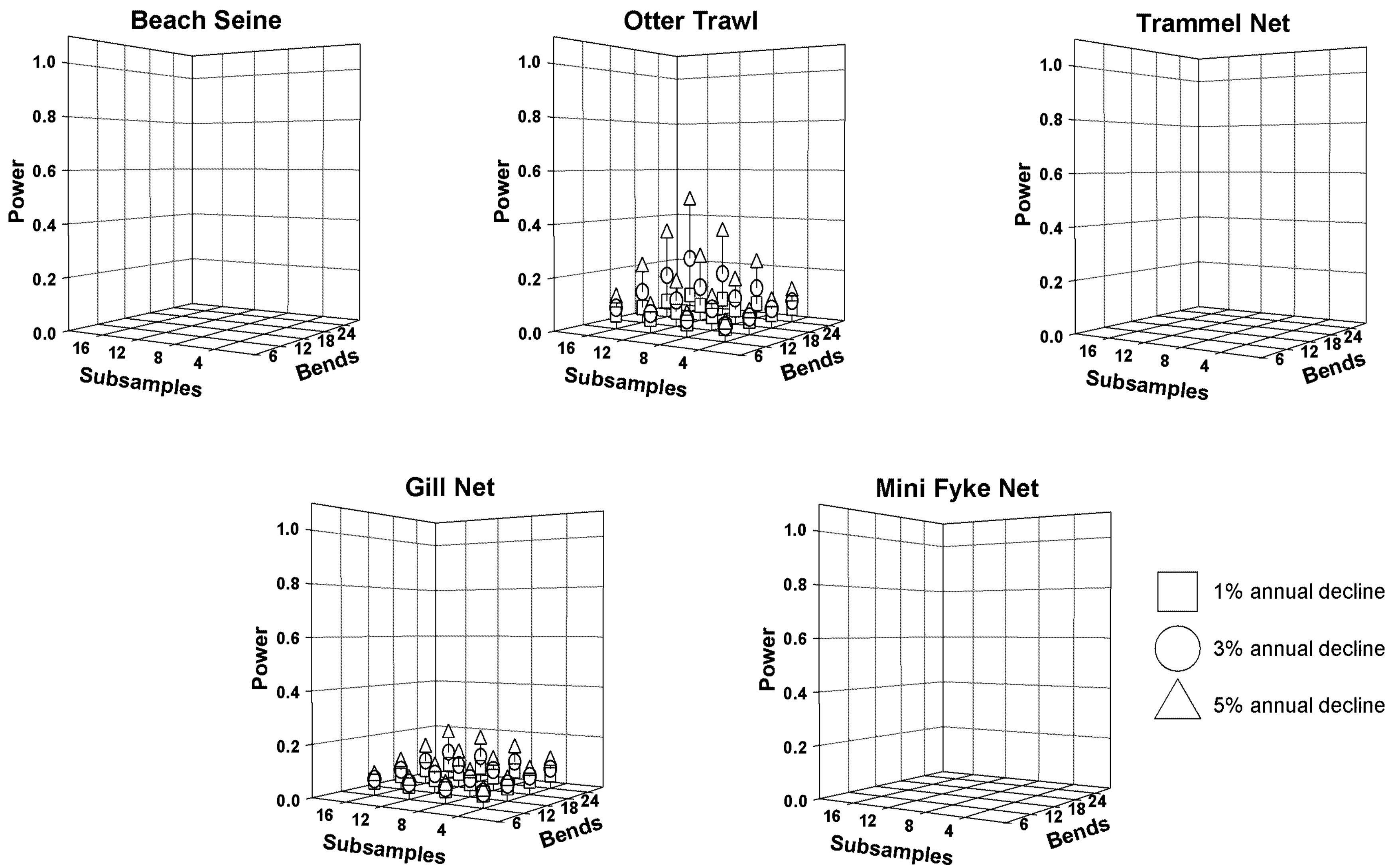

Figure 41. Twenty-year power curves for blue sucker-adult from Zone 2 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

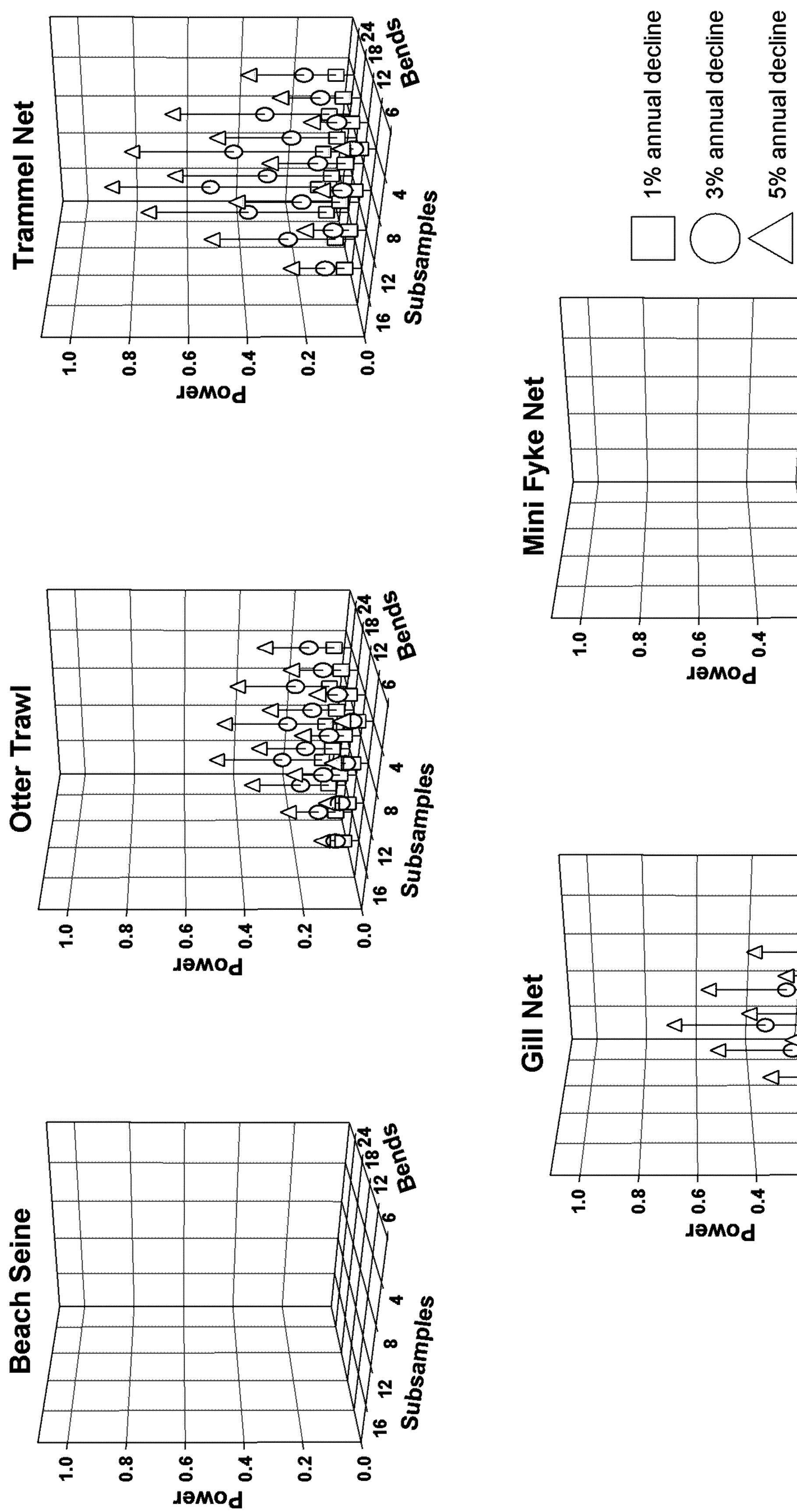

Figure 42. Twenty-year power curves for pallid sturgeon-all from Zone 2 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

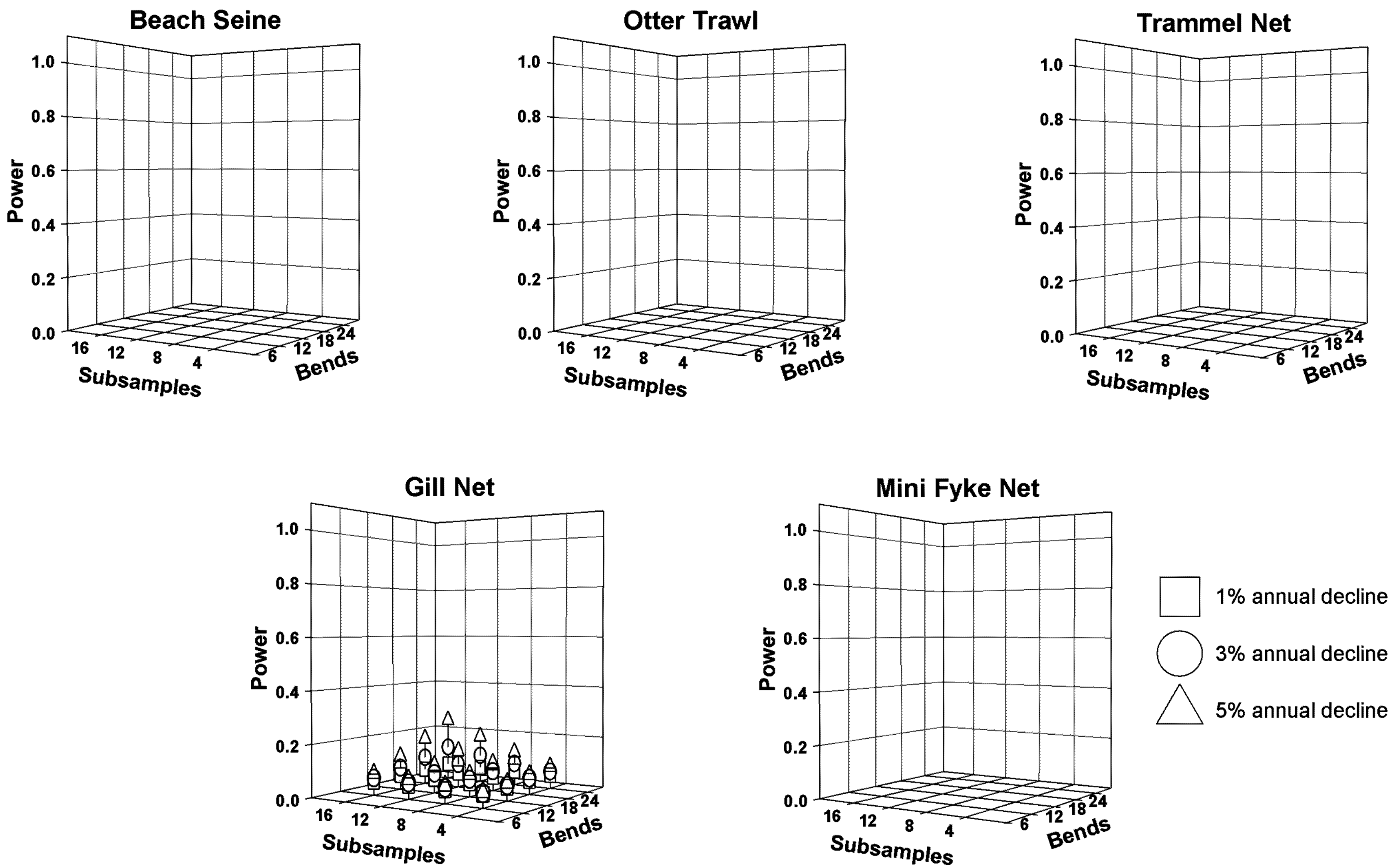

Figure 43. Twenty-year power curves for pallid sturgeon-adult from Zone 2 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

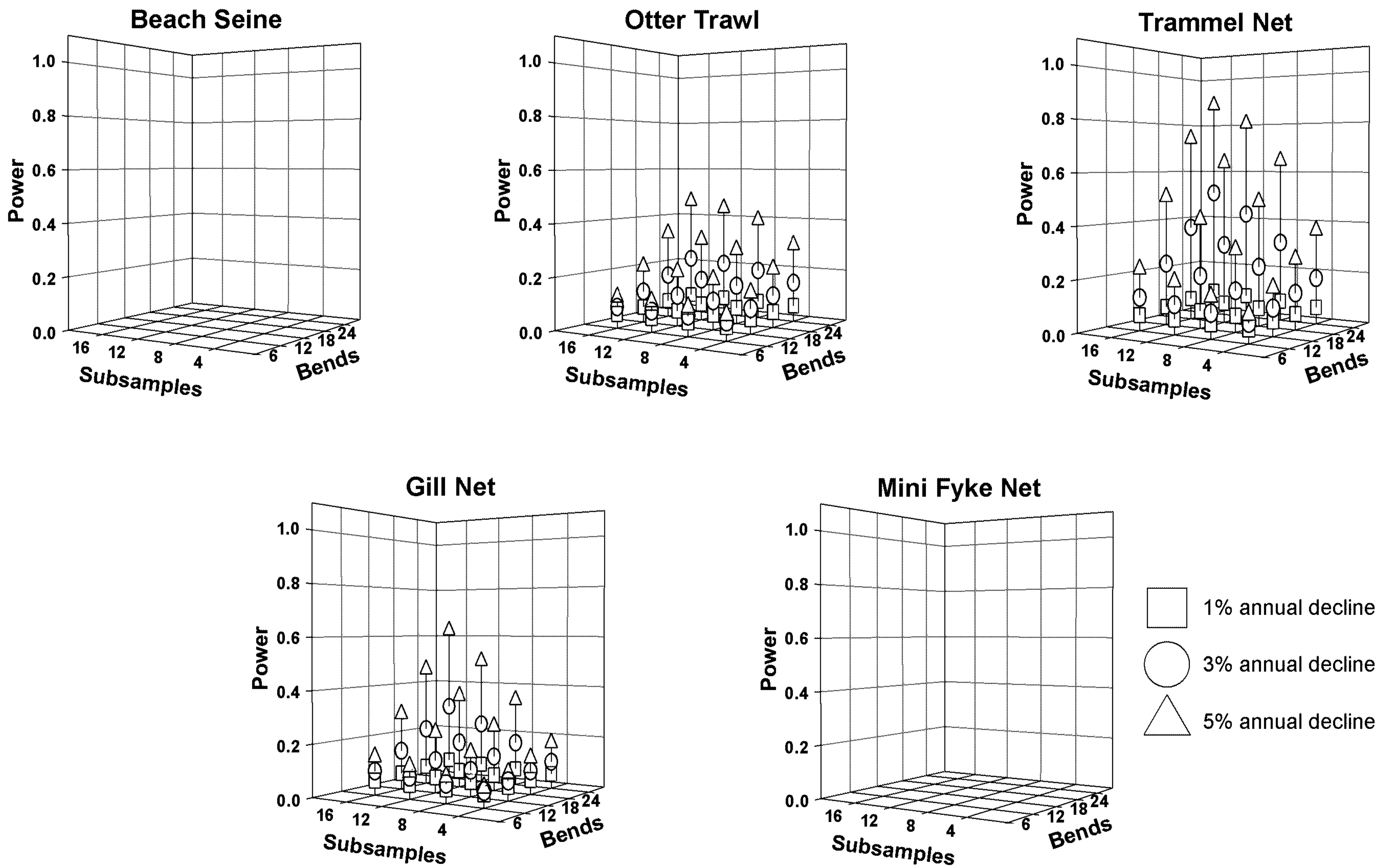

Figure 44. Twenty-year power curves for pallid sturgeon-juvenile from Zone 2 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

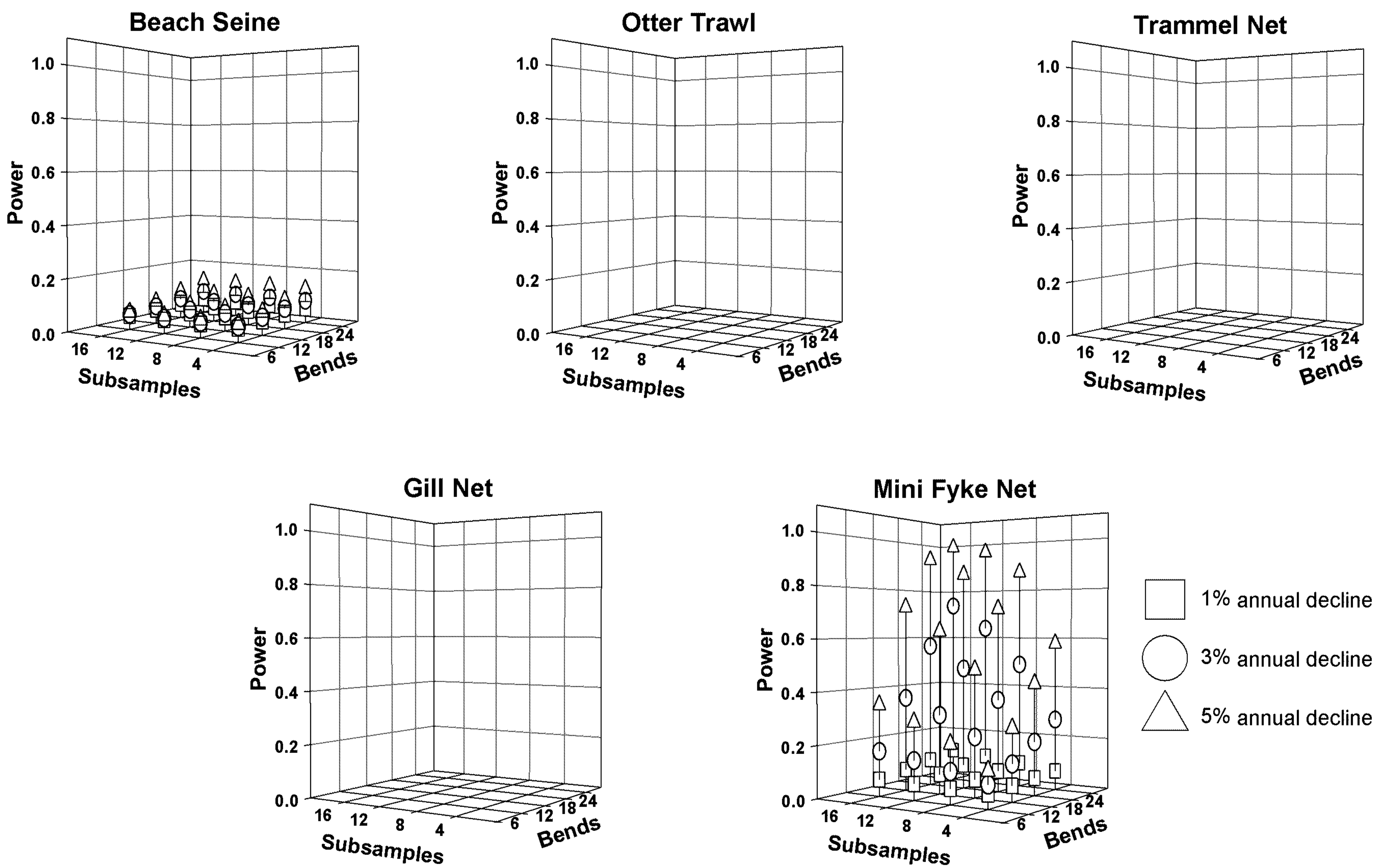

Figure 45. Twenty-year power curves for sand shiner-all from Zone 2 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

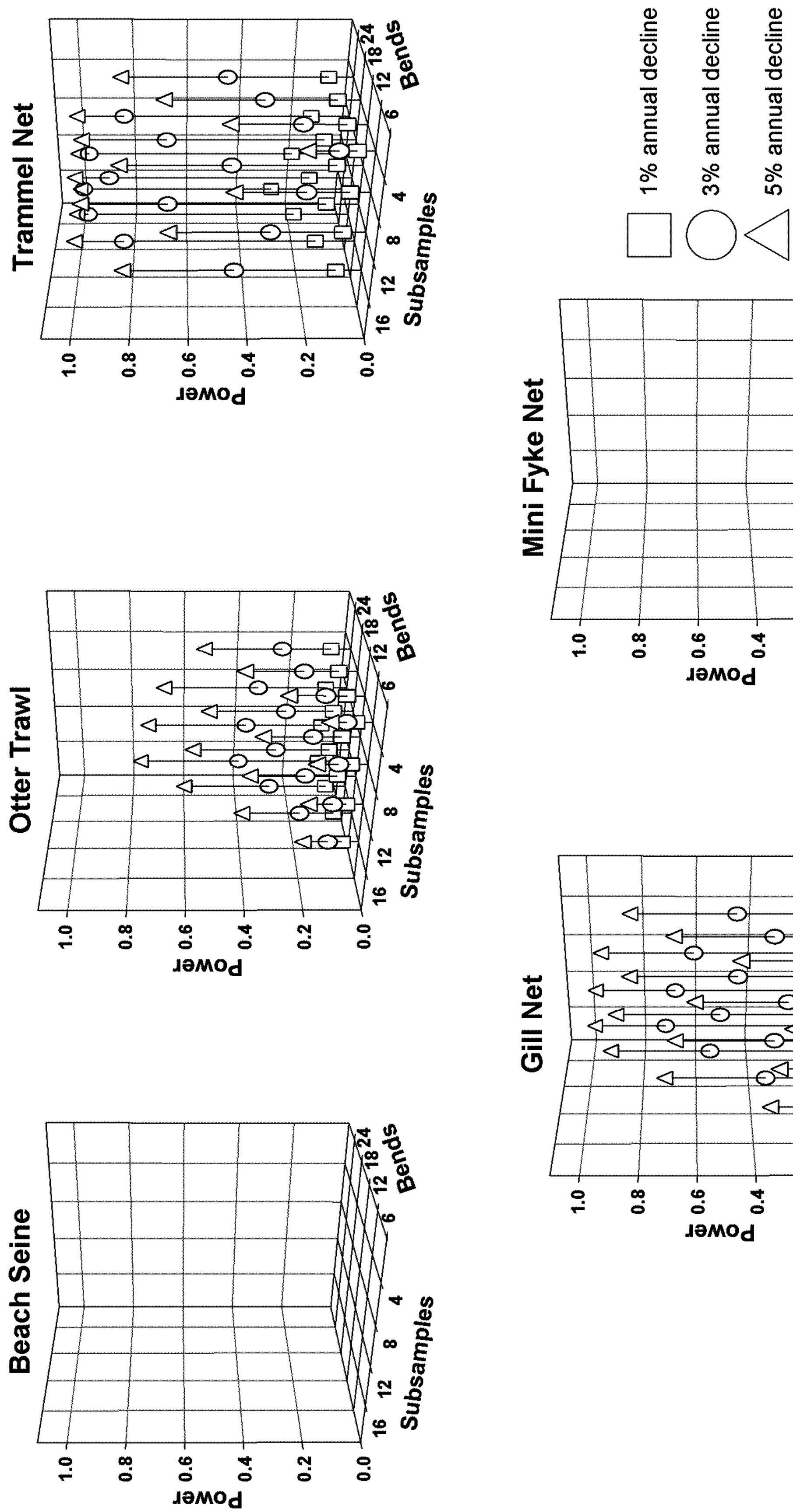

Figure 46. Twenty-year power curves for sauger-all from Zone 2 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

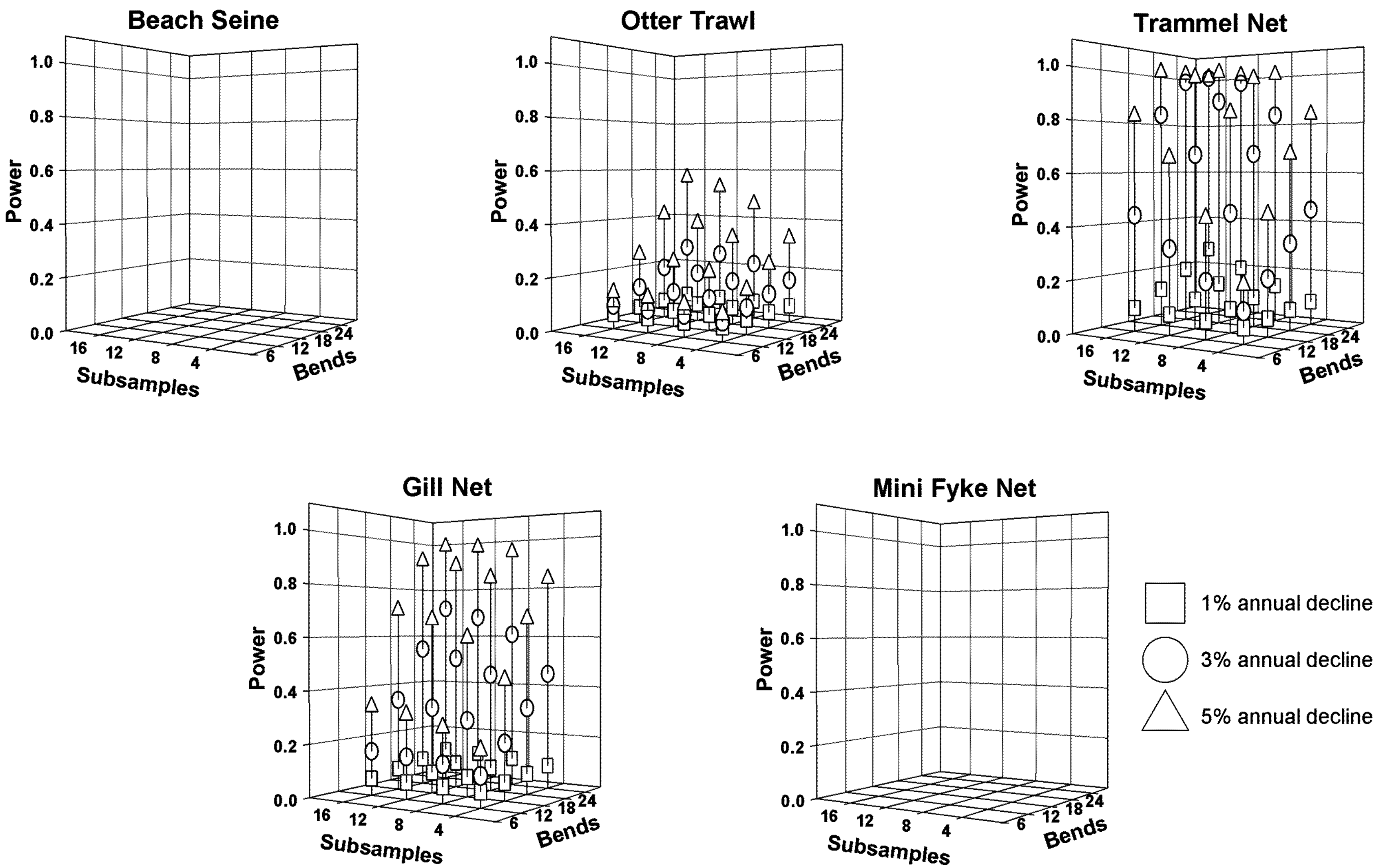

Figure 47. Twenty-year power curves for sauger-adult from Zone 2 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

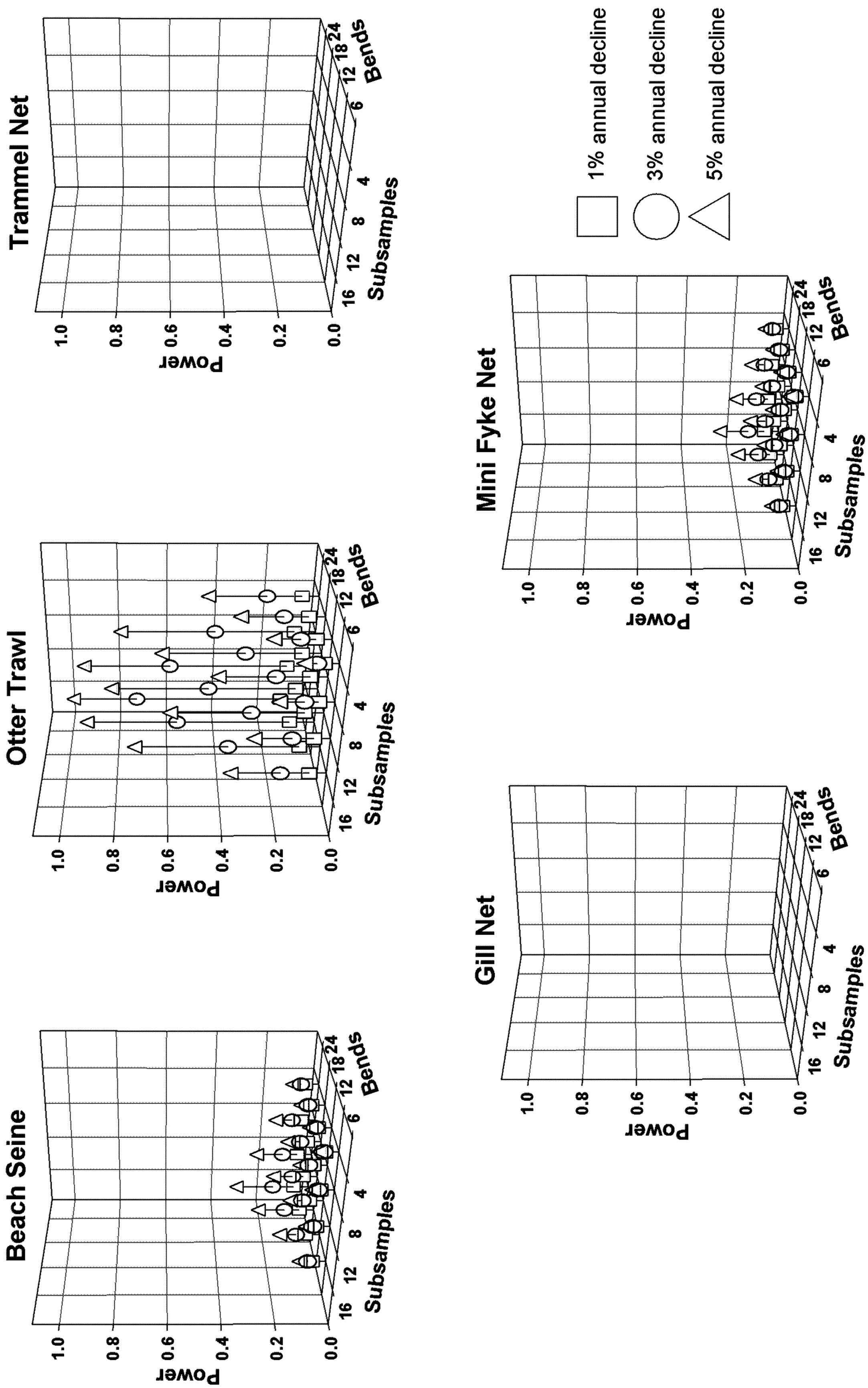

Figure 48. Twenty-year power curves for sauger-juvenile from Zone 2 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

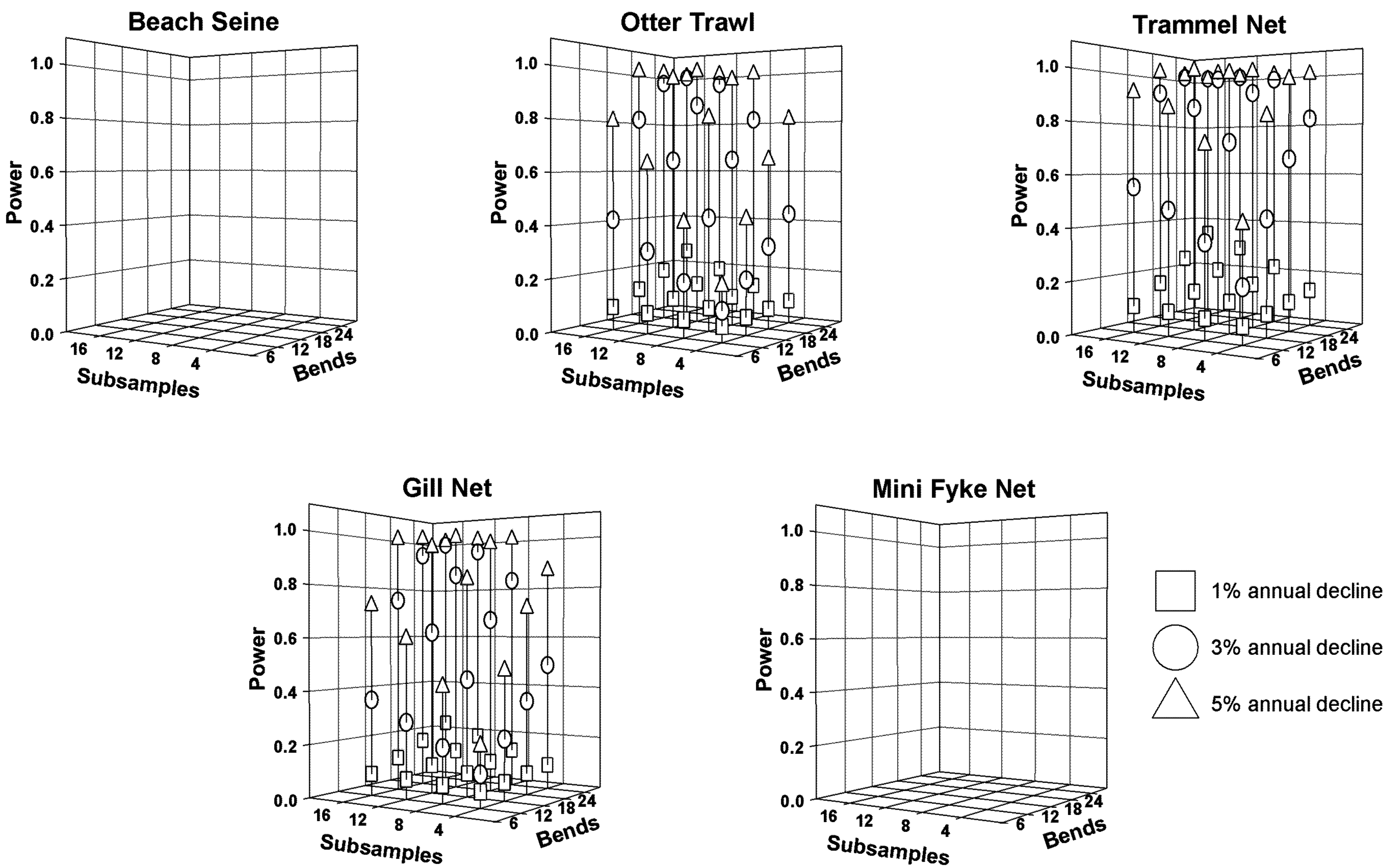

Figure 49. Twenty-year power curves for shovelnose sturgeon-all from Zone 2 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

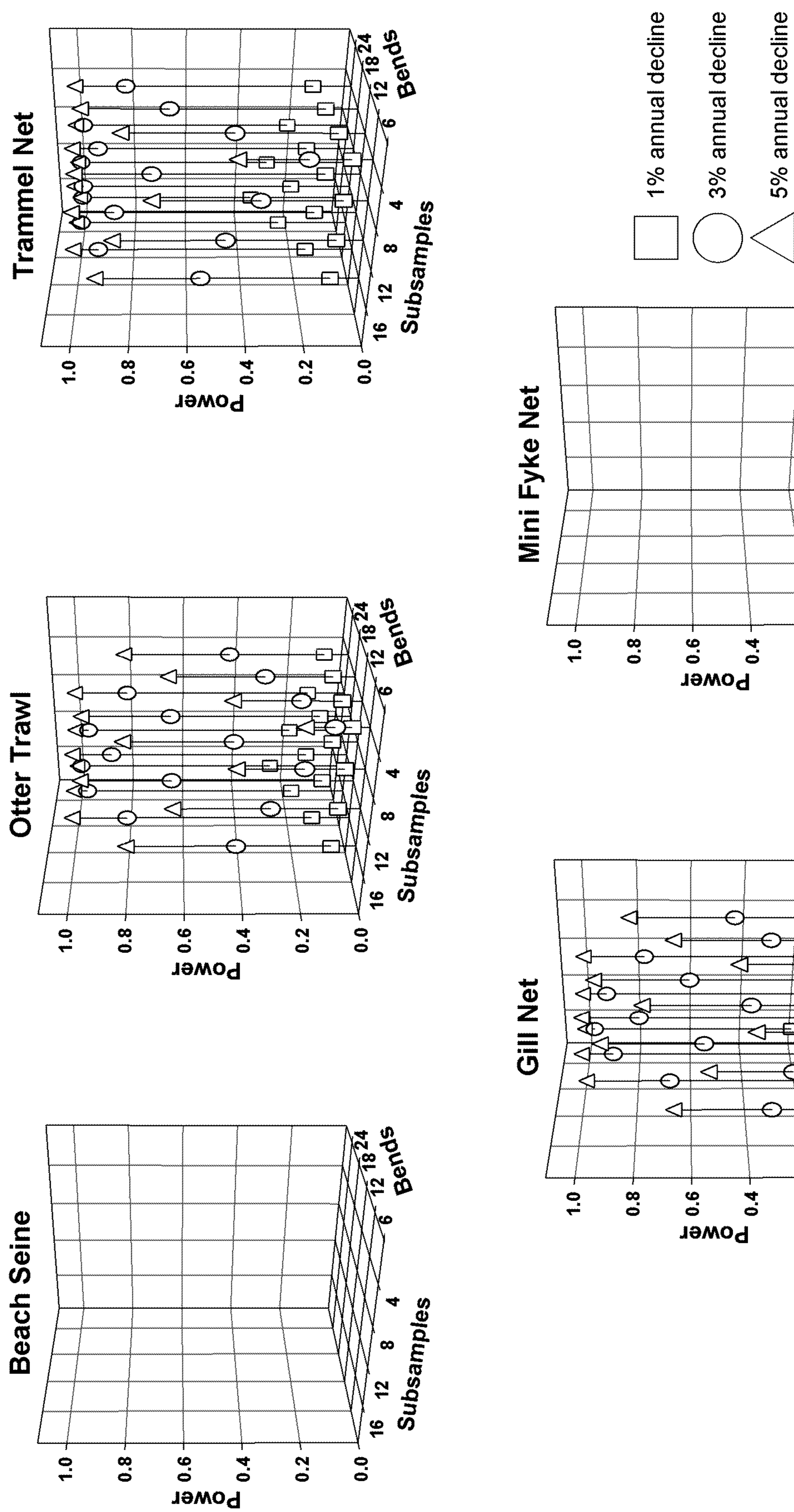

Figure 50. Twenty-year power curves for shovelnose sturgeon-adult from Zone 2 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

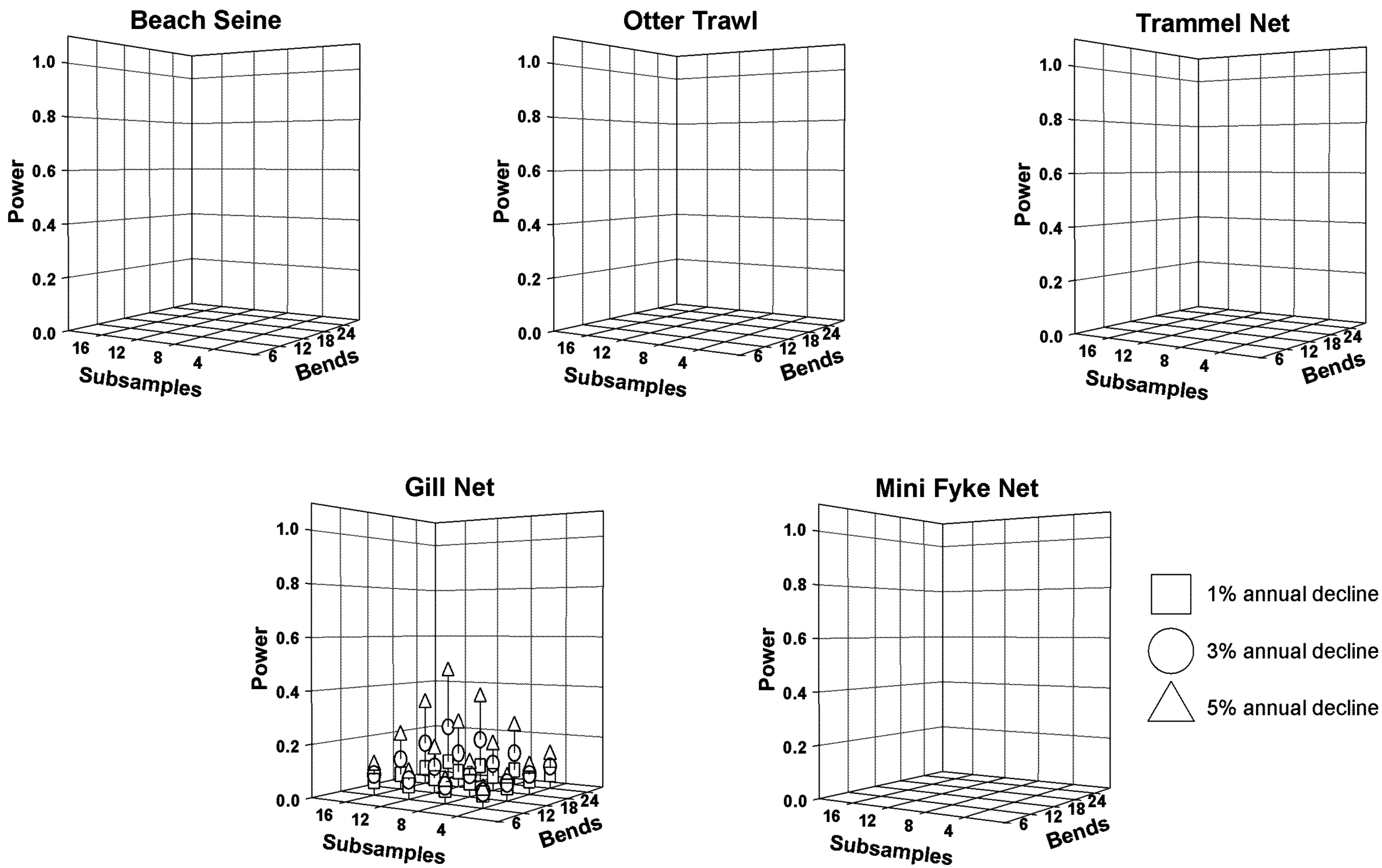

Figure 51. Twenty-year power curves for shovelnose sturgeon-juvenile from Zone 2 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

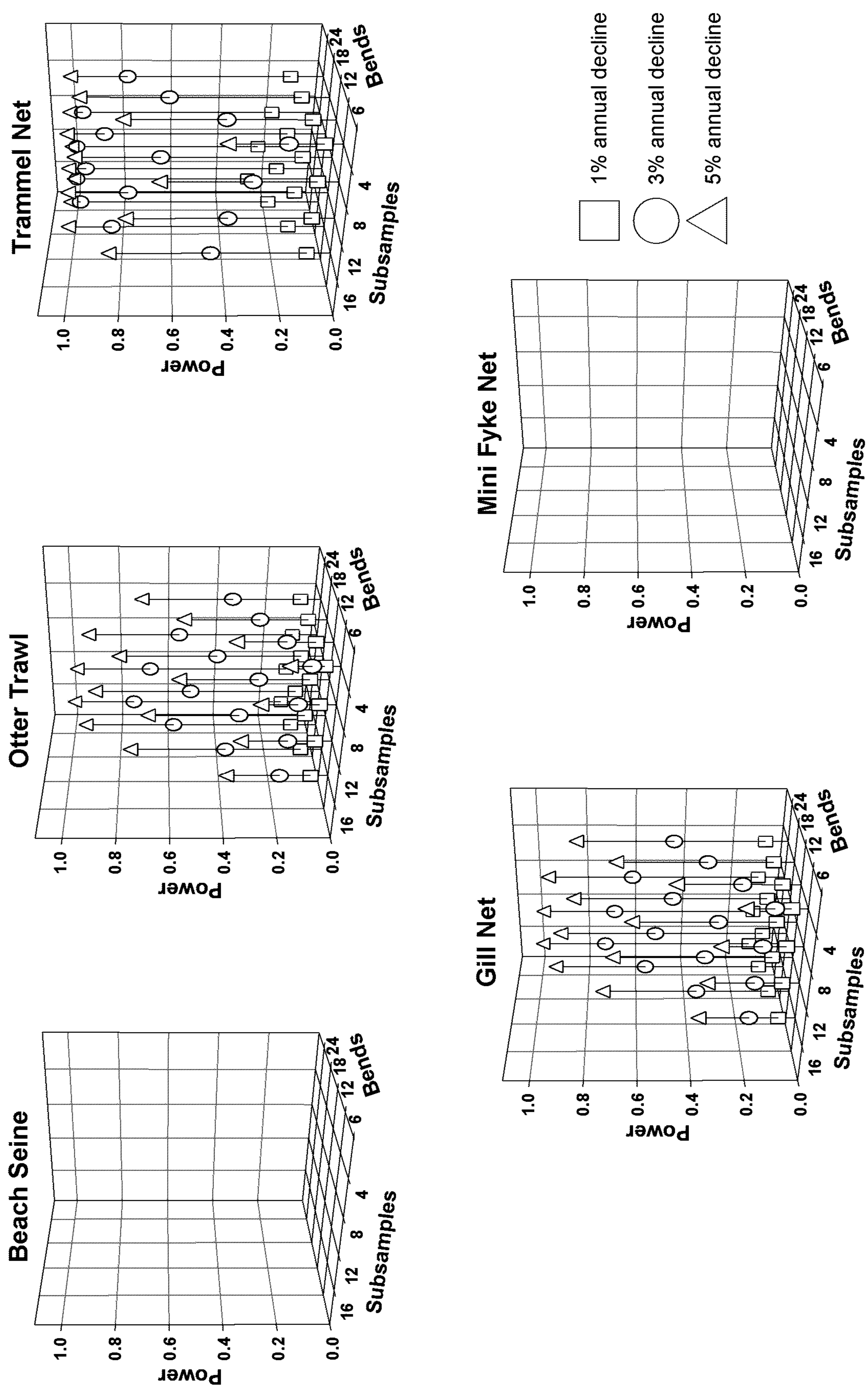

Figure 52. Twenty-year power curves for blue sucker-all from Zone 3 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

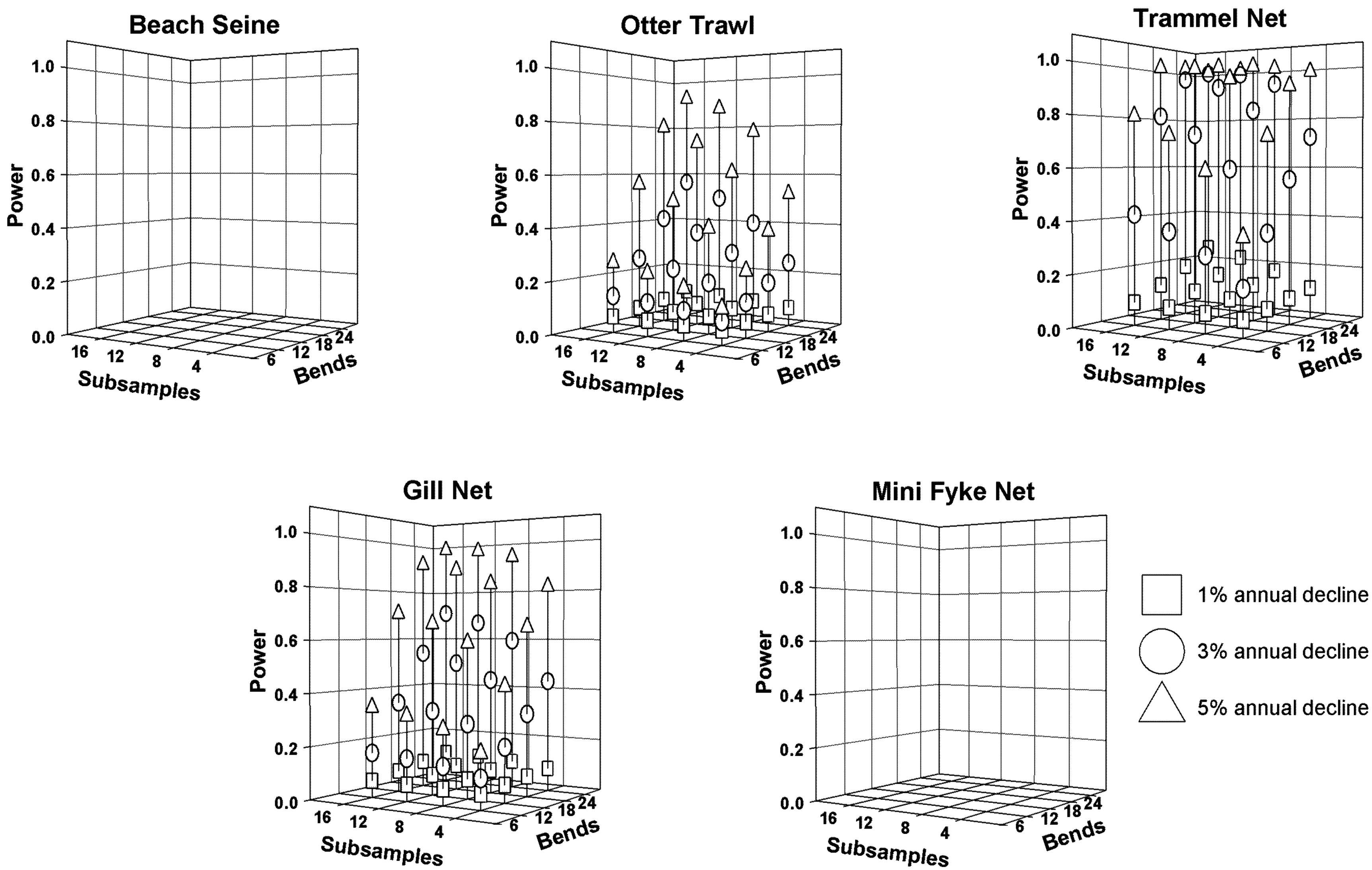

Figure 53. Twenty-year power curves for blue sucker-adult from Zone 3 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

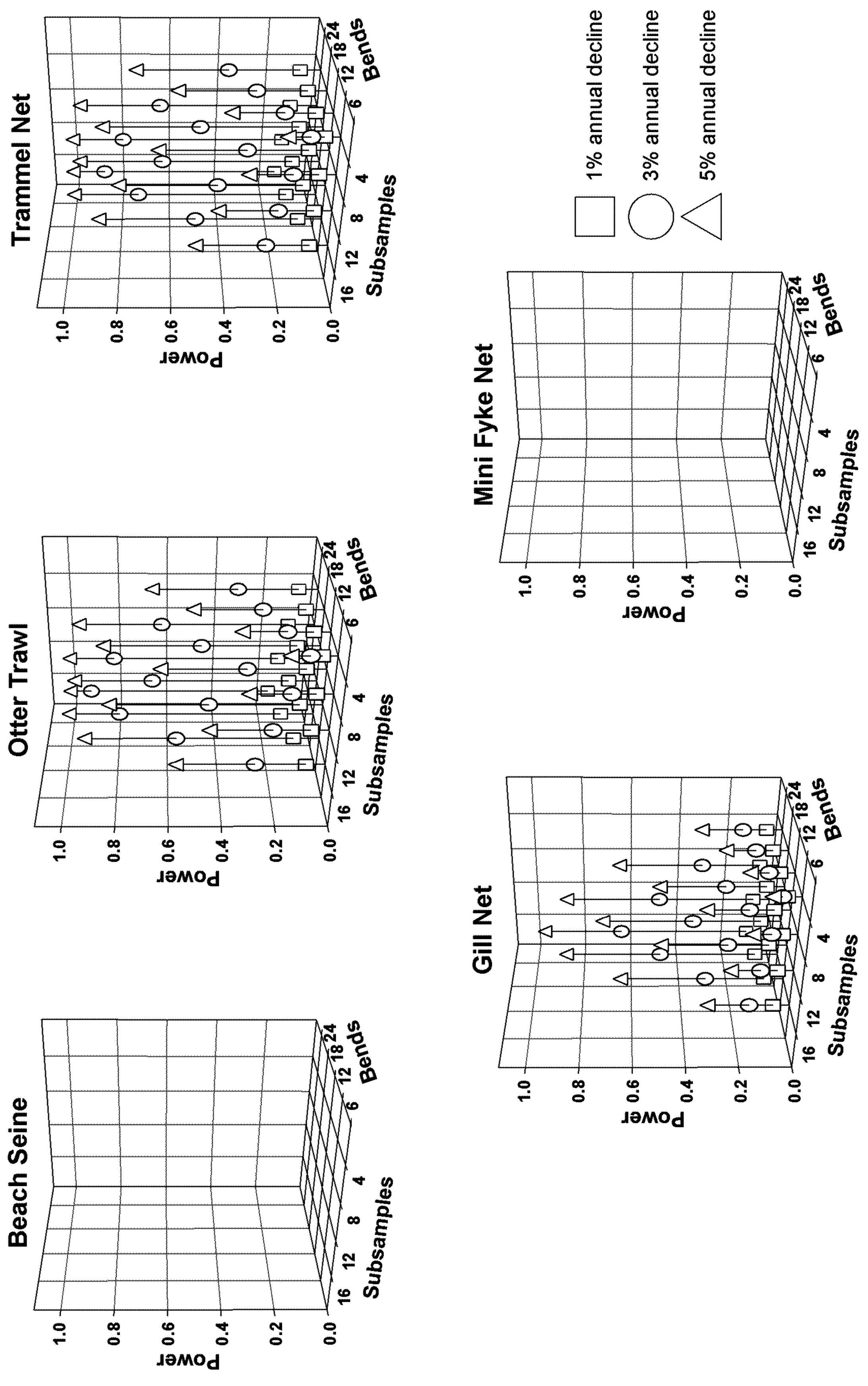

Figure 54. Twenty-year power curves for blue sucker-juvenile from Zone 3 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

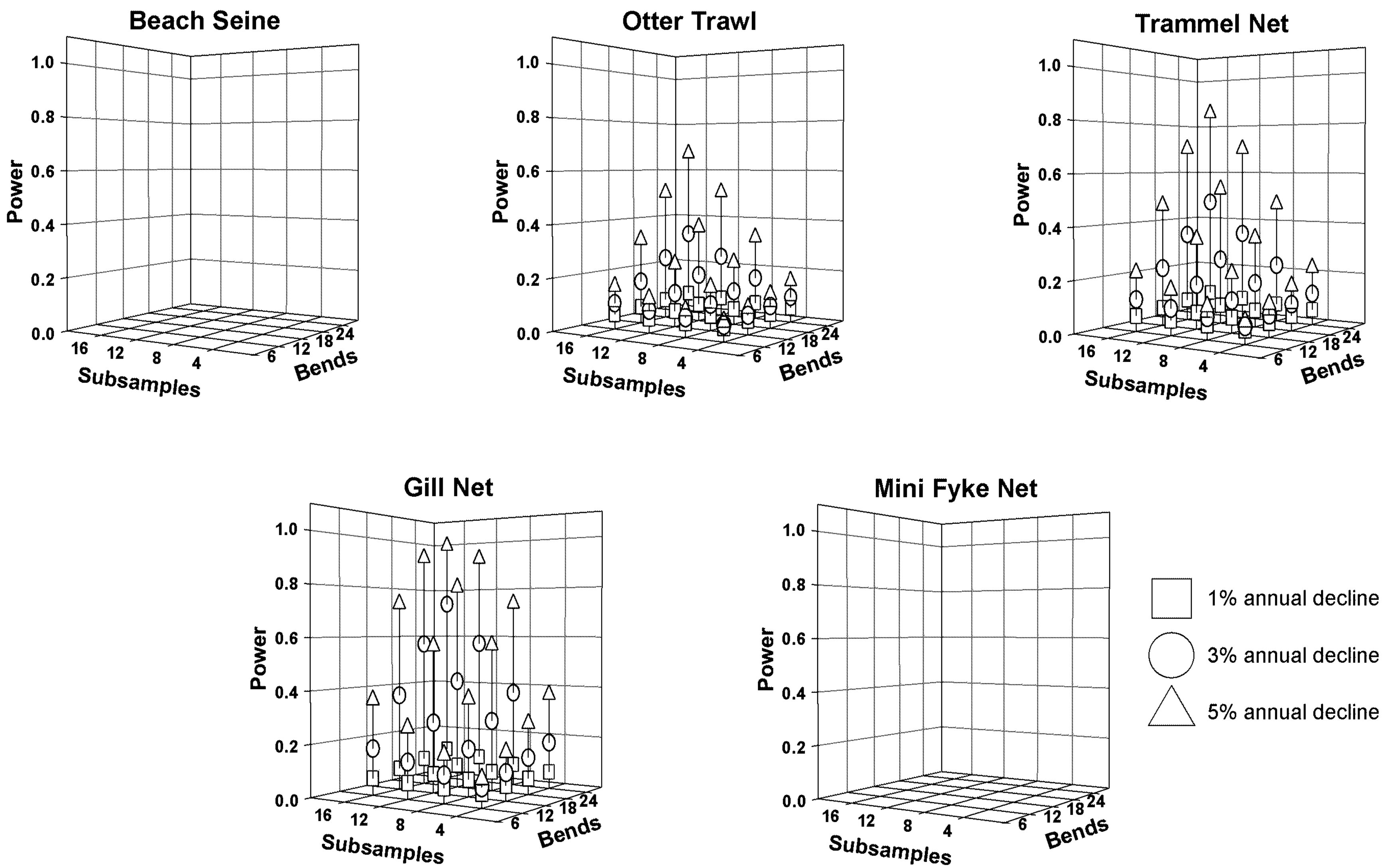

Figure 55. Twenty-year power curves for pallid sturgeon-all from Zone 3 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

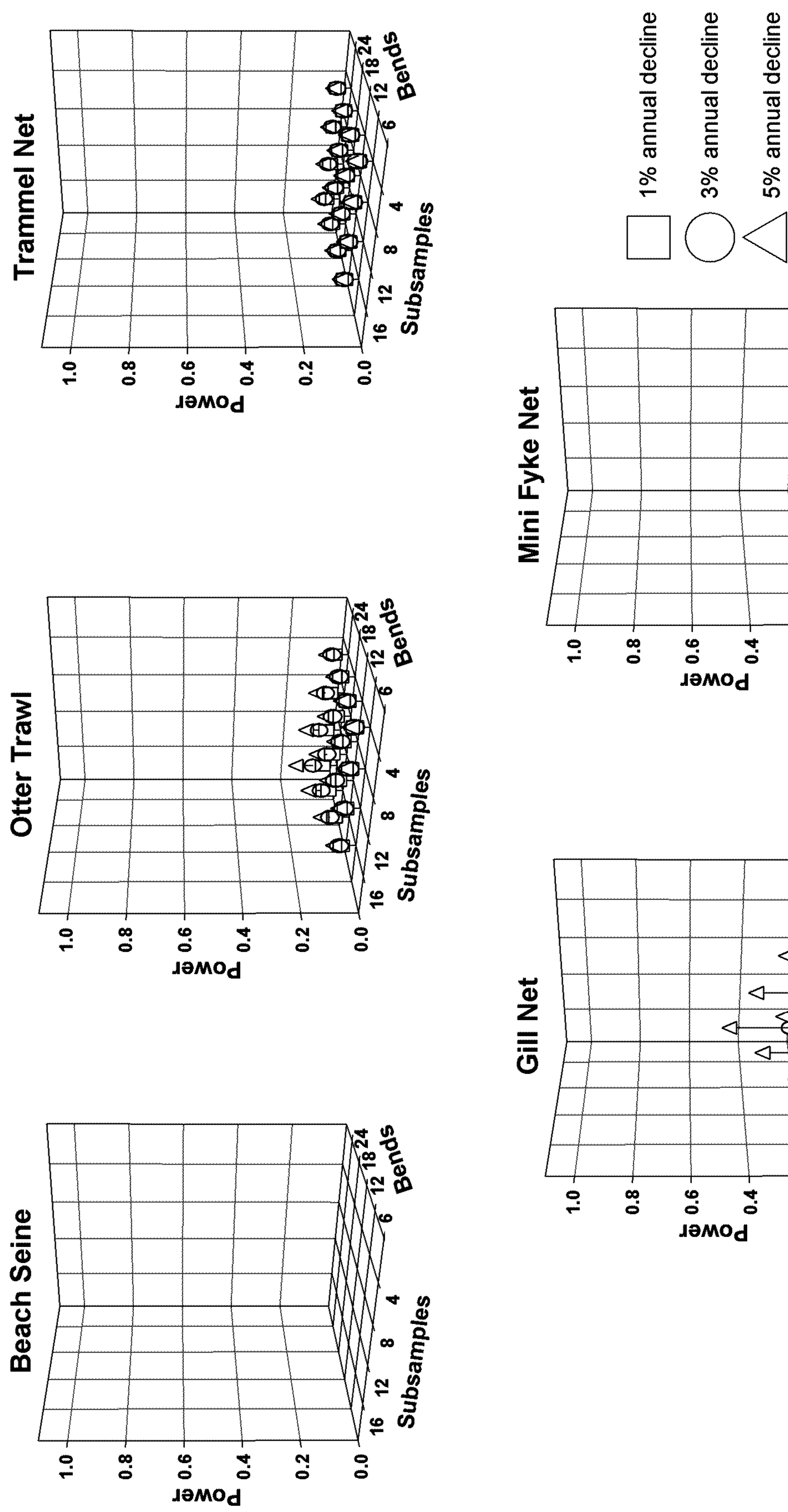

Figure 56. Twenty-year power curves for pallid sturgeon-adult from Zone 3 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

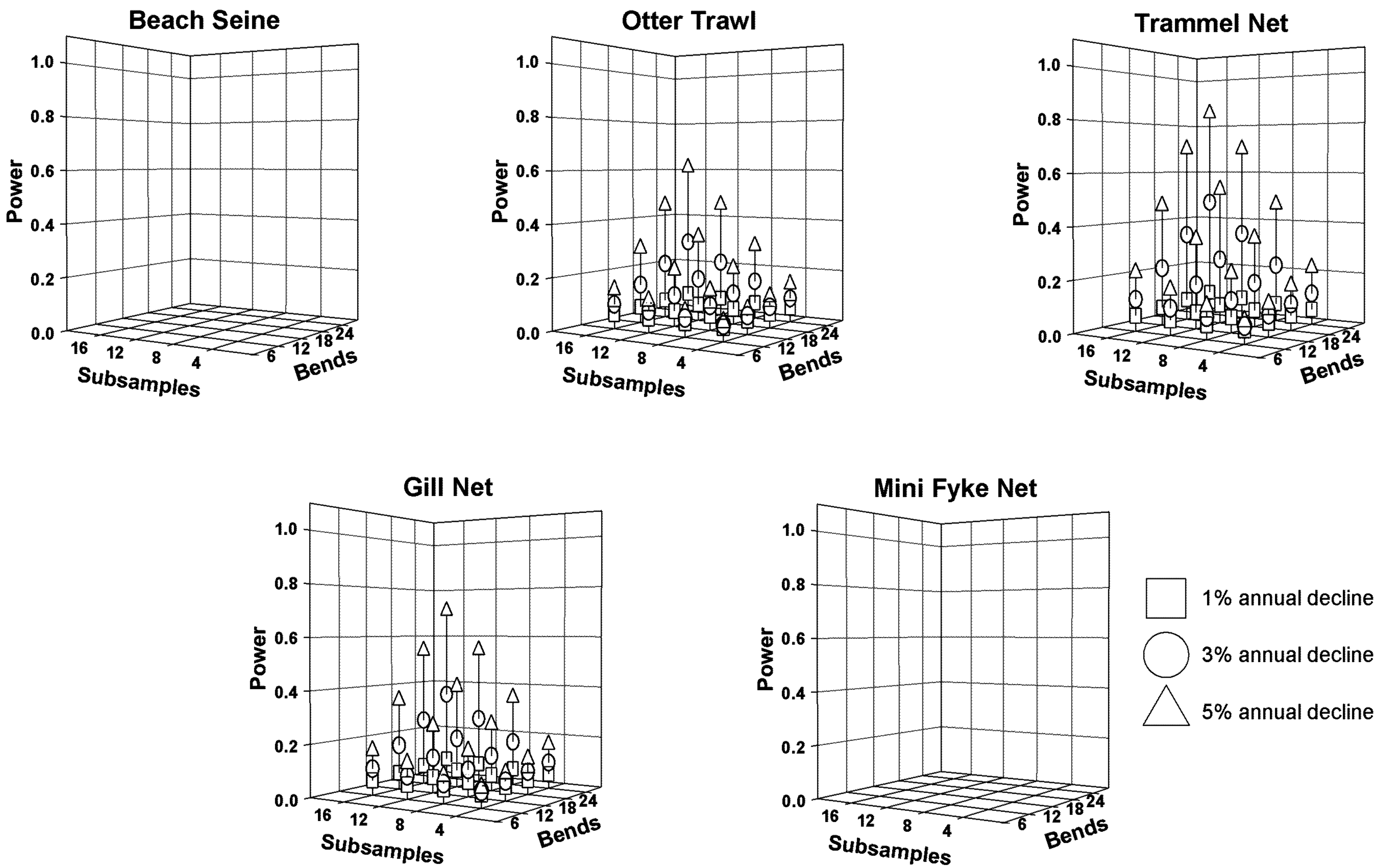

Figure 57. Twenty-year power curves for pallid sturgeon-adult from Zone 3 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

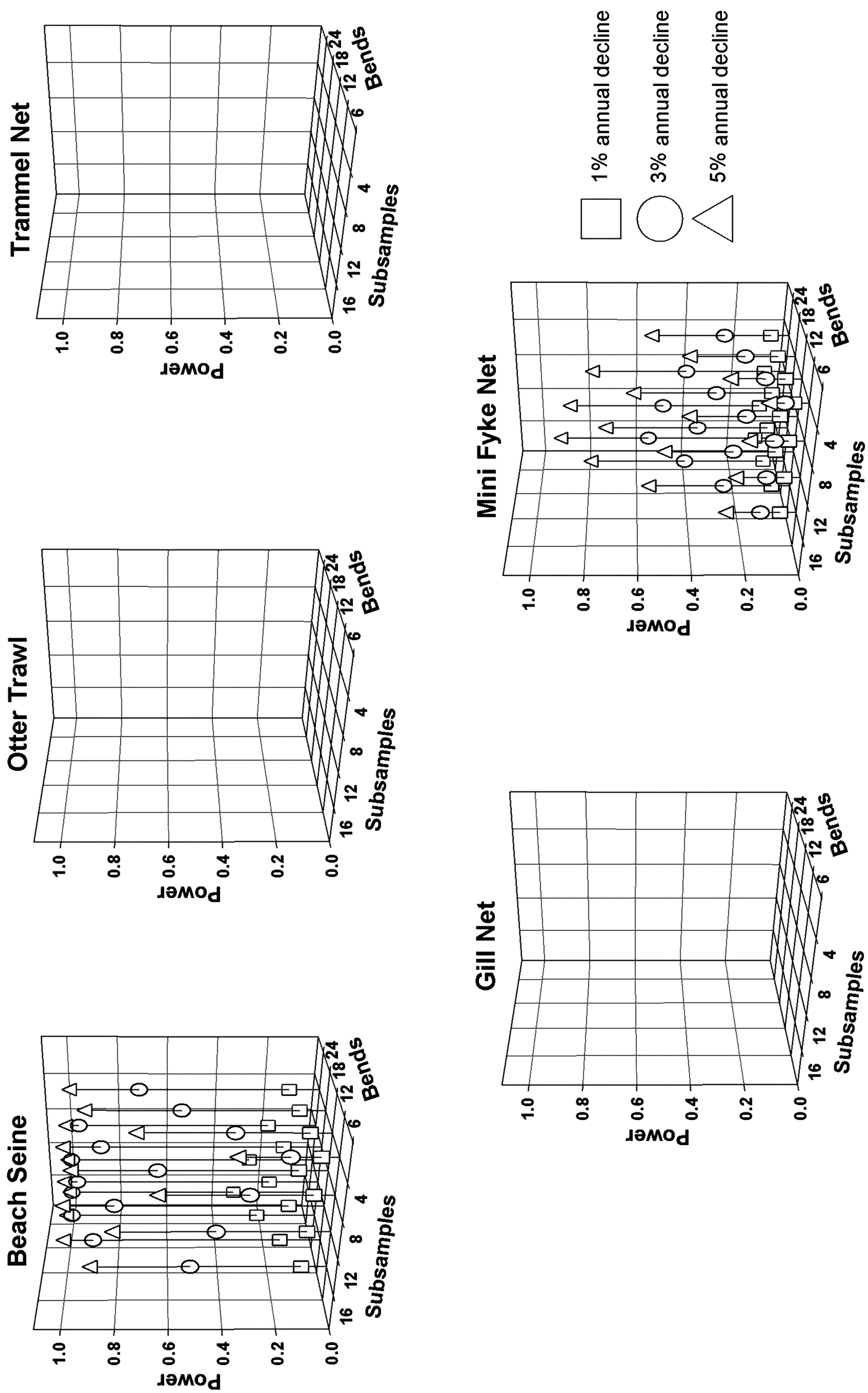

Figure 58. Twenty-year power curves for sand shiner-all from Zone 3 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

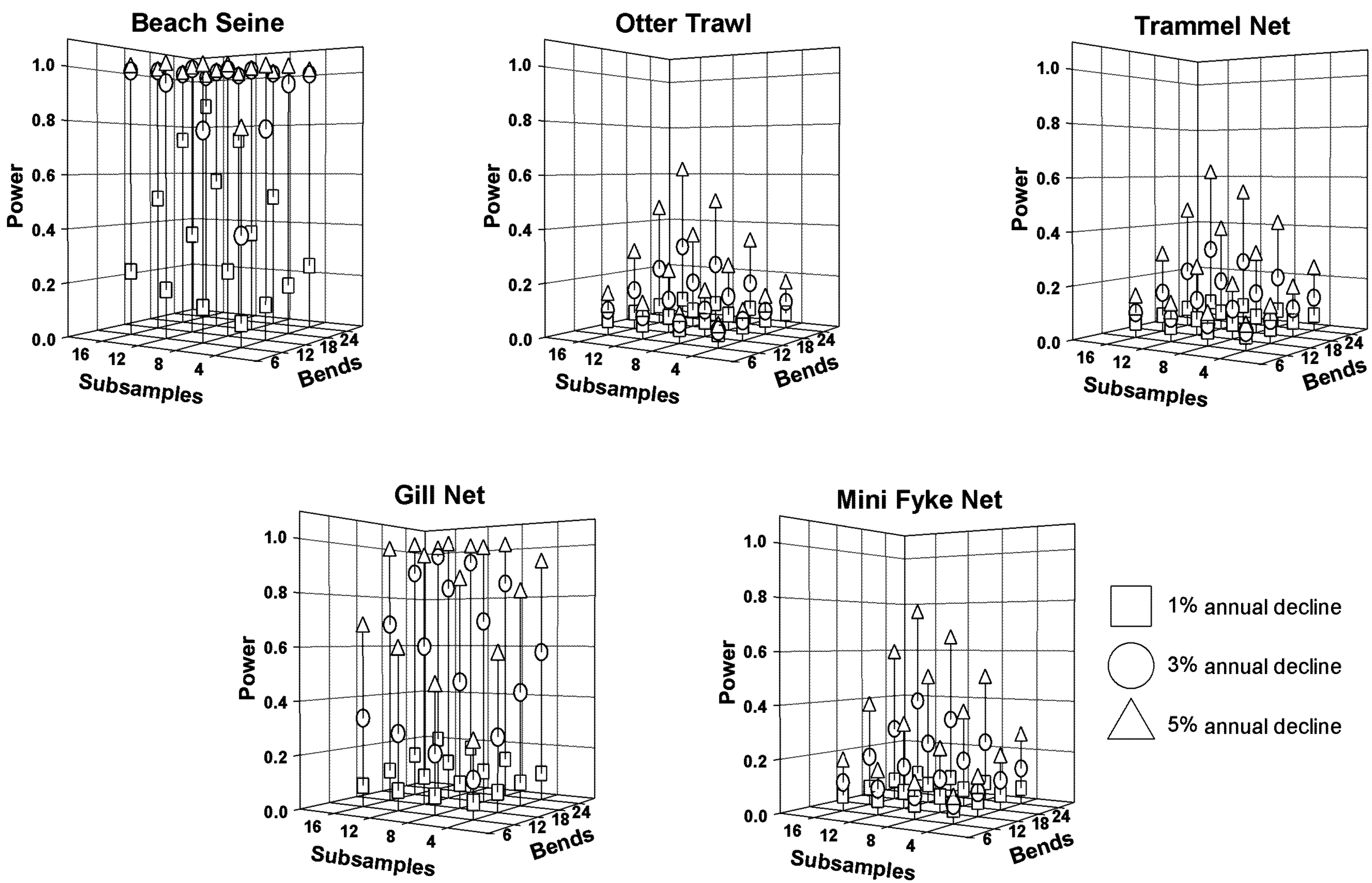

Figure 59. Twenty-year power curves for sauger-all from Zone 3 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

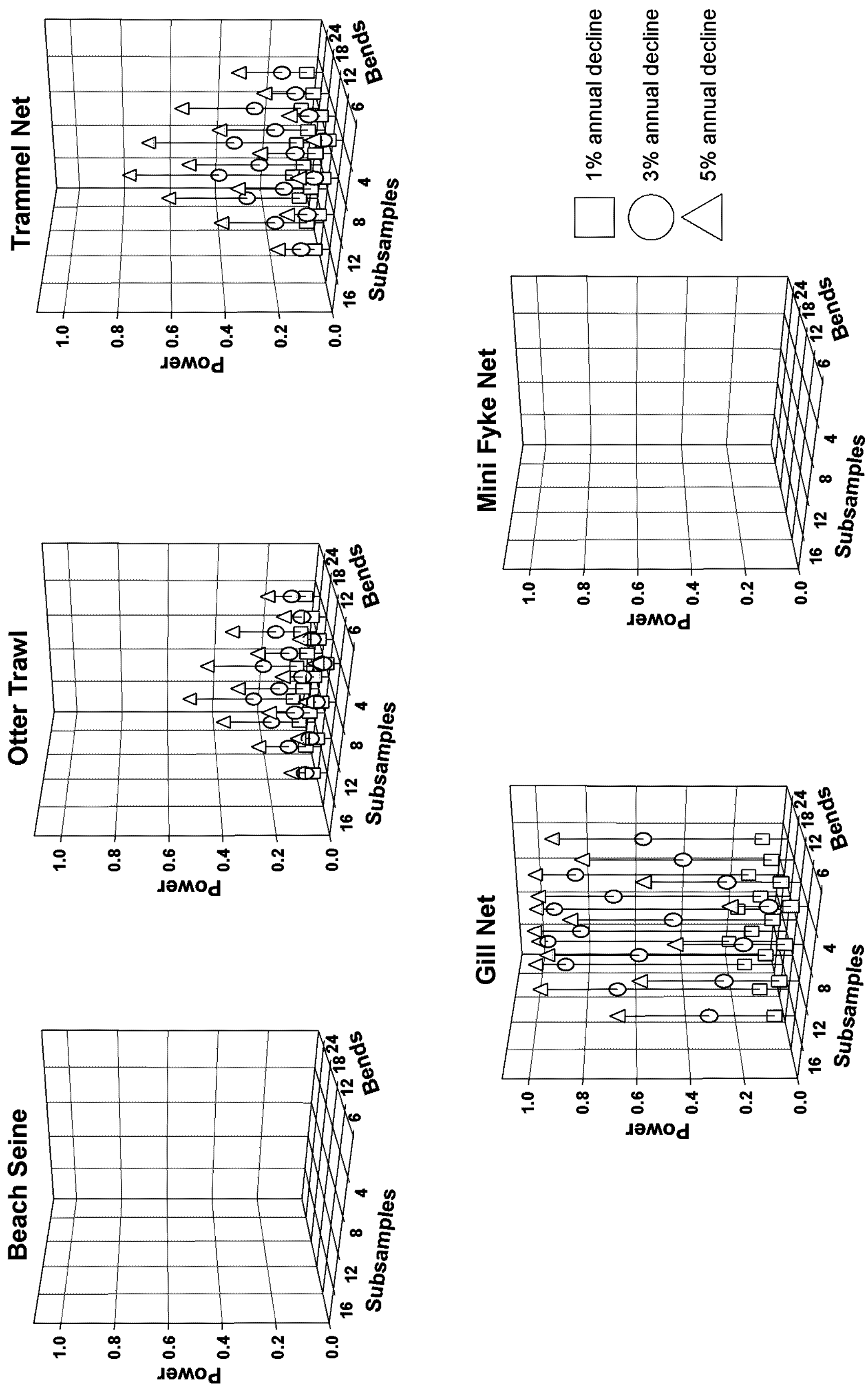

Figure 60. Twenty-year power curves for sauger-adult from Zone 3 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

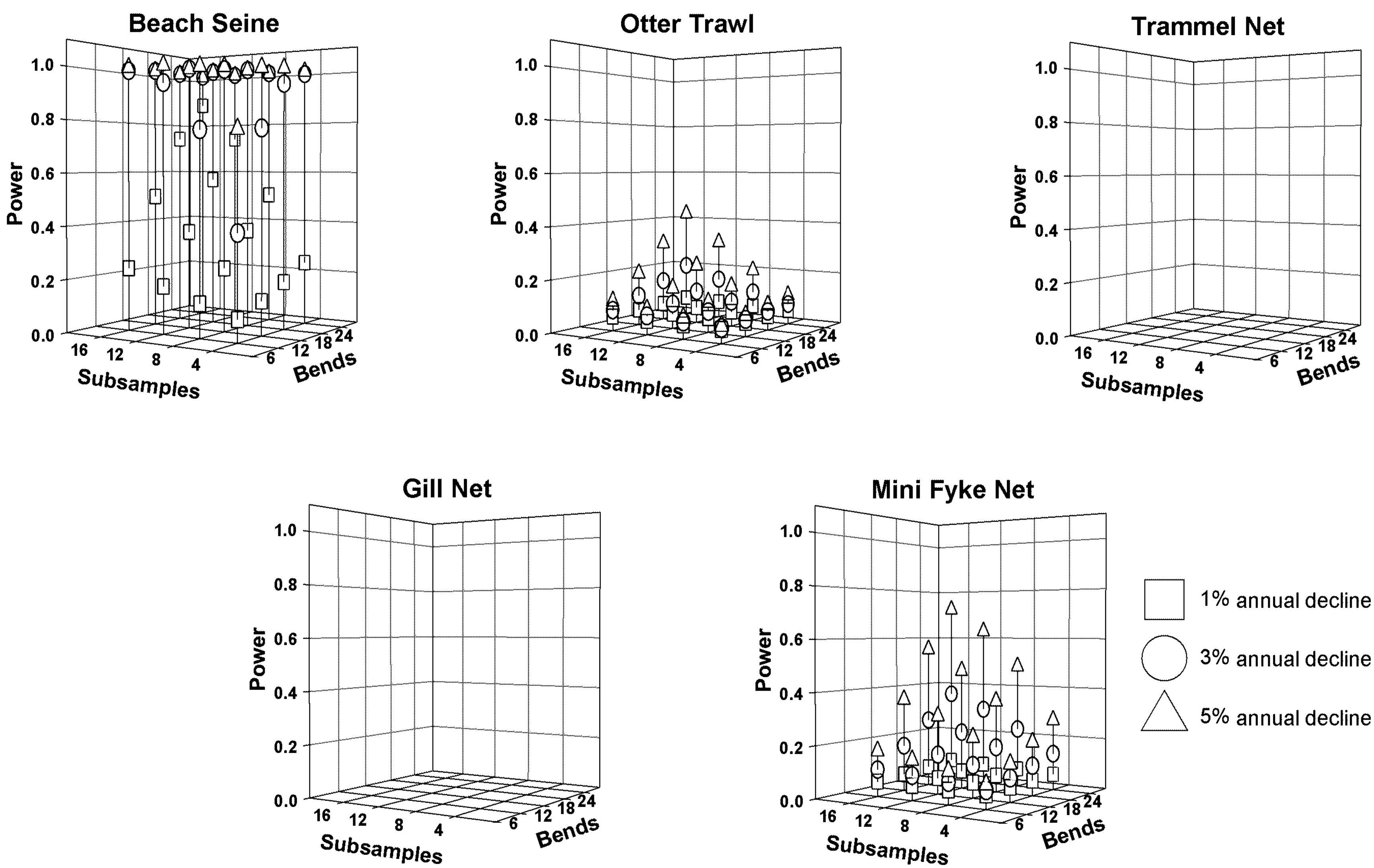

Figure 61. Twenty-year power curves for sauger-juvenile from Zone 3 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

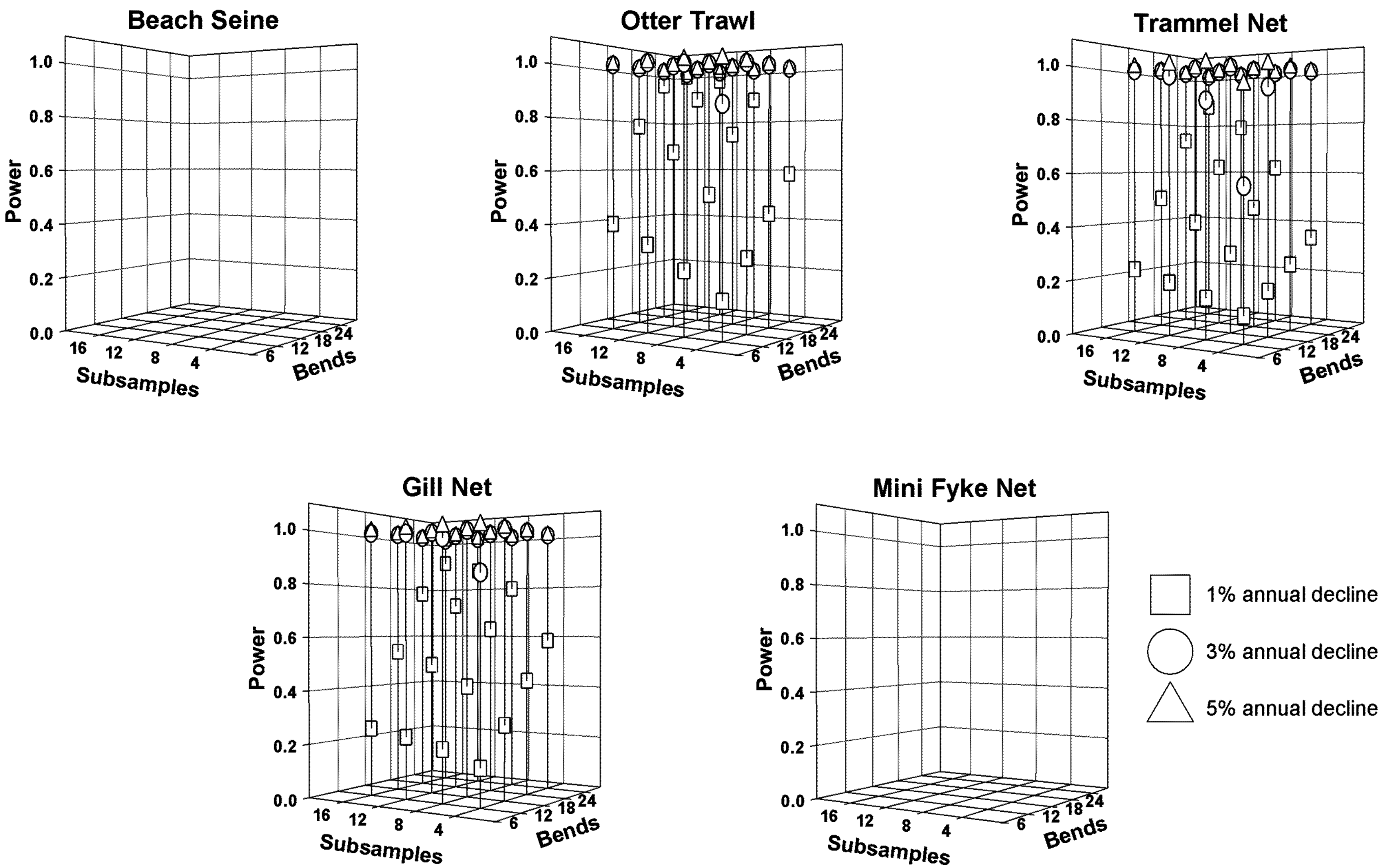

Figure 62. Twenty-year power curves for shovelnose sturgeon-all from Zone 3 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

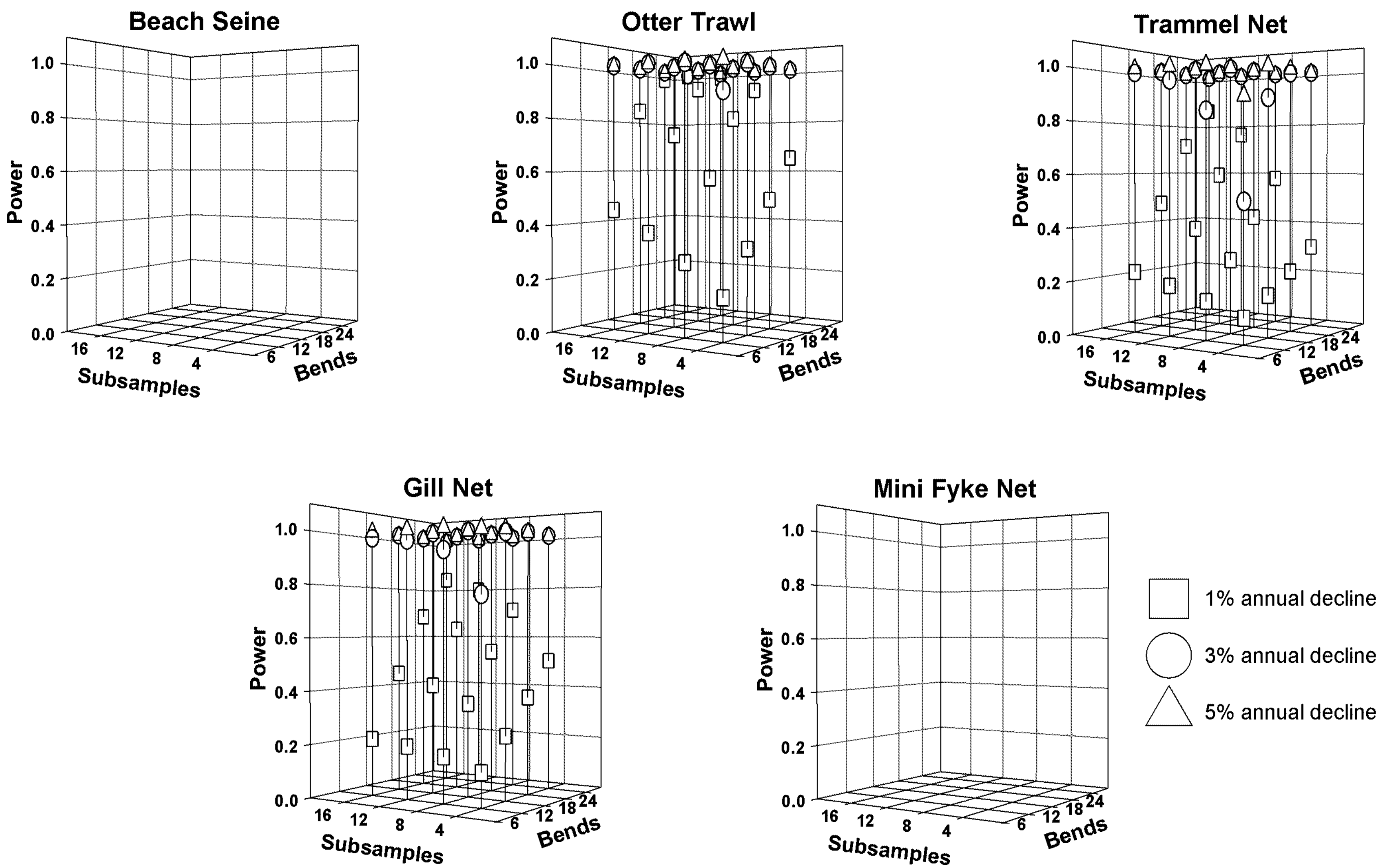

Figure 63. Twenty-year power curves for shovelnose sturgeon-adult from Zone 3 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

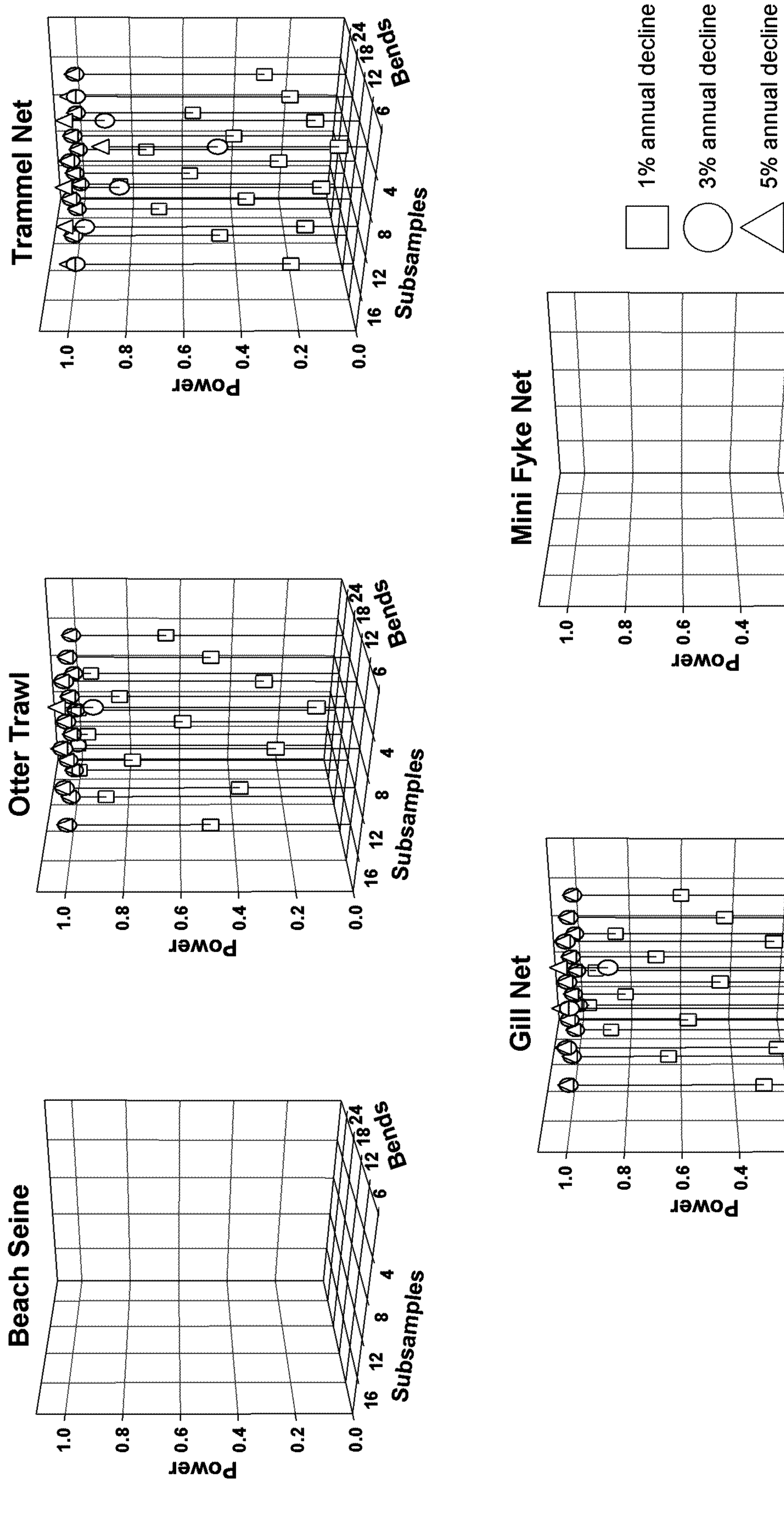

Figure 64. Twenty-year power curves for shovelnose sturgeon-juvenile from Zone 3 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

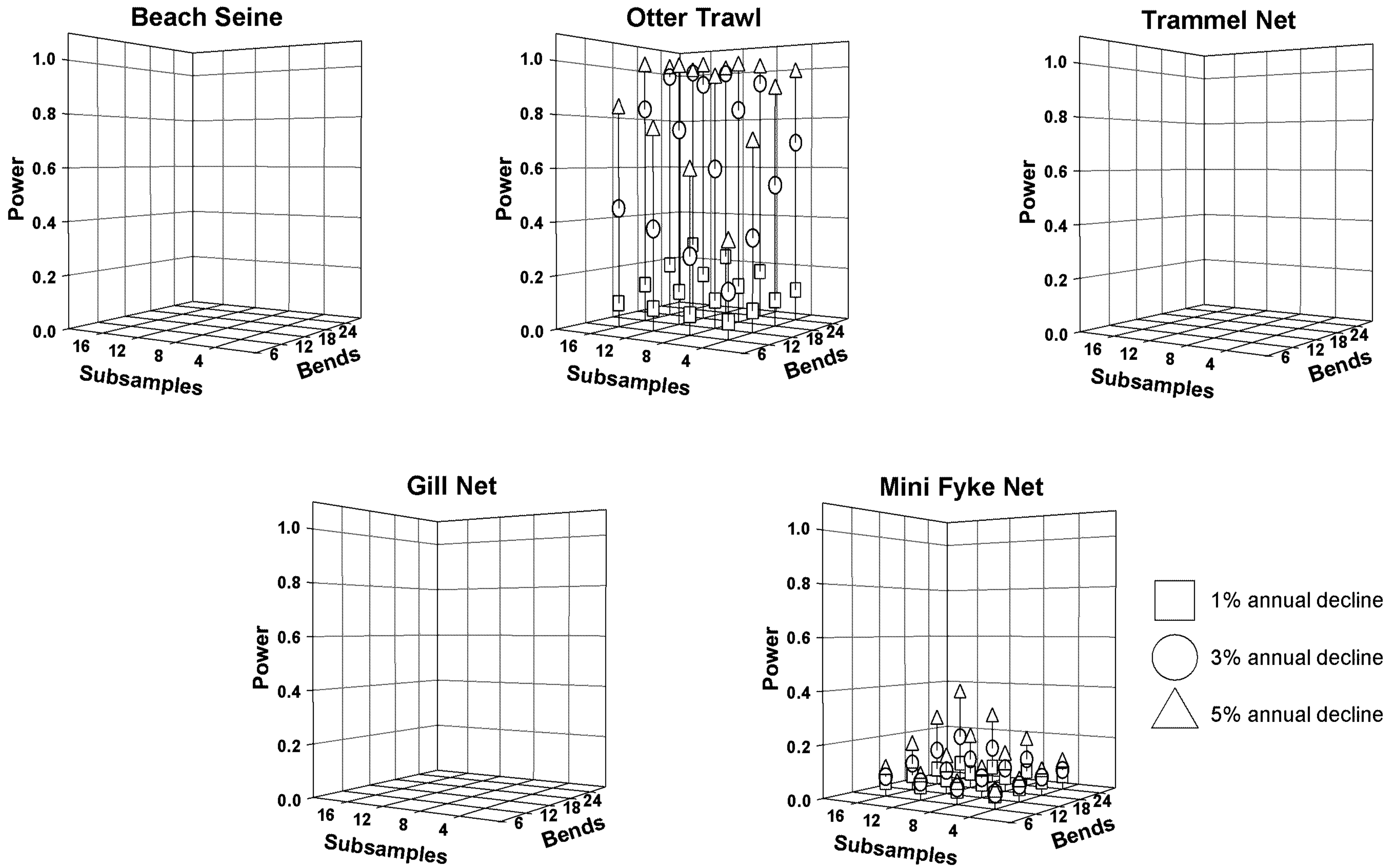

Figure 65. Twenty-year power curves for sicklefin chub-all from Zone 3 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

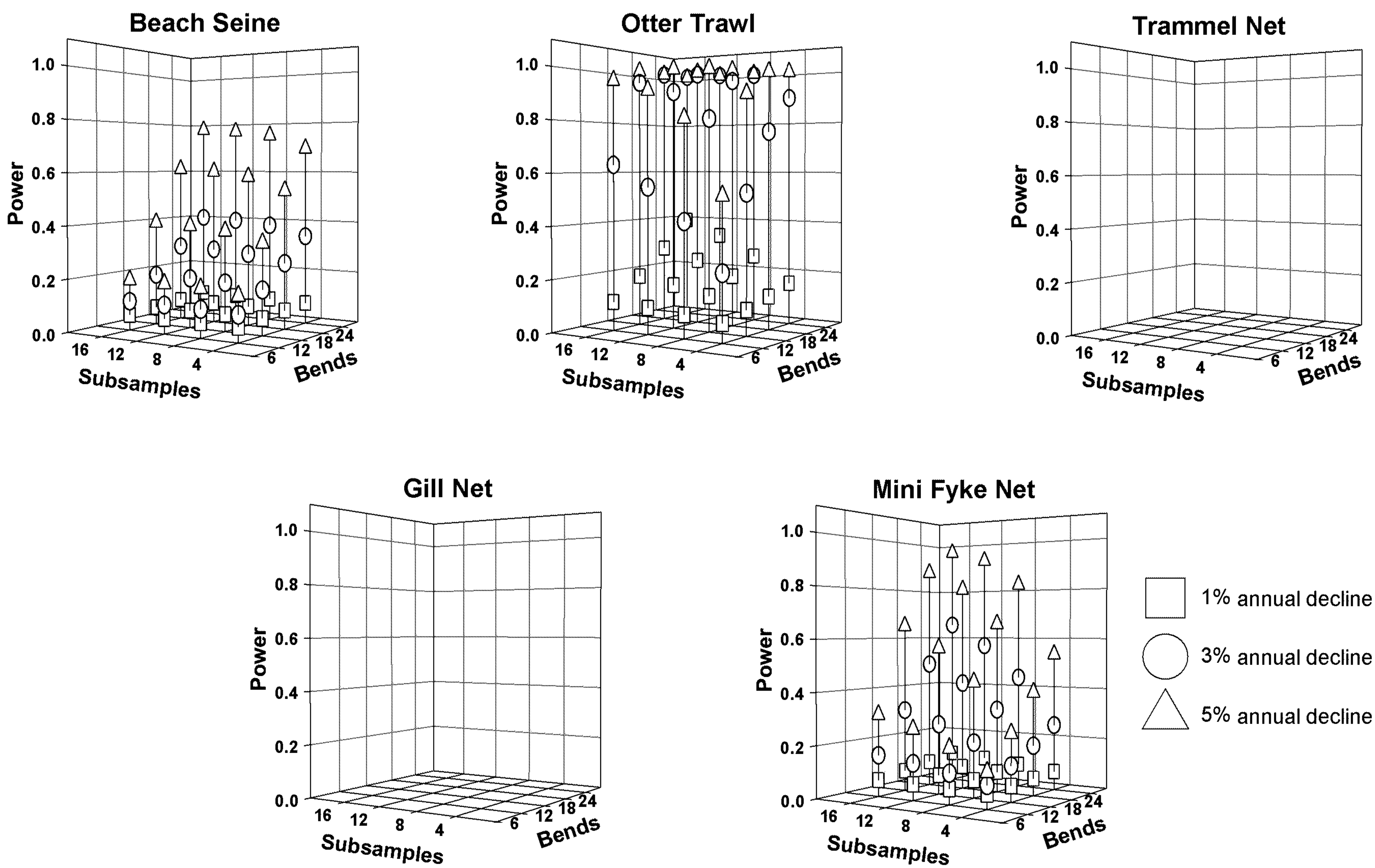

Figure 66. Twenty-year power curves for speckled chub-all from Zone 3 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

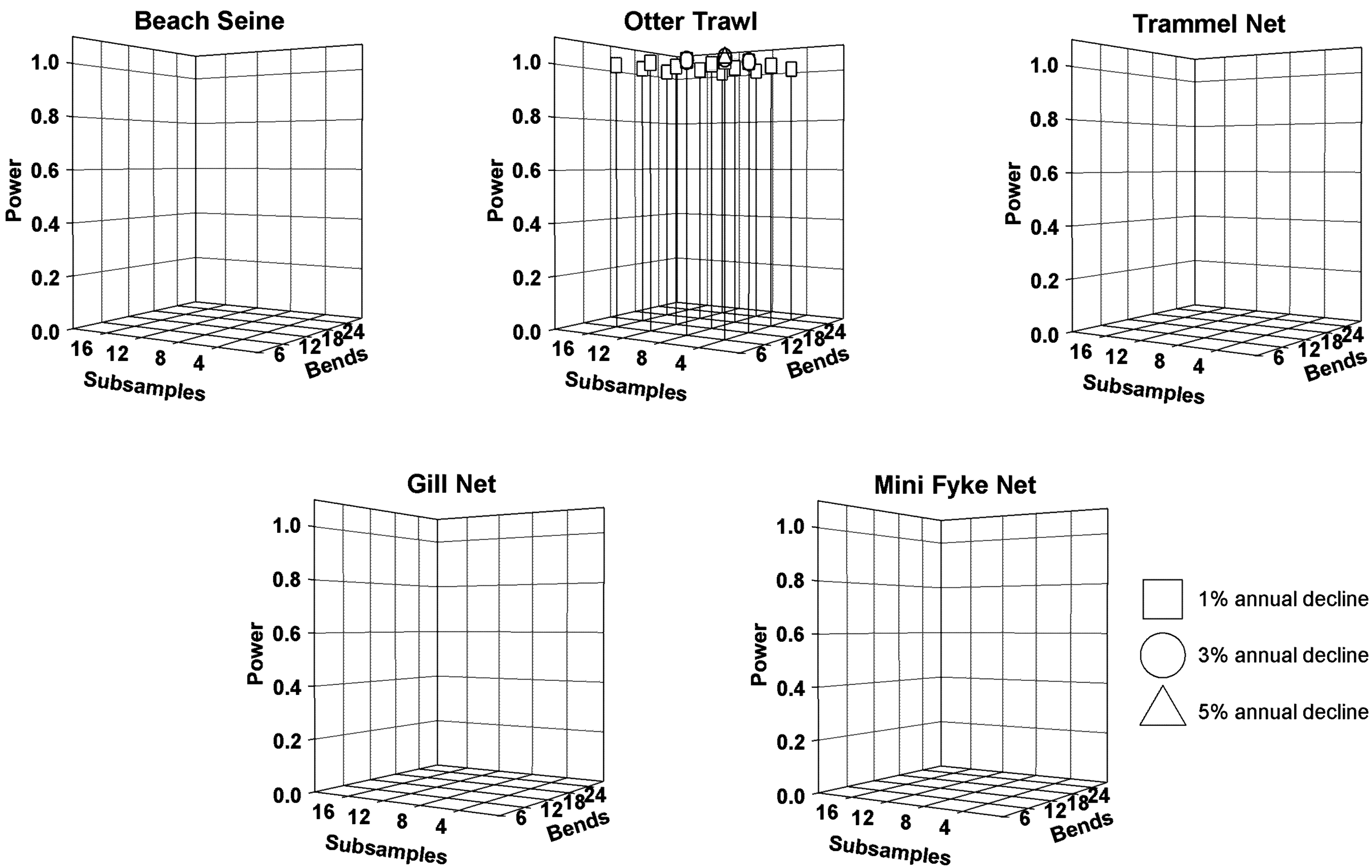

Figure 67. Twenty-year power curves for sturgeon chub-all from Zone 3 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

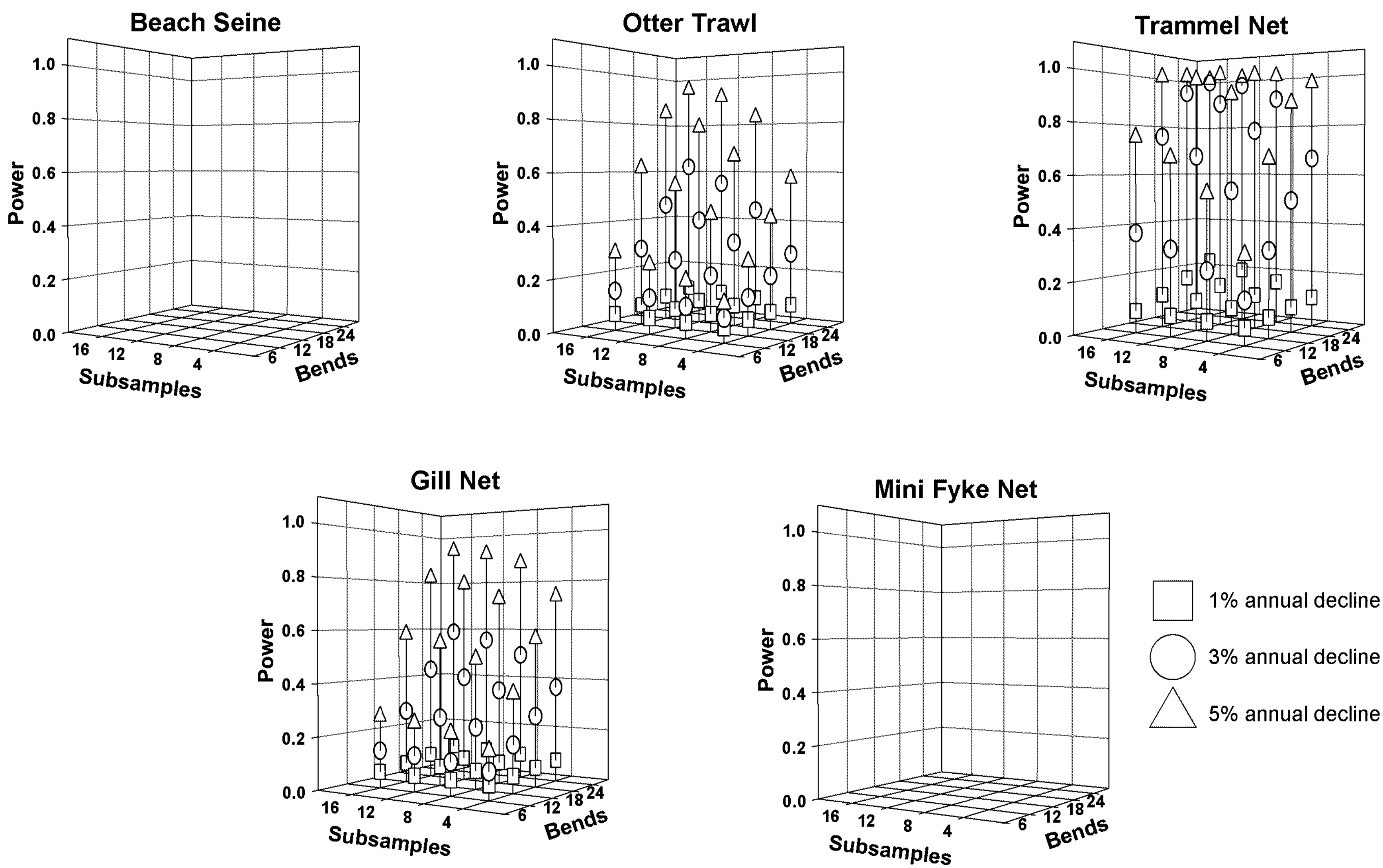

Figure 68. Twenty-year power curves for blue sucker-all from Zone 4 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

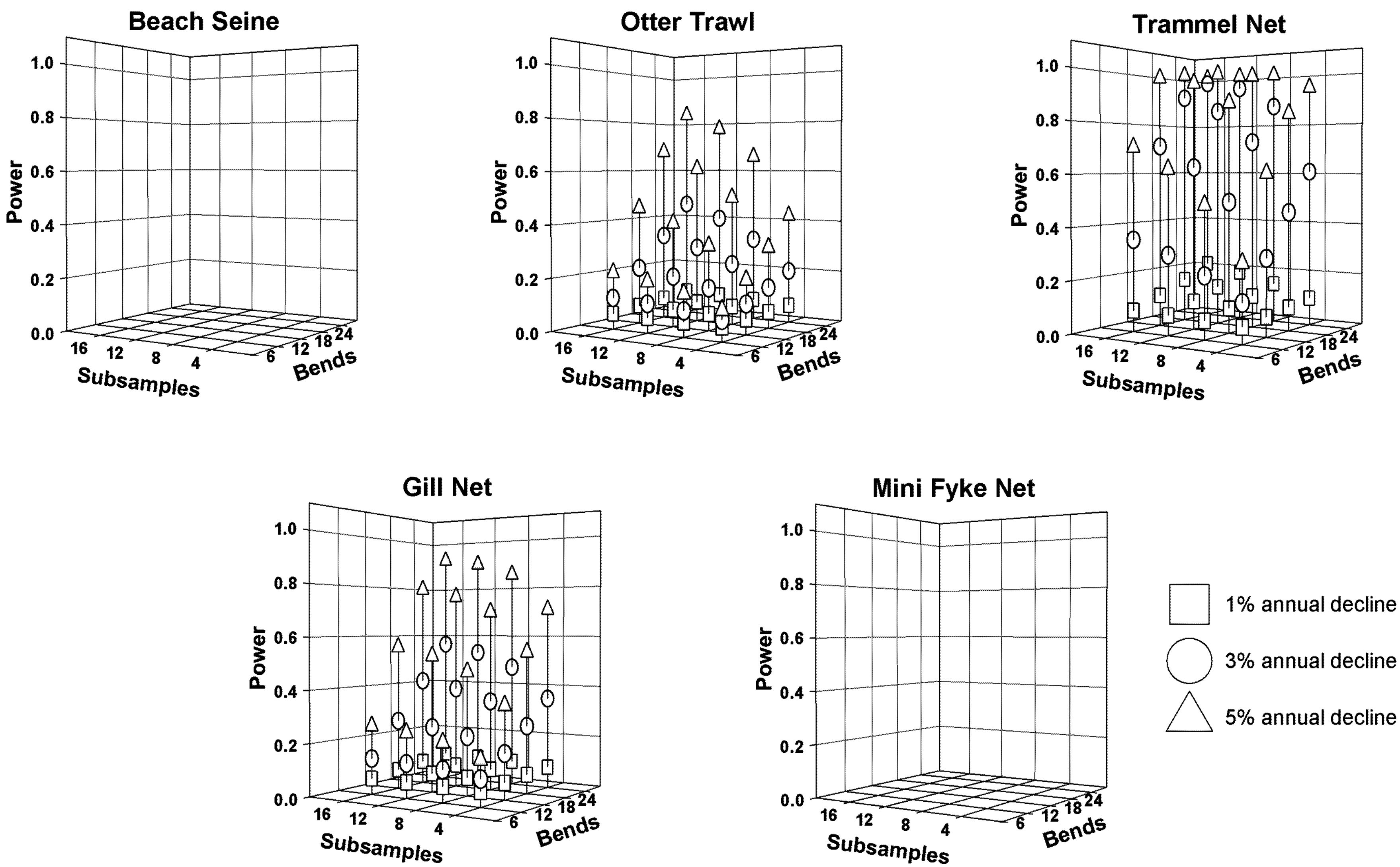

Figure 69. Twenty-year power curves for blue sucker-adult from Zone 4 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

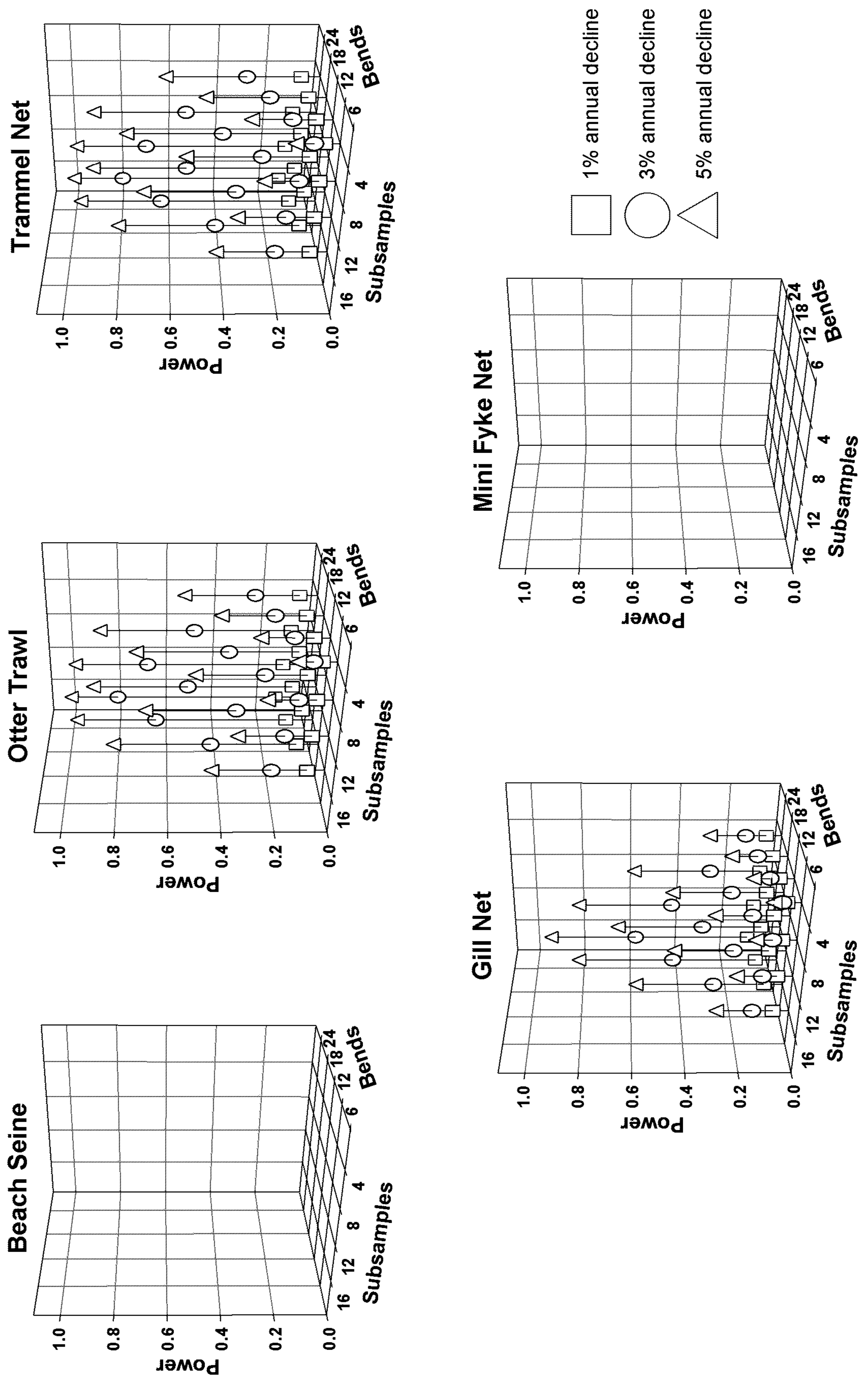

Figure 70. Twenty-year power curves for blue sucker-juvenile from Zone 4 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

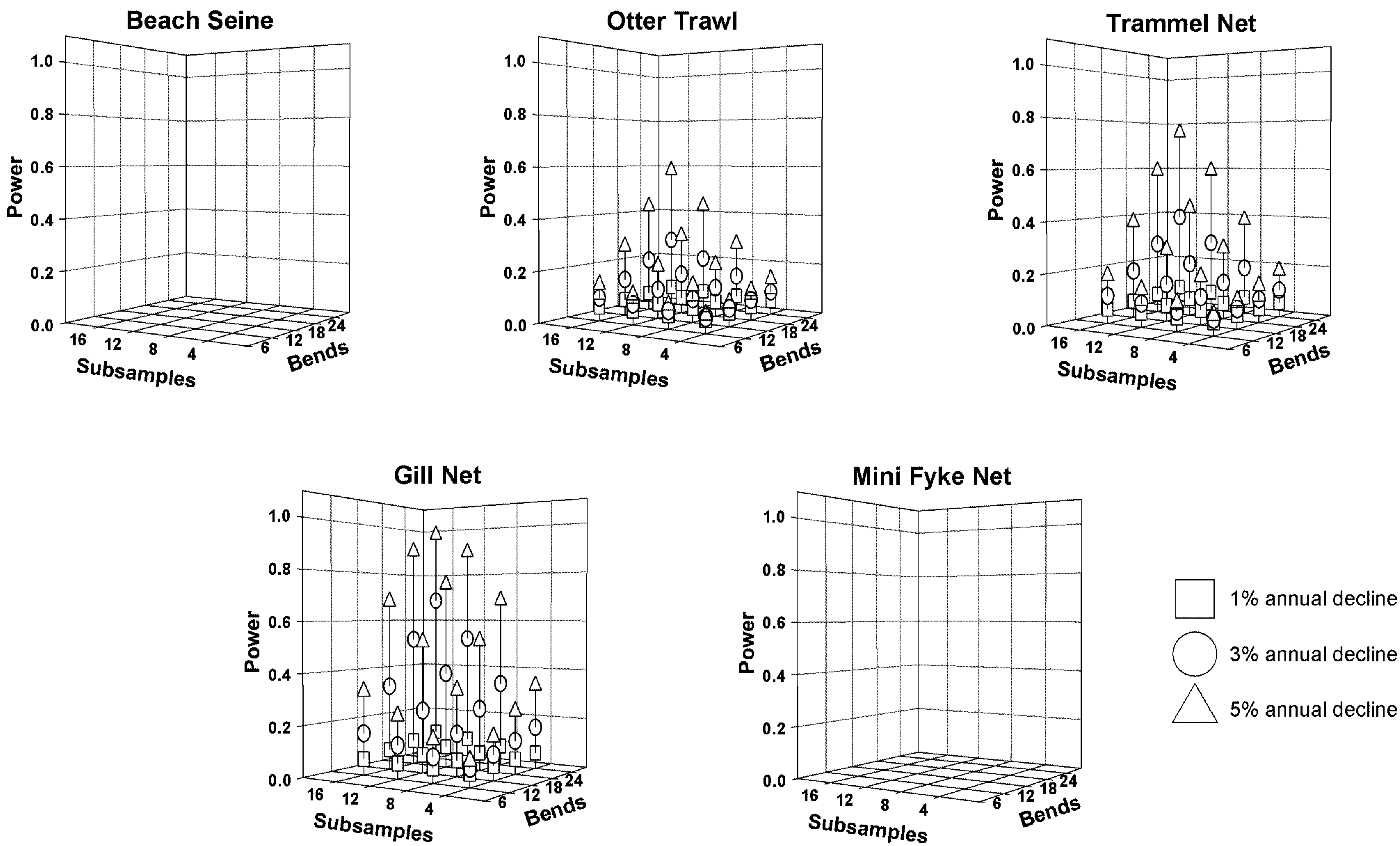

Figure 71. Twenty-year power curves for pallid sturgeon-all from Zone 4 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

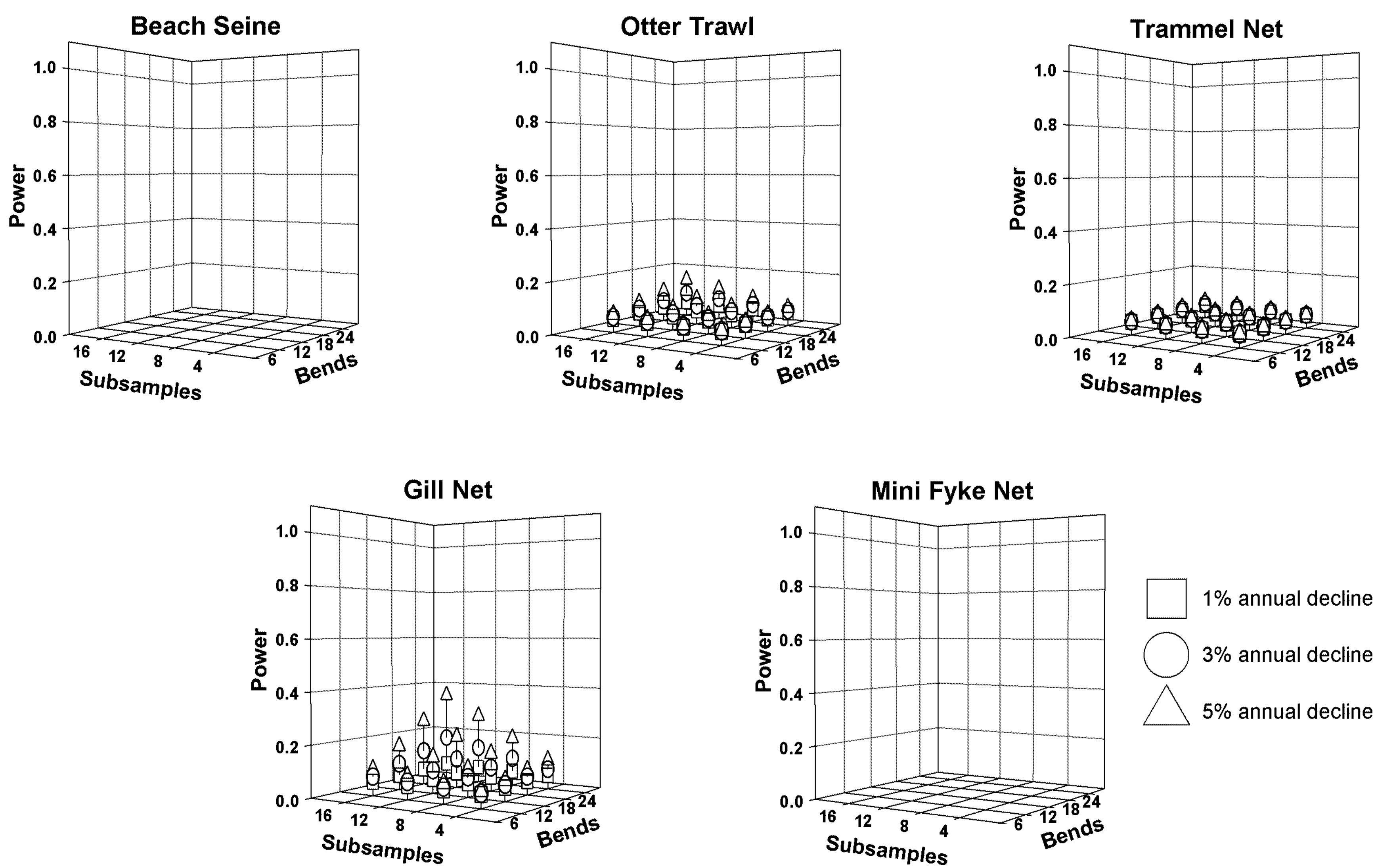

Figure 72. Twenty-year power curves for pallid sturgeon-adult from Zone 4 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

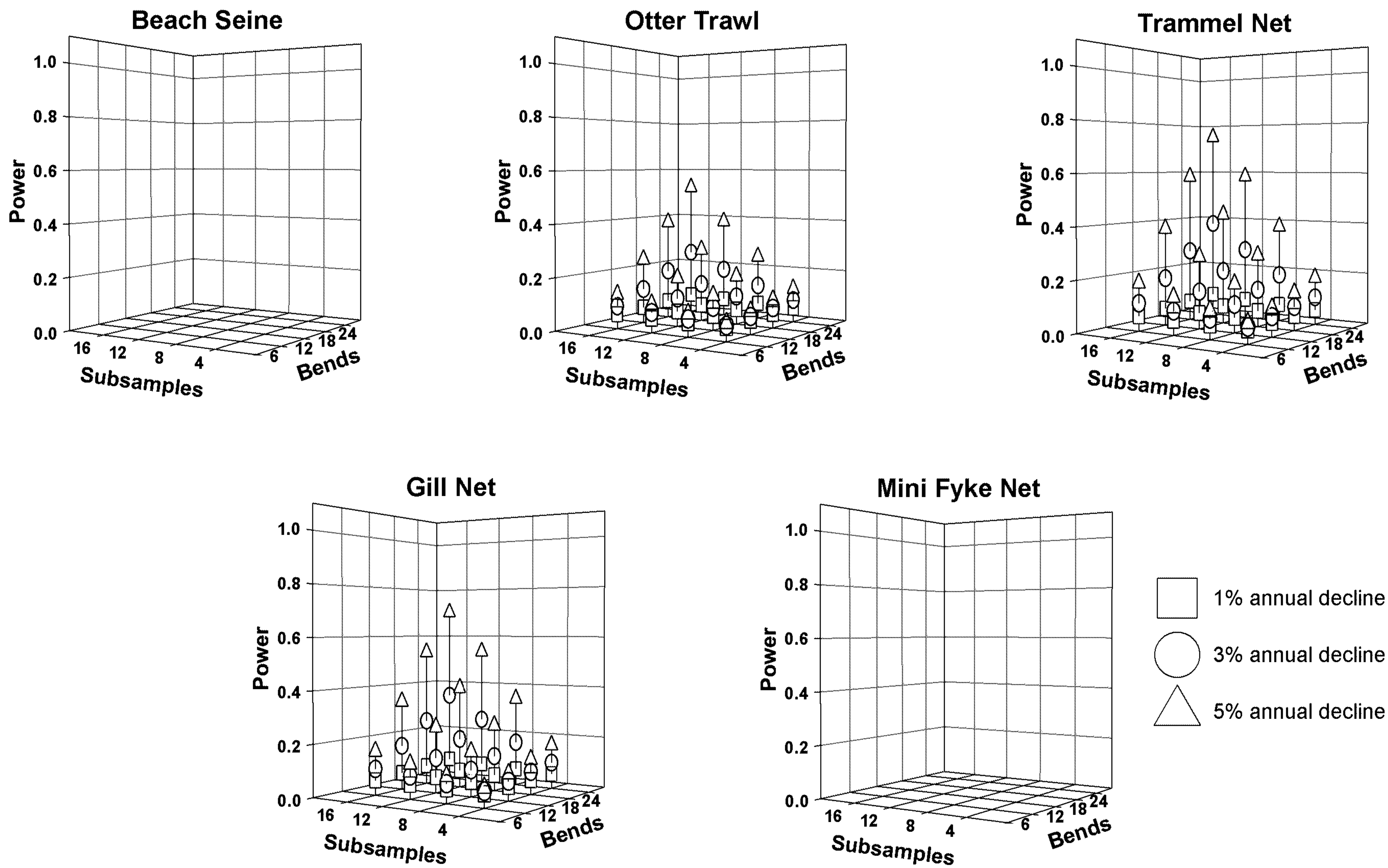

Figure 73. Twenty-year power curves for pallid sturgeon-juvenile from Zone 4 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

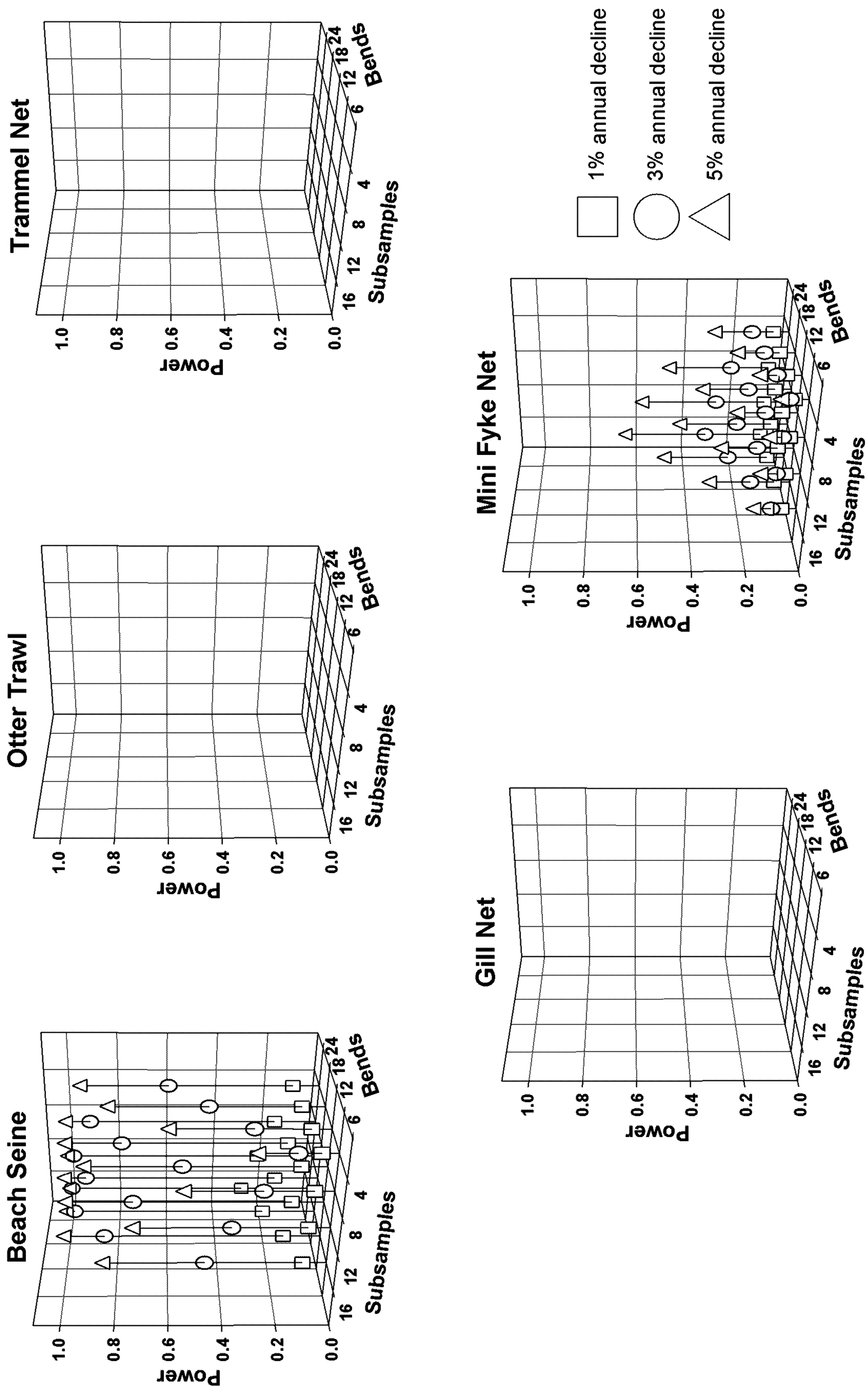

Figure 74. Twenty-year power curves for sand shiner-all from Zone 4 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

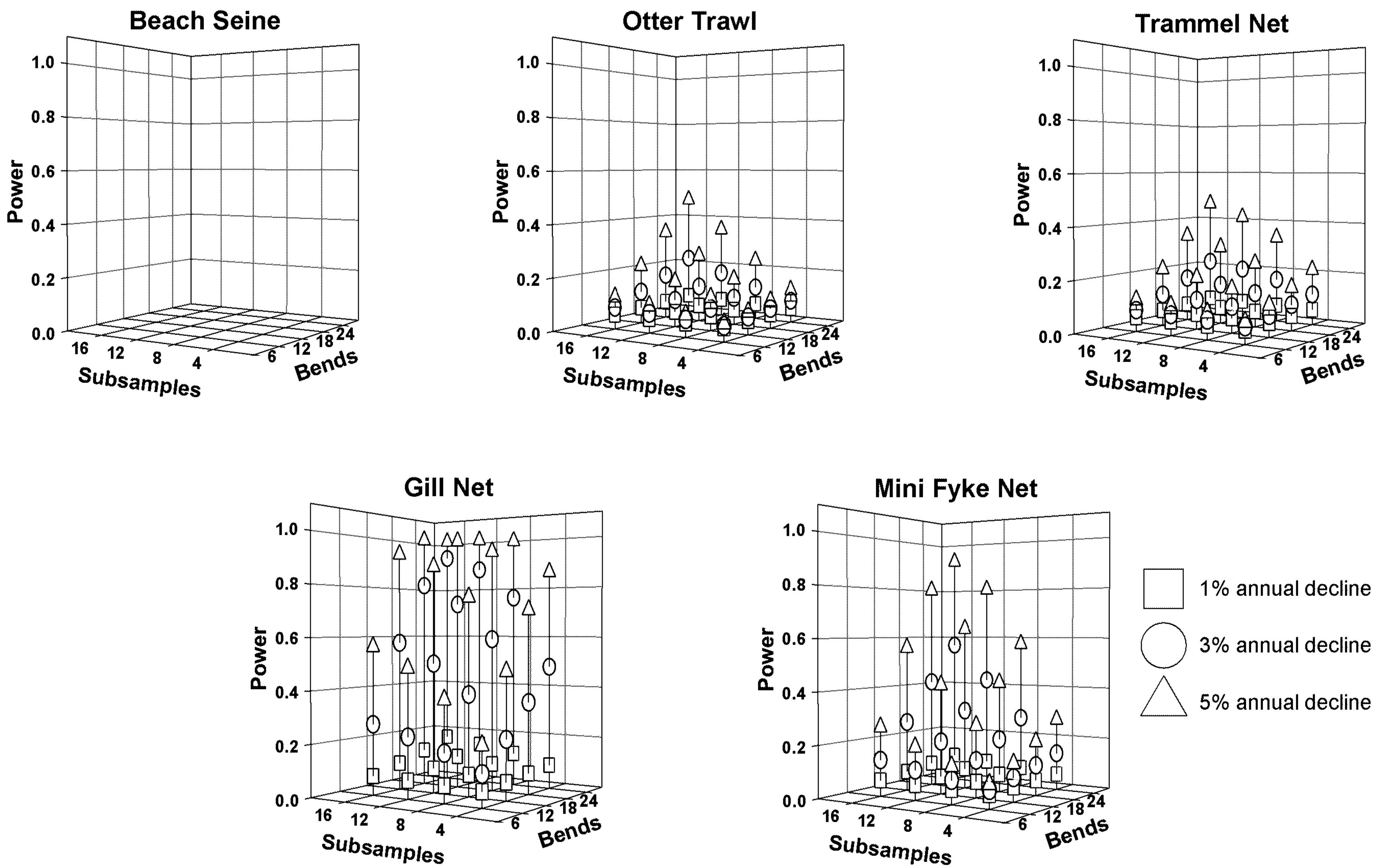

Figure 75. Twenty-year power curves for sauger-all from Zone 4 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

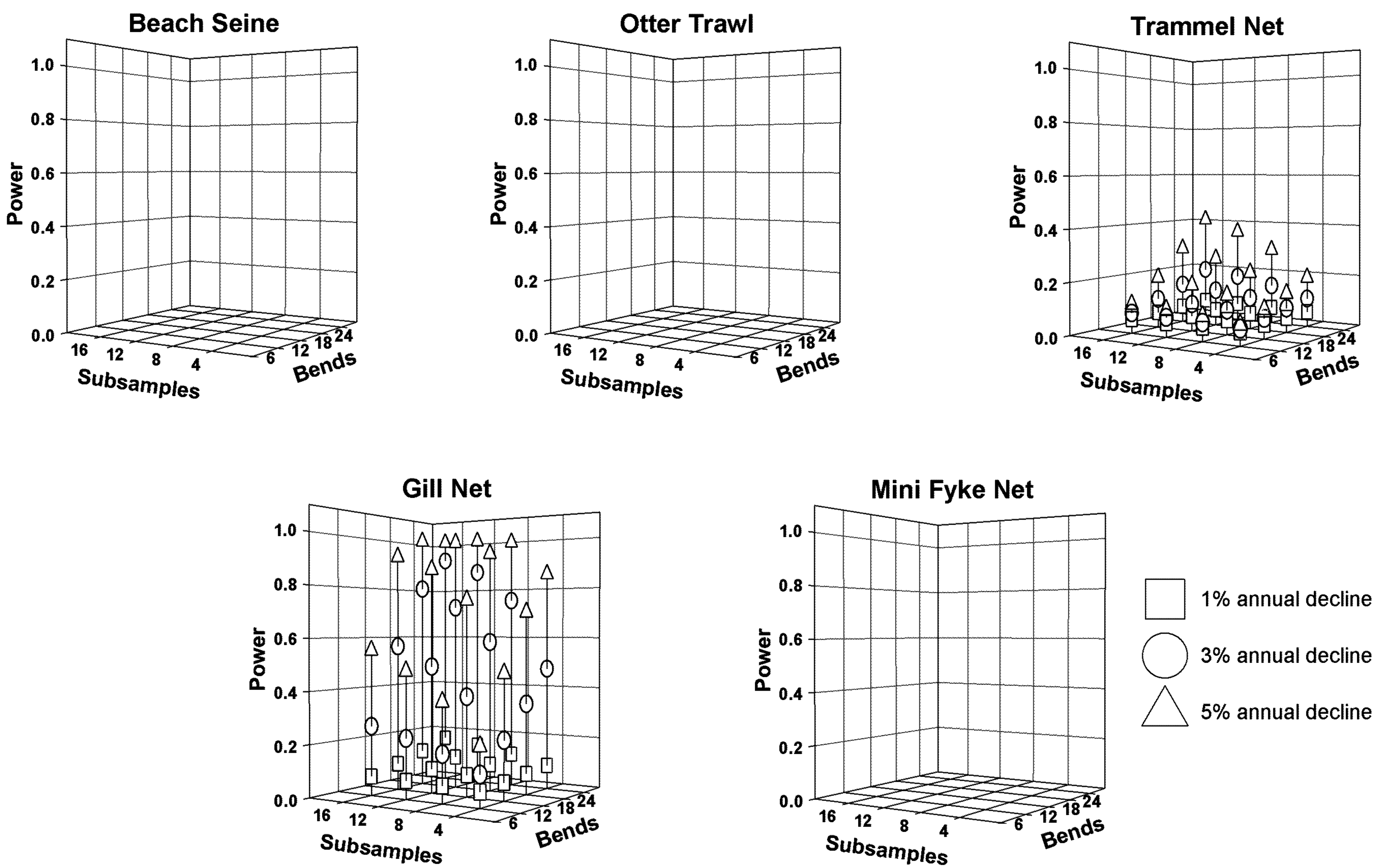

Figure 76. Twenty-year power curves for sauger-adult from Zone 4 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

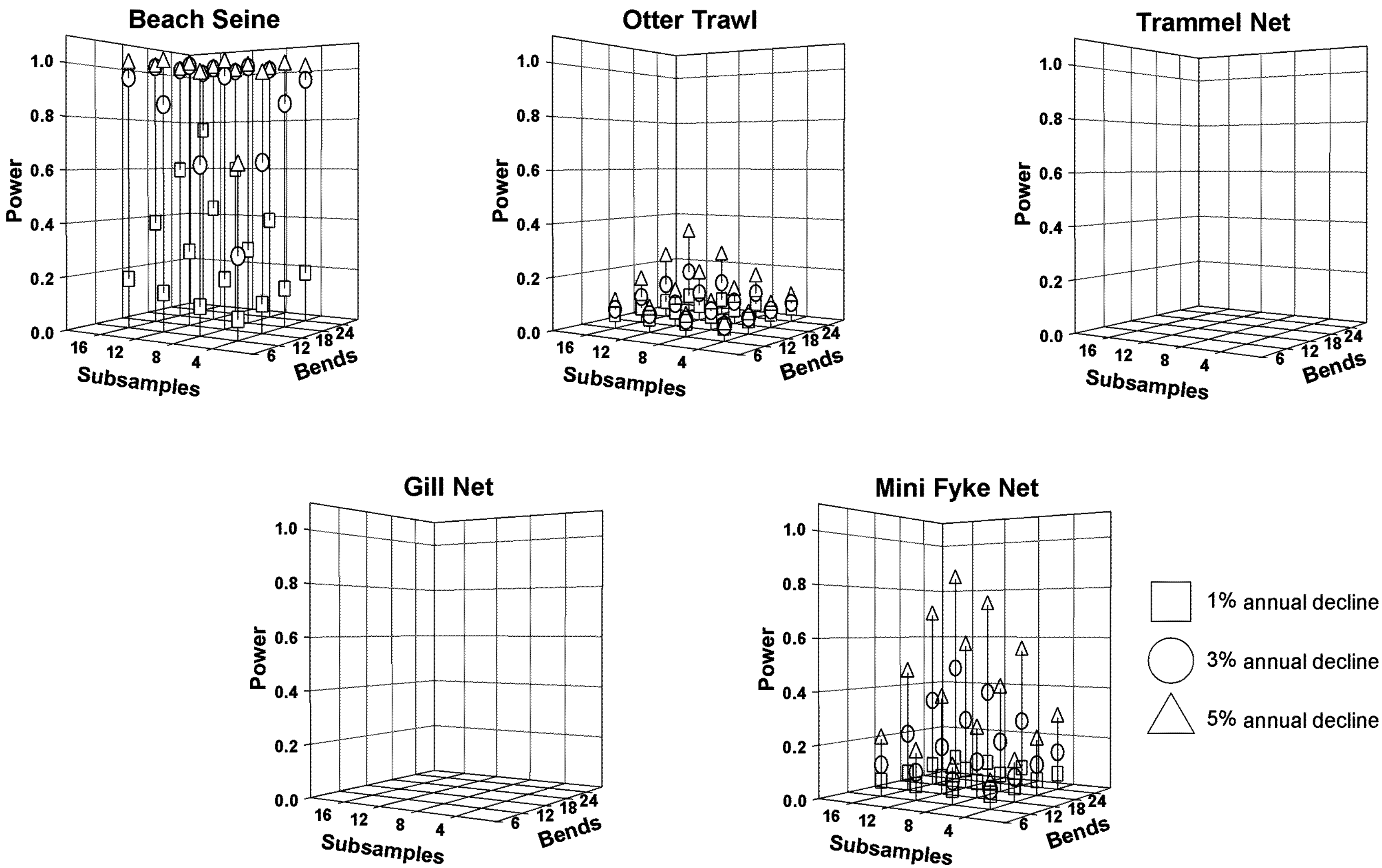

Figure 77. Twenty-year power curves for sauger-juvenile from Zone 4 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

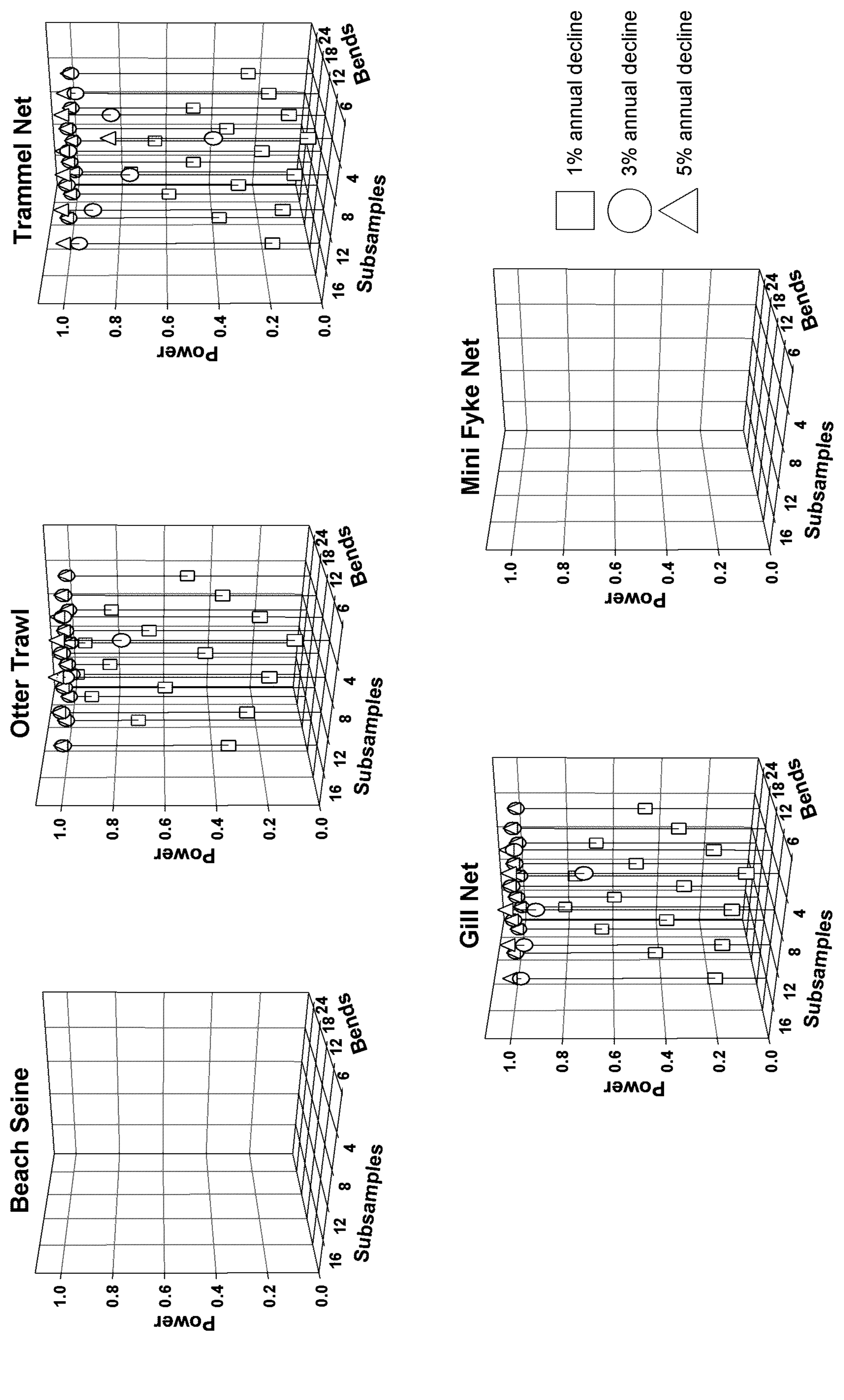

Figure 78. Twenty-year power curves for shovelnose sturgeon-all from Zone 4 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

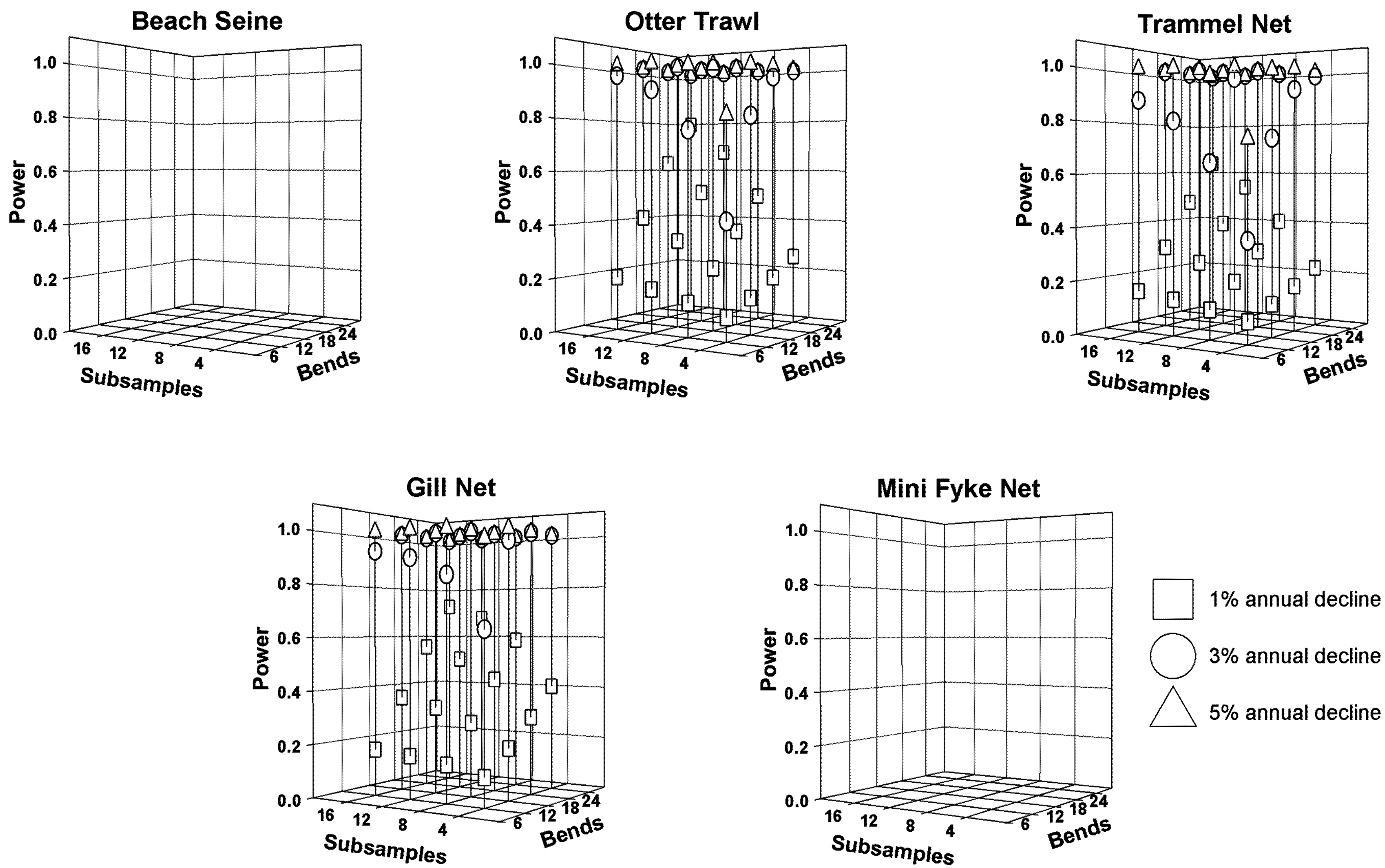

Figure 79. Twenty-year power curves for shovelnose sturgeon-adult from Zone 4 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

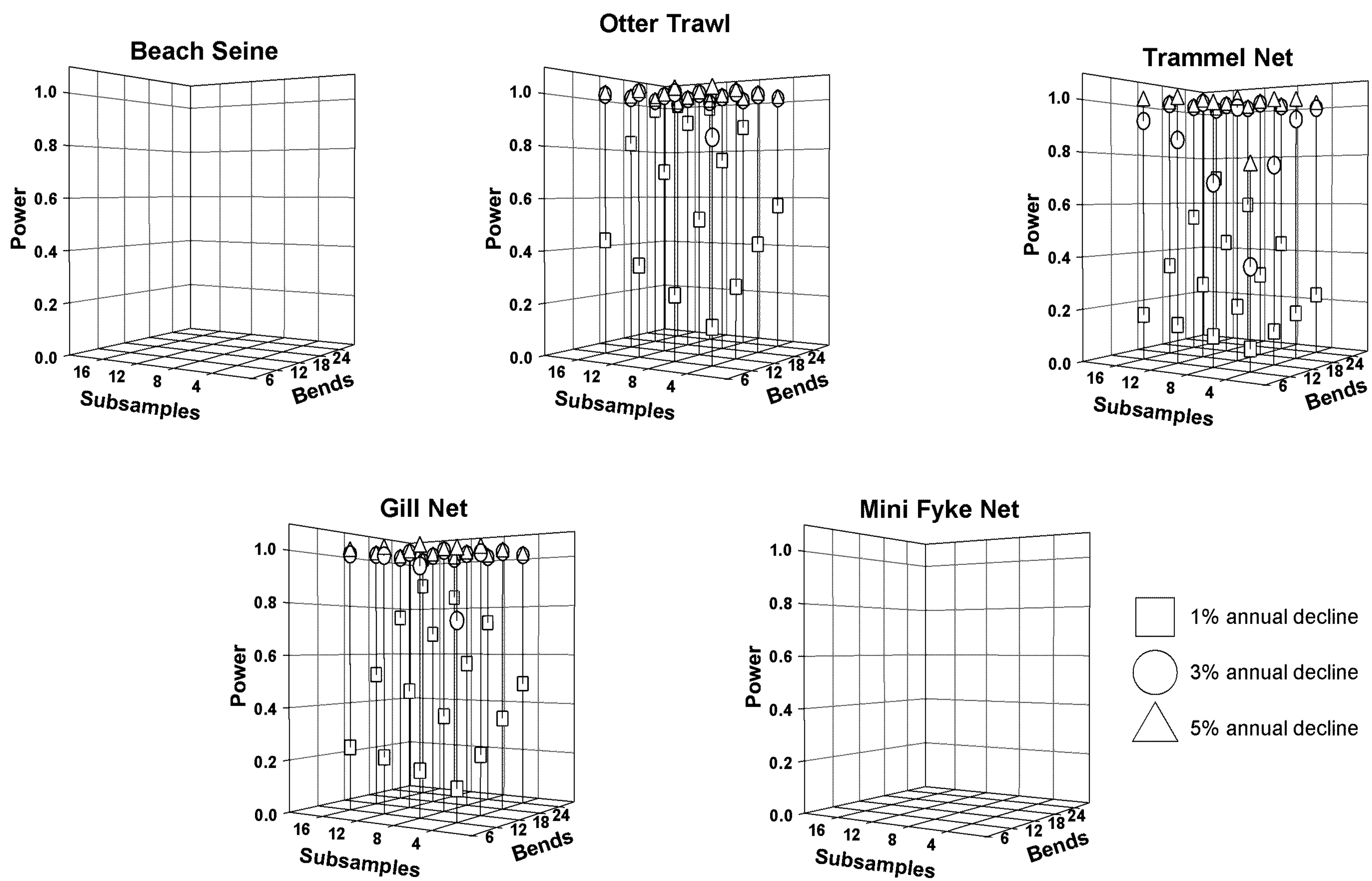

Figure 80. Twenty-year power curves for shovelnose sturgeon-juvenile from Zone 4 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

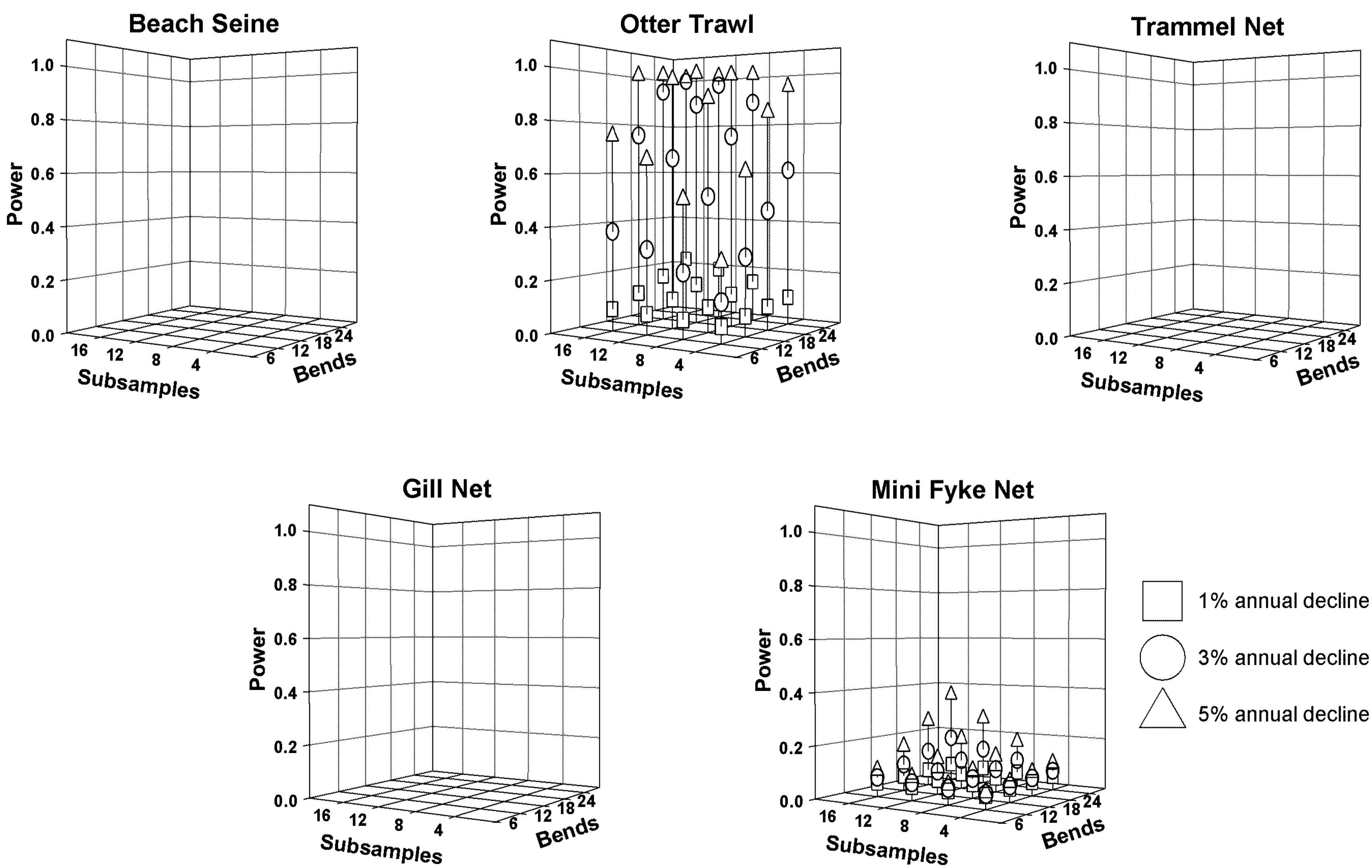

Figure 81. Twenty-year power curves for sicklefin chub-all from Zone 4 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

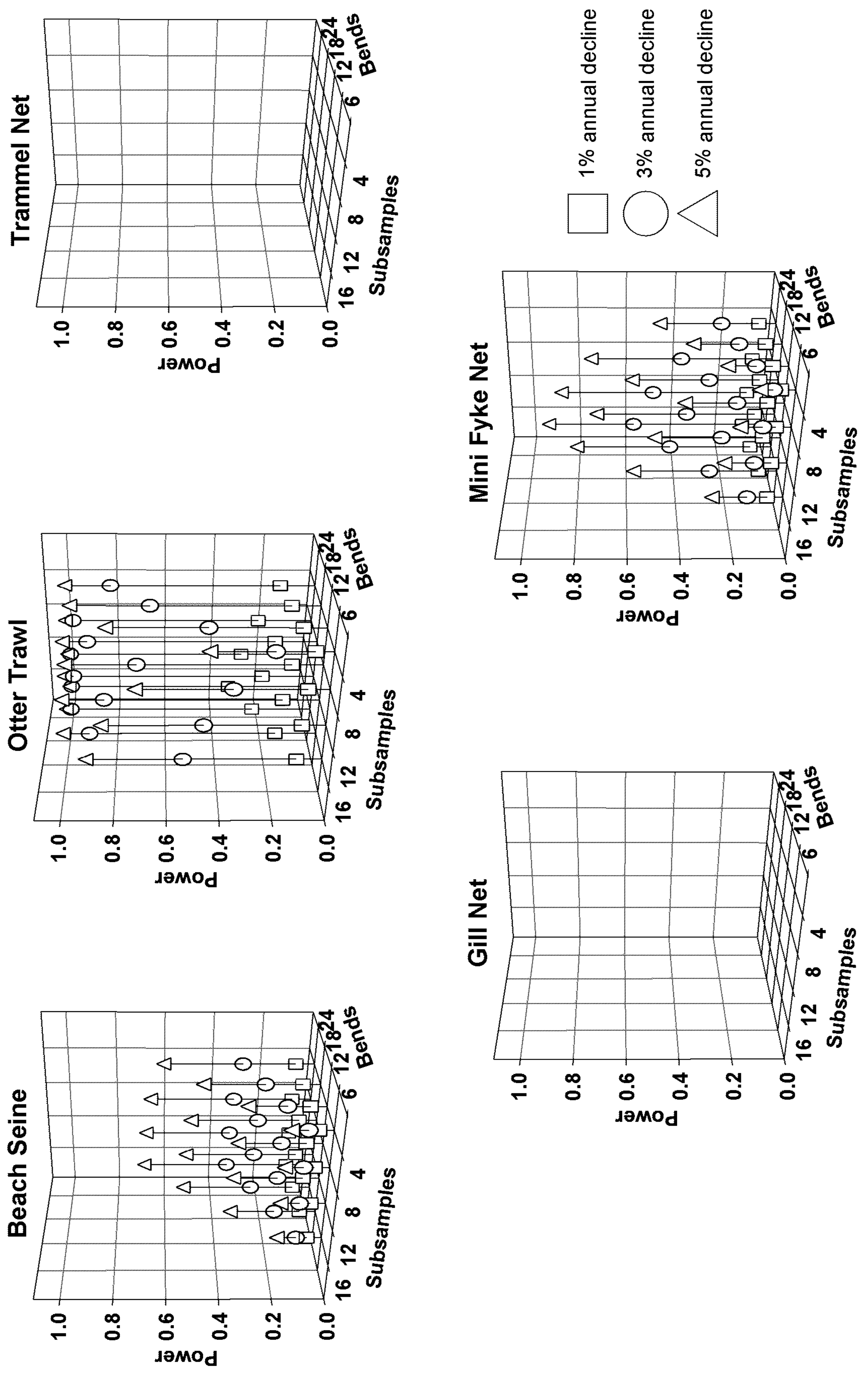

Figure 82. Twenty-year power curves for speckled chub-all from Zone 4 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

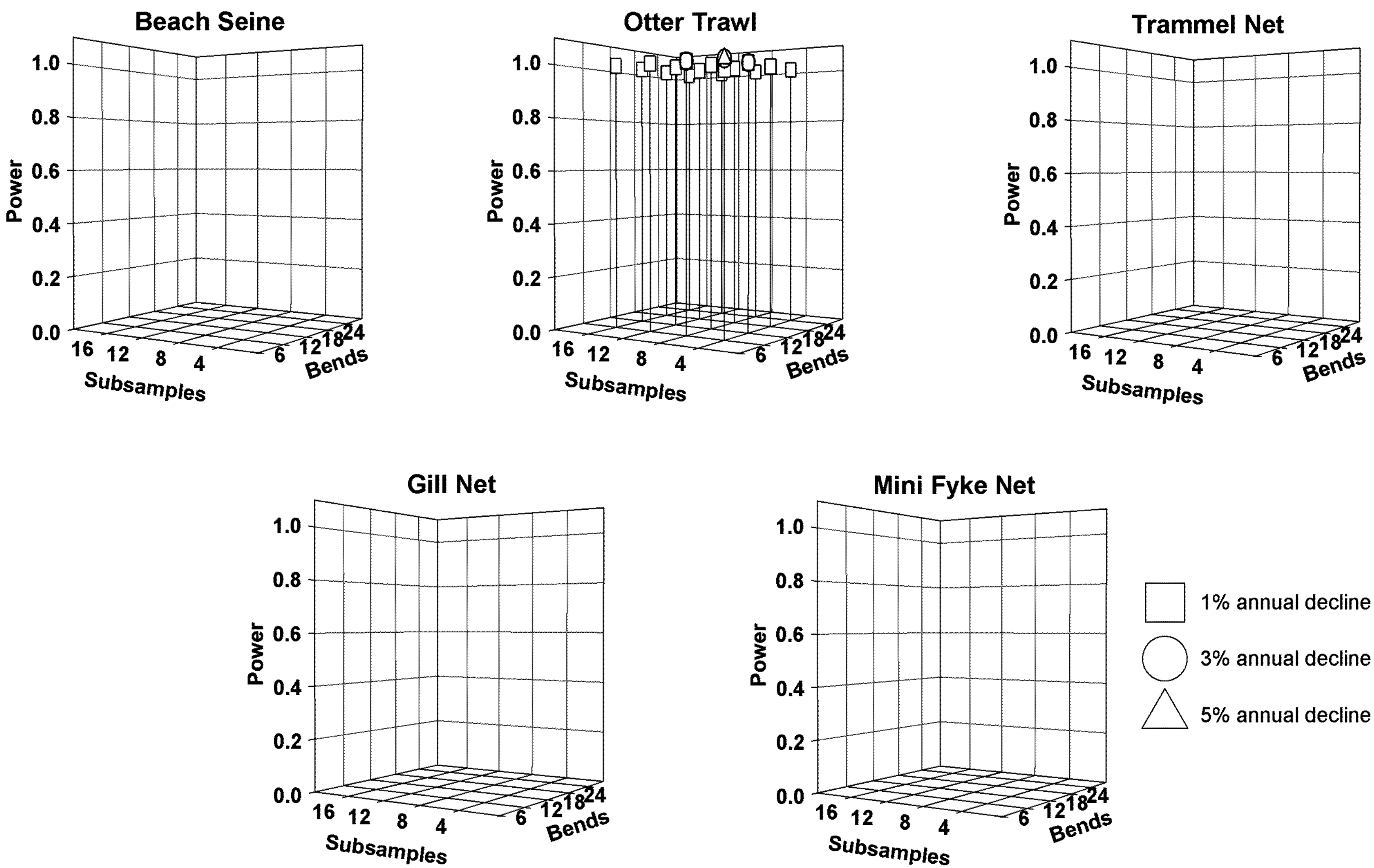

Figure 83. Twenty-year power curves for sturgeon chub-all from Zone 4 for each gear. If species catch did not meet minimum catch criteria, then power was not calculated.

Tables 3–20

Table 3. Summary of the sampling effort during 2003 to 2005 using five gear types: bag seine, gill net, mini-fyke net, otter trawl, and trammel net. These averages were calculated after the data errors and data were removed because of criteria (see methods).

[FC,Fish Community Season; ST, Sturgeon Season]

Year	Season	Segment	Number of bends	Average number of gear types per bend	Average number of subsamples per gear type
2003	FC	5	4	1.0	7.3
2003	FC	6	2	1.0	5.0
2003	FC	9	8	4.0	8.1
2003	FC	13	7	3.0	7.0
2003	FC	14	10	2.8	5.9
2003	ST	5	5	2.0	4.2
2003	ST	6	5	1.8	4.3
2003	ST	9	12	1.8	11.4
2003	ST	13	30	1.5	5.7
2003	ST	14	9	2.0	6.3
2004	FC	5	8	2.0	6.8
2004	FC	6	5	2.8	6.8
2004	FC	9	8	3.8	7.9
2004	FC	13	10	3.5	6.7
2004	FC	14	10	3.9	5.7
2004	ST	5	8	1.6	7.3
2004	ST	6	7	1.6	7.3
2004	ST	9	8	3.0	8.6
2004	ST	13	11	2.6	6.2
2004	ST	14	10	2.8	6.4
2005	FC	4	12	3.8	7.5
2005	FC	5	7	3.1	6.7
2005	FC	6	5	3.8	6.0
2005	FC	7	12	3.7	7.5
2005	FC	8	23	3.2	7.8
2005	FC	9	20	3.7	7.9
2005	FC	10	12	4.0	8.1
2005	FC	13	9	3.8	7.1
2005	FC	14	11	3.8	6.9
2005	ST	4	12	1.0	8.9
2005	ST	5	5	2.6	8.4
2005	ST	6	4	3.0	10.8
2005	ST	7	11	1.5	7.6
2005	ST	8	20	2.6	8.2
2005	ST	9	22	2.5	8.3
2005	ST	13	12	2.9	9.1
2005	ST	14	12	3.0	8.6

Table 4. In Zone 1, the total count of fish (proportion of non-occurrence in subsamples) and the number of bends the species occupied (proportion of non-occurrence in bends) in the power analysis for each gear type.

[--, a species was not caught for that gear]

Species	Beach seine		Mini-Fyke net		Otter trawl		Trammel net	
	Count	Bend	Count	Bend	Count	Bend	Count	Bend
Blue Sucker - All	-- --	-- --	-- --	-- --	1 (0.99)	1 (0.92)	2 (0.98)	2 (0.83)
Blue Sucker - Adult	-- --	-- --	-- --	-- --	-- --	-- --	2 (.98)	2 (.83)
Blue Sucker - Juvenile	-- --	-- --	-- --	-- --	1 (.99)	1 (.92)	-- --	-- --
Palid Sturgeon	-- --	-- --	-- --	-- --	6 (.94)	5 (.58)	13 (.96)	8 (.67)
Pallid Sturgeon - Adult	-- --	-- --	-- --	-- --	-- --	-- --	1 (.99)	1 (.92)
Pallid Sturgeon - Juvenile	-- --	-- --	-- --	-- --	6 (.94)	5 (.58)	12 (.96)	7 (.71)
Sand Shiner - All	-- --	-- --	1 (0.99)	1 (0.91)	-- --	-- --	-- --	-- --
Sauger - All	11 (0.9)	6 (0.45)	103 (.55)	8 (.91)	8 (.93)	5 (.58)	51 (.84)	18 (.25)
Sauger - Adult	-- --	-- --	13 (.87)	4 (.64)	-- --	-- --	49 (.85)	18 (.25)
Sauger - Juvenile	11 (.9)	6 (.45)	90 (.57)	8 (.27)	6 (.94)	4 (.67)	-- --	-- --
Shovelnose Sturgeon - All	-- --	-- --	-- --	-- --	79 (.6)	11 (.08)	131 (.74)	20 (.17)
Shovelnose Sturgeon - Adult	-- --	-- --	-- --	-- --	18 (.87)	6 (.5)	82 (.82)	15 (.38)
Shovelnose Sturgeon - Juvenile	-- --	-- --	-- --	-- --	61 (.66)	11 (.08)	49 (.86)	18 (.25)
Sicklefin Chub - All	-- --	-- --	-- --	-- --	247 (.27)	12 (0)	-- --	-- --
Speckled Chub - All	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
Sturgeon Chub - All	-- --	-- --	8 (.93)	2 (.82)	159 (.46)	12 (0)	-- --	-- --

Table 5. In Zone 2, the total count of fish (proportion of non-occurrence in subsamples) and the number of bends the species occupied (proportion of non-occurrenc einbends) in the power analysis for each gear type.

[--,a species was not caught for that gear]

Species	Beachseine		Gillnet		Mini-Fykenet		Ottertrawl		Trammelnet	
	Count	Bend	Count	Bend	Count	Bend	Count	Bend	Count	Bend
BlueSucker-All	-- --	-- --	5 (0.98)	2 (0.88)	-- --	-- --	2 (0.97)	2 (0.8)	-- --	-- --
Blue Sucker - Adult	-- --	-- --	5 (.98)	2 (.88)	-- --	-- --	2 (.97)	2 (.8)	3 (0.97)	2 (0.88)
Blue Sucker - Juvenile	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
Palid Sturgeon	-- --	-- --	13 (.96)	9 (.7)	-- --	-- --	3 (.98)	2 (.89)	14 (.95)	9 (.76)
Pallid Sturgeon - Adult	-- --	-- --	1 (.99)	1 (.92)	-- --	-- --	-- --	-- --	-- --	-- --
Pallid Sturgeon - Juvenile	-- --	-- --	12 (.96)	8 (.73)	-- --	-- --	3 (.98)	2 (.89)	14 (.95)	9 (.76)
Sand Shiner - All	23 (0.93)	5 (0.58)	-- --	-- --	83 (0.8)	12 (0.4)	-- --	-- --	-- --	-- --
Sauger - All	-- --	-- --	64 (.83)	25 (.17)	-- --	-- --	18 (.9)	5 (.72)	62 (.89)	20 (.63)
Sauger - Adult	-- --	-- --	64 (.83)	25 (.17)	-- --	-- --	10 (.94)	5 (.72)	62 (.89)	20 (.63)
Sauger - Juvenile	2 (.99)	2 (.91)	-- --	-- --	2 (.98)	2 (.9)	8 (.95)	4 (.78)	-- --	-- --
Shovelnose Sturgeon - All	-- --	-- --	106 (.76)	23 (.23)	-- --	-- --	13 (.91)	8 (.56)	91 (.82)	36 (.33)
Shovelnose Sturgeon - Adult	-- --	-- --	102 (.77)	22 (.27)	-- --	-- --	13 (.91)	8 (.56)	91 (.82)	36 (.33)
Shovelnose Sturgeon - Juvenile	-- --	-- --	4 (.99)	4 (.87)	-- --	-- --	-- --	-- --	-- --	-- --
Sicklefin Chub - All	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
Speckled Chub - All	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --
Sturgeon Chub - All	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --	-- --

Table 6. In Zone 3, the total count of fish (proportion of non-occurrence in subsamples) and the number of bends the species occupied (proportion of non-occurrence in bends) in the power analysis for each gear type.

[--, a species was not caught for that gear]

Species	Beach seine		Gill net		Mini-Fyke net		Otter trawl		Trammel net	
	Count	Bend	Count	Bend	Count	Bend	Count	Bend	Count	Bend
Blue Sucker - All	-- --	-- --	611 (0.77)	55 (0.34)	-- --	-- --	248 (0.9)	120 (0.52)	867 (0.79)	180 (0.32)
Blue Sucker - Adult	-- --	-- --	590 (.78)	50 (.4)	-- --	-- --	210 (.92)	105 (.58)	817 (.8)	174 (.34)
Blue Sucker - Juvenile	-- --	-- --	21 (.97)	19 (.77)	-- --	-- --	38 (.98)	30 (.88)	50 (.98)	36 (.86)
Palid Sturgeon	-- --	-- --	22 (.97)	20 (.76)	-- --	-- --	20 (.99)	18 (.93)	23 (.99)	23 (.91)
Pallid Sturgeon - Adult	-- --	-- --	9 (.99)	8 (.93)	-- --	-- --	1 (.99)	1 (.96)	2 (.99)	2 (.98)
Pallid Sturgeon - Juvenile	-- --	-- --	14 (.98)	14 (.83)	-- --	-- --	19 (.99)	17 (.93)	21 (.99)	21 (.92)
Sand Shiner - All	578 (0.76)	54 (0.33)	-- --	-- --	1,272 (0.8)	51 (0.35)	-- --	-- --	-- --	-- --
Sauger - All	24 (.96)	13 (.84)	220 (.85)	72 (.36)	23 (.98)	17 (.87)	33 (.99)	20 (.9)	46 (.98)	33 (.88)
Sauger - Adult	-- --	-- --	219 (.85)	71 (.37)	-- --	-- --	12 (.99)	10 (.93)	40 (.98)	27 (.87)
Sauger - Juvenile	24 (.96)	13 (.84)	-- --	-- --	18 (.98)	12 (.88)	20 (.99)	10 (.95)	-- --	-- --
Shovelnose Sturgeon - All	-- --	-- --	12,304 (.17)	109 (.03)	-- --	-- --	2,921 (.53)	242 (.03)	4,913 (.5)	248 (.06)
Shovelnose Sturgeon - Adult	-- --	-- --	8,427 (.24)	107 (.04)	-- --	-- --	1,367 (.72)	213 (.15)	2,770 (.62)	234 (.11)
Shovelnose Sturgeon - Juvenile	-- --	-- --	3,877 (.33)	103 (.08)	-- --	-- --	1,554 (.64)	227 (.09)	2,143 (.62)	231 (.13)
Sicklefin Chub - All	-- --	-- --	-- --	-- --	225 (.88)	21 (.6)	1,881 (.73)	164 (.34)	-- --	-- --
Speckled Chub - All	191 (.92)	22 (.77)	-- --	-- --	397 (.89)	49 (.62)	1,985 (.71)	194 (.22)	-- --	-- --
Sturgeon Chub - All	-- --	-- --	-- --	-- --	-- --	-- --	270 (.92)	106 (.58)	-- --	-- --

Table 7 In Zone 4, the total count of fish (proportion of non-occurrence in subsamples) and the number of bends the species occupied (proportion of non-occurrence in bends) in the power analysis for each gear type.

[--, a species was not caught for that gear]

Species	Beach seine		Gill net		Mini-Fyke net		Otter trawl		Trammel net	
	Count	Bend	Count	Bend	Count	Bend	Count	Bend	Count	Bend
Blue Sucker - All	-- --	-- --	566 (0.77)	50 (0.34)	-- --	-- --	226 (0.91)	112 (0.53)	801 (0.79)	166 (0.31)
Blue Sucker - Adult	-- --	-- --	546 (.78)	45 (.41)	-- --	-- --	191 (.93)	97 (.59)	757 (.8)	161 (.33)
Blue Sucker - Juvenile	-- --	-- --	20 (.97)	18 (.76)	-- --	-- --	35 (.98)	27 (.89)	44 (.98)	33 (.86)
Palid Sturgeon	-- --	-- --	22 (.97)	20 (.74)	-- --	-- --	20 (.99)	18 (.92)	22 (.99)	22 (.91)
Pallid Sturgeon - Adult	-- --	-- --	9 (.99)	8 (.92)	-- --	-- --	1 (.99)	1 (.96)	2 (.99)	2 (.98)
Pallid Sturgeon - Juvenile	-- --	-- --	14 (.98)	14 (.82)	-- --	-- --	19 (.99)	17 (.93)	20 (.99)	20 (.92)
Sand Shiner - All	467 (0.77)	61 (0.35)	-- --	-- --	419 (0.87)	53 (0.44)	-- --	-- --	-- --	-- --
Sauger - All	-- --	-- --	218 (.84)	70 (.33)	16 (.98)	14 (.88)	29 (.99)	18 (.9)	35 (.98)	27 (.89)
Sauger - Adult	-- --	-- --	217 (.84)	69 (.34)	-- --	-- --	-- --	-- --	33 (.98)	25 (.9)
Sauger - Juvenile	13 (.97)	10 (.86)	-- --	-- --	11 (.98)	9 (.9)	19 (.99)	9 (.95)	-- --	-- --
Shovelnose Sturgeon - All	-- --	-- --	12,248 (.15)	103 (.02)	-- --	-- --	2,854 (.53)	231 (.03)	4,569 (.5)	226 (.07)
Shovelnose Sturgeon - Adult	-- --	-- --	8,397 (.21)	102 (.03)	-- --	-- --	1,338 (.72)	204 (.15)	2,588 (.62)	212 (.12)
Shovelnose Sturgeon - Juvenile	-- --	-- --	3,851 (.3)	99 (.06)	-- --	-- --	1,516 (.63)	217 (.09)	1,981 (.62)	210 (.13)
Sicklefin Chub - All	-- --	-- --	-- --	-- --	225 (.88)	21 (.6)	1,880 (.72)	163 (.32)	-- --	-- --
Speckled Chub - All	191 (.92)	22 (.74)	-- --	-- --	397 (.88)	49 (.58)	1,984 (.7)	193 (.19)	-- --	-- --
Sturgeon Chub - All	-- --	-- --	-- --	-- --	-- --	-- --	269 (.91)	105 (.56)	-- --	-- --

Table 8. Model statistics for all models used in the power analysis.

[z, zone; gt, gear-trammel net; gg, gear-gill net; --, no number required; go, gear-otter trawl; seg, segment; sf, season-fish community; ss, season-sturgeon; gm, gear-mini fyke net; gb, gear-beach seine]

Species	Model type	Yearly catch per unit	Factor levels					Unbound		Bound	
			Year	Season	Segment	Bend	Subsamples	Bend variance component estimate (10^{-3})	Subsample variance component estimate	Bend variance component estimate (10^{-2})	Subsample variance component estimate
Blue Sucker-Adult	z1,gt	0.0093	1	1	1	12	93	-0.0048	0.0033	0	0.0033
Blue Sucker-Adult	z2,gg	.0231	2	1	2	17	172	--	--	.2548	.0187
Blue Sucker-Adult	z2,go	.0064	1	1	2	10	62	-.0386	.0020	0	.0019
Blue Sucker-Adult	z2,seg5,go	.0051	1	1	1	6	43	-.0008	.0014	0	.0014
Blue Sucker-Adult	z2,seg6,gg	.0461	1	1	1	8	92	--	--	.5583	.0347
Blue Sucker-Adult	z2,seg6,go	.0077	1	1	1	4	19	-.1032	.0033	0	.0032
Blue Sucker-Adult	z2,sf,go	.0064	1	1	2	10	62	-.0386	.0020	0	.0019
Blue Sucker-Adult	z3,gg	.2192	2	1	5	83	752	--	--	9.1395	.4072
Blue Sucker-Adult	z3,go	.0445	3	2	6	250	1,979	--	--	.9201	.0916
Blue Sucker-Adult	z3,gt	.2194	3	2	6	264	1,929	--	--	6.6243	.8378
Blue Sucker-Adult	z3,seg7,gg	.3752	1	1	1	7	48	--	--	10.9616	1.5885
Blue Sucker-Adult	z3,seg7,go	.0673	1	1	1	11	85	--	--	.0146	.0245
Blue Sucker-Adult	z3,seg7,gt	.2228	1	2	1	22	175	--	--	8.3736	.4435
Blue Sucker-Adult	z3,sf,go	.0532	3	1	6	133	1,033	--	--	1.6146	.1424
Blue Sucker-Adult	z3,sf,gt	.2946	3	1	6	135	1,006	--	--	8.7405	1.3031
Blue Sucker-Adult	z3,ss,go	.0359	3	1	4	117	946	--	--	.0671	.0368
Blue Sucker-Adult	z3,ss,gt	.1441	3	1	5	129	923	--	--	4.4758	.3296
Blue Sucker-Adult	z4,gg	.2104	2	1	4	76	704	--	--	9.0045	.3279
Blue Sucker-Adult	z4,go	.0449	3	2	5	239	1,894	--	--	.9614	.0946
Blue Sucker-Adult	z4,gt	.2208	3	2	5	242	1,754	--	--	6.3780	.8777
Blue Sucker-Adult	z4,seg10,go	.0123	1	1	1	12	96	-.1074	.0051	0	.0050
Blue Sucker-Adult	z4,seg10,gt	.0401	1	1	1	12	96	--	--	.0897	.0206
Blue Sucker-Adult	z4,seg13,gg	.0155	1	1	1	22	205	--	--	.0297	.0039
Blue Sucker-Adult	z4,seg13,go	.0157	3	2	1	57	471	--	--	.0270	.0076
Blue Sucker-Adult	z4,seg13,gt	.0586	3	2	1	56	360	--	--	.6402	.0446
Blue Sucker-Adult	z4,seg14,gg	.0297	1	1	1	22	192	-.6228	.0464	0	.0459
Blue Sucker-Adult	z4,seg14,go	.0265	3	2	1	61	456	--	--	.0302	.0165
Blue Sucker-Adult	z4,seg14,gt	.1328	3	2	1	60	393	--	--	2.5972	.0908
Blue Sucker-Adult	z4,seg8,gg	.6368	1	1	1	12	116	--	--	10.9631	.8017
Blue Sucker-Adult	z4,seg8,go	.1673	1	2	1	39	304	--	--	.6971	.2032
Blue Sucker-Adult	z4,seg8,gt	.5884	1	2	1	40	315	--	--	17.5400	2.2713

Table 8. Model statistics for all models used in the power analysis.—Continued

[z, zone; gt, gear-trammel net; gg, gear-gill net; --, no number required; go, gear-otter trawl; seg, segment; sf, season-fish community; ss, season-sturgeon; gm, gear-mini fyke net; gb, gear-beach seine]

Species	Model type	Yearly catch per unit	Factor levels					Unbound		Bound	
			Year	Season	Segment	Bend	Subsamples	Bend variance component estimate (10^{-3})	Subsample variance component estimate	Bend variance component estimate (10^{-2})	Subsample variance component estimate
Blue Sucker-Adult	z4,seg9,gg	0.4113	1	1	1	20	191	--	--	26.8122	0.6706
Blue Sucker-Adult	z4,seg9,go	.0710	3	2	1	70	567	--	--	2.6072	.1875
Blue Sucker-Adult	z4,seg9,gt	.4052	3	2	1	74	590	--	--	8.0997	1.2926
Blue Sucker-Adult	z4,sf,go	.0540	3	1	5	122	948	--	--	1.7570	.1529
Blue Sucker-Adult	z4,sf,gt	.2980	3	1	5	123	914	--	--	8.6586	1.3703
Blue Sucker-Adult	z4,ss,go	.0359	3	1	4	117	946	--	--	.0671	.0368
Blue Sucker-Adult	z4,ss,gt	.1436	3	1	4	119	840	--	--	4.1118	.3401
Blue Sucker-All	z1,go	.0027	1	1	1	12	95	--	--	2.33×10^{-6}	.0007
Blue Sucker-All	z1,gt	.0093	1	1	1	12	93	-0.0048	0.0033	0	.0033
Blue Sucker-All	z2,gg	.0231	2	1	2	17	172	--	--	.2548	.0187
Blue Sucker-All	z2,go	.0064	1	1	2	10	62	-.0386	.0020	0	.0019
Blue Sucker-All	z2,seg5,go	.0051	1	1	1	6	43	-.0008	.0014	0	.0014
Blue Sucker-All	z2,seg6,gg	.0461	1	1	1	8	92	--	--	.5583	.0347
Blue Sucker-All	z2,seg6,go	.0077	1	1	1	4	19	-.1032	.0033	0	.0032
Blue Sucker-All	z3,gg	.2266	2	1	5	83	752	--	--	9.4215	.4218
Blue Sucker-All	z3,go	.0525	3	2	6	250	1,979	--	--	.9236	.0944
Blue Sucker-All	z3,gt	.2359	3	2	6	264	1,929	--	--	7.4271	.8632
Blue Sucker-All	z3,seg7,gg	.3819	1	1	1	7	48	--	--	11.4268	1.7381
Blue Sucker-All	z3,seg7,go	.0793	1	1	1	11	85	--	--	.0029	.0281
Blue Sucker-All	z3,seg7,gt	.2413	1	2	1	22	175	--	--	10.6548	.5264
Blue Sucker-All	z3,sf,go	.0582	3	1	6	133	1,033	--	--	1.5929	.1443
Blue Sucker-All	z3,sf,gt	.3073	3	1	6	135	1,006	--	--	9.7024	1.3309
Blue Sucker-All	z3,ss,go	.0469	3	1	4	117	946	--	--	.1060	.0405
Blue Sucker-All	z3,ss,gt	.1646	3	1	5	129	923	--	--	5.0986	.3524
Blue Sucker-All	z4,gg	.2181	2	1	4	76	704	--	--	9.2767	.3334
Blue Sucker-All	z4,go	.0526	3	2	5	239	1,894	--	--	.9657	.0974
Blue Sucker-All	z4,gt	.2366	3	2	5	242	1,754	--	--	7.0243	.8974
Blue Sucker-All	z4,seg10,go	.0123	1	1	1	12	96	-.1074	.0051	0	.0050
Blue Sucker-All	z4,seg10,gt	.0450	1	1	1	12	96	--	--	.0462	.0230
Blue Sucker-All	z4,seg13,gg	.0184	1	1	1	22	205	--	--	.0076	.0055
Blue Sucker-All	z4,seg13,go	.0216	3	2	1	57	471	--	--	.0296	.0107
Blue Sucker-All	z4,seg13,gt	.0632	3	2	1	56	360	--	--	.5812	.0530

Table 8. Model statistics for all models used in the power analysis.—Continued

[z, zone; gt, gear-trammel net; gg, gear-gill net; --, no number required; go, gear-otter trawl; seg, segment; sf, season-fish community; ss, season-sturgeon; gm, gear-mini fyke net; gb, gear-beach seine]

Species	Model type	Yearly catch per unit	Factor levels					Unbound		Bound	
			Year	Season	Segment	Bend	Subsamples	Bend variance component estimate (10^{-3})	Subsample variance component estimate	Bend variance component estimate (10^{-2})	Subsample variance component estimate
Blue Sucker-All	z4,seg14,gg	0.0332	1	1	1	22	192	--	--	0.0605	0.0464
Blue Sucker-All	z4,seg14,go	.0331	3	2	1	61	456	-0.0419	0.0182	0	.0182
Blue Sucker-All	z4,seg14,gt	.1412	3	2	1	60	393	--	--	2.7660	.0913
Blue Sucker-All	z4,seg8,gg	.6495	1	1	1	12	116	--	--	12.1138	.8121
Blue Sucker-All	z4,seg8,go	.1721	1	2	1	39	304	--	--	.9117	.2038
Blue Sucker-All	z4,seg8,gt	.6017	1	2	1	40	315	--	--	19.9930	2.2484
Blue Sucker-All	z4,seg9,gg	.4260	1	1	1	20	191	--	--	26.9806	.6827
Blue Sucker-All	z4,seg9,go	.0813	3	2	1	70	567	--	--	2.5534	.1921
Blue Sucker-All	z4,seg9,gt	.4375	3	2	1	74	590	--	--	8.7100	1.3570
Blue Sucker-All	z4,sf,go	.0584	3	1	5	122	948	--	--	1.7344	.1548
Blue Sucker-All	z4,sf,gt	.3105	3	1	5	123	914	--	--	9.5975	1.3929
Blue Sucker-All	z4,ss,go	.0469	3	1	4	117	946	--	--	.1060	.0405
Blue Sucker-All	z4,ss,gt	.1628	3	1	4	119	840	--	--	4.4430	.3568
Blue Sucker-Juvenile	z1,go	.0027	1	1	1	12	95	--	--	$2.33x10^{-6}$	.0007
Blue Sucker-Juvenile	z3,gg	.0075	2	1	5	83	752	-.0276	.0025	0	.0024
Blue Sucker-Juvenile	z3,go	.0080	3	2	6	250	1,979	--	--	.0045	.0031
Blue Sucker-Juvenile	z3,gt	.0166	3	2	6	264	1,929	--	--	.0511	.0104
Blue Sucker-Juvenile	z3,seg7,gg	.0067	1	1	1	7	48	-.0505	.0046	0	.0046
Blue Sucker-Juvenile	z3,seg7,go	.0120	1	1	1	11	85	-.1347	.0054	0	.0053
Blue Sucker-Juvenile	z3,seg7,gt	.0185	1	2	1	22	175	--	--	.1387	.0143
Blue Sucker-Juvenile	z3,sf,go	.0050	3	1	6	133	1,033	--	--	.0082	.0023
Blue Sucker-Juvenile	z3,sf,gt	.0127	3	1	6	135	1,006	--	--	.0134	.0070
Blue Sucker-Juvenile	z3,ss,go	.0110	3	1	4	117	946	--	--	.0008	.0040
Blue Sucker-Juvenile	z3,ss,gt	.0205	3	1	5	129	923	--	--	.0913	.0141
Blue Sucker-Juvenile	z4,gg	.0077	2	1	4	76	704	-.0248	.0023	0	.0023
Blue Sucker-Juvenile	z4,go	.0077	3	2	5	239	1,894	--	--	.0054	.0030
Blue Sucker-Juvenile	z4,gt	.0158	3	2	5	242	1,754	--	--	.0416	.0100
Blue Sucker-Juvenile	z4,seg10,gt	.0050	1	1	1	12	96	--	--	0	.0024
Blue Sucker-Juvenile	z4,seg13,gg	.0030	1	1	1	22	205	-.0101	.0010	0	.0010
Blue Sucker-Juvenile	z4,seg13,go	.0059	3	2	1	57	471	--	--	.0079	.0025
Blue Sucker-Juvenile	z4,seg13,gt	.0047	3	2	1	56	360	-.0432	.0024	0	.0023

Table 8. Model statistics for all models used in the power analysis.—Continued

[z, zone; gt, gear-trammel net; gg, gear-gill net; --, no number required; go, gear-otter trawl; seg, segment; sf, season-fish community; ss, season-sturgeon; gm, gear-mini fyke net; gb, gear-beach seine]

Species	Model type	Yearly catch per unit	Factor levels					Unbound		Bound	
			Year	Season	Segment	Bend	Subsamples	Bend variance component estimate (10^{-3})	Subsample variance component estimate	Bend variance component estimate (10^{-2})	Subsample variance component estimate
Blue Sucker-Juvenile	z4,seg14,gg	0.0035	1	1	1	22	192	-0.0021	0.0012	0	0.0012
Blue Sucker-Juvenile	z4,seg14,go	.0066	3	2	1	61	456	--	--	.0009	.0019
Blue Sucker-Juvenile	z4,seg14,gt	.0084	3	2	1	60	393	--	--	.0135	.0027
Blue Sucker-Juvenile	z4,seg8,gg	.0126	1	1	1	12	116	--	--	.0011	.0037
Blue Sucker-Juvenile	z4,seg8,go	.0048	1	2	1	39	304	-.0016	.0040	0	.0040
Blue Sucker-Juvenile	z4,seg8,gt	.0133	1	2	1	40	315	-.1004	.0102	0	.0101
Blue Sucker-Juvenile	z4,seg9,gg	.0146	1	1	1	20	191	-.0863	.0040	0	.0039
Blue Sucker-Juvenile	z4,seg9,go	.0103	3	2	1	70	567	--	--	.0109	.0043
Blue Sucker-Juvenile	z4,seg9,gt	.0323	3	2	1	74	590	--	--	.1241	.0206
Blue Sucker-Juvenile	z4,sf,go	.0044	3	1	5	122	948	--	--	.0106	.0021
Blue Sucker-Juvenile	z4,sf,gt	.0124	3	1	5	123	914	--	--	.0163	.0066
Blue Sucker-Juvenile	z4,ss,go	.0110	3	1	4	117	946	--	--	.0008	.0040
Blue Sucker-Juvenile	z4,ss,gt	.0192	3	1	4	119	840	--	--	.0680	.0138
Pallid Sturgeon-Adult	z1,gt	.0026	1	1	1	12	93	-.0043	.0010	0	.0010
Pallid Sturgeon-Adult	z2,gg	.0071	1	1	2	13	110	--	--	.0010	.0043
Pallid Sturgeon-Adult	z2,seg6,gg	.0143	1	1	1	6	47	--	--	.0042	.0100
Pallid Sturgeon-Adult	z3,gg	.0028	3	1	5	112	943	--	--	.0013	.0008
Pallid Sturgeon-Adult	z3,go	.0011	1	1	3	28	237	--	--	.0002	.0003
Pallid Sturgeon-Adult	z3,gt	.0011	2	1	5	103	761	--	--	.0004	.0014
Pallid Sturgeon-Adult	z4,gg	.0030	3	1	4	105	895	--	--	.0014	.0009
Pallid Sturgeon-Adult	z4,go	.0011	1	1	3	28	237	--	--	.0002	.0003
Pallid Sturgeon-Adult	z4,gt	.0012	2	1	4	93	678	--	--	.0004	.0015
Pallid Sturgeon-Adult	z4,seg13,gg	.0035	1	1	1	48	336	-.0056	.0009	0	.0009
Pallid Sturgeon-Adult	z4,seg13,gt	.0016	2	1	1	21	133	-.0087	.0003	0	.0003
Pallid Sturgeon-Adult	z4,seg8,gg	.0052	1	1	1	12	116	-.0135	.0015	0	.0015
Pallid Sturgeon-Adult	z4,seg9,gg	.0039	1	1	1	23	251	--	--	.0066	.0011
Pallid Sturgeon-Adult	z4,seg9,go	.0034	1	1	1	9	82	--	--	.0005	.0007
Pallid Sturgeon-Adult	z4,seg9,gt	.0028	2	1	1	31	248	--	--	.0010	.0040
Pallid Sturgeon-All	z1,go	.0184	1	1	1	12	95	-.0655	.0050	0	.0050
Pallid Sturgeon-All	z1,gt	.0285	1	2	1	24	200	-.1502	.0121	0	.0120
Pallid Sturgeon-All	z1,sf,gt	.0491	1	1	1	12	93	-.2706	.0226	0	.0223

Table 8. Model statistics for all models used in the power analysis.—Continued

[z, zone; gt, gear-trammel net; gg, gear-gill net; --, no number required; go, gear-otter trawl; seg, segment; sf, season-fish community; ss, season-sturgeon; gm, gear-mini fyke net; gb, gear-beach seine]

Species	Model type	Yearly catch per unit	Factor levels					Unbound		Bound	
			Year	Season	Segment	Bend	Subsamples	Bend variance component estimate (10^{-3})	Subsample variance component estimate	Bend variance component estimate (10^{-2})	Subsample variance component estimate
Pallid Sturgeon-All	z1,ss,gt	0.0080	1	1	1	12	107	-0.0257	0.0031	0	0.0030
Pallid Sturgeon-All	z2,gg	.0323	3	1	2	30	282	--	--	.0472	.0263
Pallid Sturgeon-All	z2,go	.0086	1	2	2	18	124	--	--	.0373	.0012
Pallid Sturgeon-All	z2,gt	.0186	2	2	2	38	269	--	--	.0419	.0086
Pallid Sturgeon-All	z2,seg5,gg	.0573	1	1	1	16	143	--	--	.0820	.0462
Pallid Sturgeon-All	z2,seg5,go	.0172	1	2	1	10	75	--	--	.0650	.0019
Pallid Sturgeon-All	z2,seg5,gt	.0235	2	2	1	20	138	--	--	.0359	.0133
Pallid Sturgeon-All	z2,seg6,gg	.0072	1	1	1	14	139	-.0013	.0059	0	.0059
Pallid Sturgeon-All	z2,seg6,gt	.0137	2	2	1	18	131	--	--	.0481	.0037
Pallid Sturgeon-All	z2,sf,go	.0095	1	1	2	10	62	--	--	.1007	.0005
Pallid Sturgeon-All	z2,sf,gt	.0306	2	1	2	18	131	--	--	.0947	.0134
Pallid Sturgeon-All	z2,ss,go	.0077	1	1	2	8	62	--	--	.0274	.0017
Pallid Sturgeon-All	z2,ss,gt	.0067	2	1	2	20	138	-.0311	.0041	0	.0040
Pallid Sturgeon-All	z3,gg	.0084	2	1	5	83	752	-.0228	.0027	0	.0026
Pallid Sturgeon-All	z3,go	.0032	3	2	6	250	1,979	-.0011	.0021	0	.0021
Pallid Sturgeon-All	z3,gt	.0055	3	2	6	264	1,929	-.0276	.0043	0	.0043
Pallid Sturgeon-All	z3,seg7,gt	.0039	1	2	1	22	175	--	--	.0055	.0012
Pallid Sturgeon-All	z3,sf,go	.0041	3	1	6	133	1,033	-.0085	.0022	0	.0022
Pallid Sturgeon-All	z3,sf,gt	.0063	3	1	6	135	1,006	-.0285	.0044	0	.0044
Pallid Sturgeon-All	z3,ss,gt	.0047	3	1	5	129	923	-.0266	.0043	0	.0042
Pallid Sturgeon-All	z4,gg	.0093	2	1	4	76	704	-.0258	.0028	0	.0028
Pallid Sturgeon-All	z4,go	.0034	3	2	5	239	1,894	-.0011	.0022	0	.0022
Pallid Sturgeon-All	z4,gt	.0057	3	2	5	242	1,754	-.0311	.0046	0	.0046
Pallid Sturgeon-All	z4,seg10,go	.0054	1	1	1	12	96	-.0159	.0014	0	.0014
Pallid Sturgeon-All	z4,seg10,gt	.0112	1	1	1	12	96	-.0680	.0060	0	.0059
Pallid Sturgeon-All	z4,seg13,gg	.0109	1	1	1	22	205	-.0070	.0030	0	.0030
Pallid Sturgeon-All	z4,seg13,go	.0043	3	2	1	57	471	--	--	.0009	.0015
Pallid Sturgeon-All	z4,seg13,gt	.0052	3	2	1	56	360	-.0063	.0018	0	.0018
Pallid Sturgeon-All	z4,seg14,gg	.0037	1	1	1	22	192	-.0307	.0017	0	.0017
Pallid Sturgeon-All	z4,seg14,go	.0006	3	2	1	61	456	-.0008	.0002	0	.0002
Pallid Sturgeon-All	z4,seg14,gt	.0022	3	2	1	60	393	-.0015	.0007	0	.0007
Pallid Sturgeon-All	z4,seg8,gg	.0075	1	1	1	12	116	-.0408	.0022	0	.0021
Pallid Sturgeon-All	z4,seg8,go	.0092	1	2	1	39	304	-.0390	.0071	0	.0070

Table 8. Model statistics for all models used in the power analysis.—Continued

[z, zone; gt, gear-trammel net; gg, gear-gill net; --, no number required; go, gear-otter trawl; seg, segment; sf, season-fish community; ss, season-sturgeon; gm, gear-mini fyke net; gb, gear-beach seine]

Species	Model type	Yearly catch per unit	Factor levels					Unbound		Bound	
			Year	Season	Segment	Bend	Subsamples	Bend variance component estimate (10^{-3})	Subsample variance component estimate	Bend variance component estimate (10^{-2})	Subsample variance component estimate
Pallid Sturgeon-All	z4,seg8,gt	0.0070	1	2	1	40	315	-0.0742	0.0055	0	0.0054
Pallid Sturgeon-All	z4,seg9,gg	.0141	1	1	1	20	191	-.0254	.0042	0	.0042
Pallid Sturgeon-All	z4,seg9,go	.0035	3	2	1	70	567	-.0061	.0019	0	.0019
Pallid Sturgeon-All	z4,seg9,gt	.0089	3	2	1	74	590	-.0539	.0083	0	.0083
Pallid Sturgeon-All	z4,sf,go	.0043	3	1	5	122	948	-.0093	.0024	0	.0024
Pallid Sturgeon-All	z4,sf,gt	.0062	3	1	5	123	914	-.0322	.0046	0	.0046
Pallid Sturgeon-All	z4,ss,go	.0024	3	1	4	117	946	--	--	.0006	.0020
Pallid Sturgeon-All	z4,ss,gt	.0051	3	1	4	119	840	-.0299	.0047	0	.0046
Pallid Sturgeon-Juvenile	z1,go	.0184	1	1	1	12	95	-.0655	.0050	0	.0050
Pallid Sturgeon-Juvenile	z1,gt	.0272	1	2	1	24	200	--	--	.0076	.0116
Pallid Sturgeon-Juvenile	z1,sf,gt	.0465	1	1	1	12	93	--	--	.0218	.0213
Pallid Sturgeon-Juvenile	z1,ss,gt	.0080	1	1	1	12	107	-.0257	.0031	0	.0030
Pallid Sturgeon-Juvenile	z2,gg	.0299	3	1	2	30	282	--	--	.0443	.0246
Pallid Sturgeon-Juvenile	z2,go	.0086	1	2	2	18	124	--	--	.0373	.0012
Pallid Sturgeon-Juvenile	z2,gt	.0186	2	2	2	38	269	--	--	.0419	.0086
Pallid Sturgeon-Juvenile	z2,seg5,gg	.0573	1	1	1	16	143	--	--	.0820	.0462
Pallid Sturgeon-Juvenile	z2,seg5,go	.0172	1	2	1	10	75	--	--	.0650	.0019
Pallid Sturgeon-Juvenile	z2,seg5,gt	.0235	2	2	1	20	138	--	--	.0359	.0133
Pallid Sturgeon-Juvenile	z2,seg6,gg	.0024	1	1	1	14	139	-.0138	.0025	0	.0025
Pallid Sturgeon-Juvenile	z2,seg6,gt	.0137	2	2	1	18	131	--	--	.0481	.0037
Pallid Sturgeon-Juvenile	z2,sf,go	.0095	1	1	2	10	62	--	--	.1007	.0005
Pallid Sturgeon-Juvenile	z2,sf,gt	.0306	2	1	2	18	131	--	--	.0947	.0134
Pallid Sturgeon-Juvenile	z2,ss,go	.0077	1	1	2	8	62	--	--	.0274	.0017
Pallid Sturgeon-Juvenile	z2,ss,gt	.0067	2	1	2	20	138	-.0311	.0041	0	.0040
Pallid Sturgeon-Juvenile	z3,gg	.0047	2	1	5	83	752	-.0305	.0018	0	.0017
Pallid Sturgeon-Juvenile	z3,go	.0031	3	2	6	250	1,979	-.0011	.0021	0	.0021
Pallid Sturgeon-Juvenile	z3,gt	.0051	3	2	6	264	1,929	-.0191	.0038	0	.0038
Pallid Sturgeon-Juvenile	z3,seg7,gt	.0039	1	2	1	22	175	--	--	.0055	.0012
Pallid Sturgeon-Juvenile	z3,sf,go	.0041	3	1	6	133	1,033	-.0085	.0022	0	.0022
Pallid Sturgeon-Juvenile	z3,sf,gt	.0063	3	1	6	135	1,006	-.0285	.0044	0	.0044
Pallid Sturgeon-Juvenile	z3,ss,go	.0020	3	1	4	117	946	--	--	.0006	.0020
Pallid Sturgeon-Juvenile	z3,ss,gt	.0040	3	1	5	129	923	-.0090	.0031	0	.0031
Pallid Sturgeon-Juvenile	z4,gg	.0054	2	1	4	76	704	-.0337	.0019	0	.0018

Table 8. Model statistics for all models used in the power analysis.—Continued

[z, zone; gt, gear-trammel net; gg, gear-gill net; --, no number required; go, gear-otter trawl; seg, segment; sf, season-fish community; ss, season-sturgeon; gm, gear-mini fyke net; gb, gear-beach seine]

Species	Model type	Yearly catch per unit	Factor levels					Unbound		Bound	
			Year	Season	Segment	Bend	Subsamples	Bend variance component estimate (10^{-3})	Subsample variance component estimate	Bend variance component estimate (10^{-2})	Subsample variance component estimate
Pallid Sturgeon-Juvenile	z4,go	0.0032	3	2	5	239	1,894	-0.0012	0.0022	0	0.0022
Pallid Sturgeon-Juvenile	z4,gt	.0053	3	2	5	242	1,754	-.0219	.0040	0	.0040
Pallid Sturgeon-Juvenile	z4,seg10,go	.0054	1	1	1	12	96	-.0159	.0014	0	.0014
Pallid Sturgeon-Juvenile	z4,seg10,gt	.0112	1	1	1	12	96	-.0680	.0060	0	.0059
Pallid Sturgeon-Juvenile	z4,seg13,gg	.0067	1	1	1	22	205	-.0342	.0019	0	.0019
Pallid Sturgeon-Juvenile	z4,seg13,go	.0043	3	2	1	57	471	--	--	.0009	.0015
Pallid Sturgeon-Juvenile	z4,seg13,gt	.0047	3	2	1	56	360	-.0040	.0017	0	.0016
Pallid Sturgeon-Juvenile	z4,seg14,gg	.0037	1	1	1	22	192	-.0307	.0017	0	.0017
Pallid Sturgeon-Juvenile	z4,seg14,go	.0006	3	2	1	61	456	-.0008	.0002	0	.0002
Pallid Sturgeon-Juvenile	z4,seg14,gt	.0022	3	2	1	60	393	-.0015	.0007	0	.0007
Pallid Sturgeon-Juvenile	z4,seg8,gg	.0023	1	1	1	12	116	-.0004	.0007	0	.0007
Pallid Sturgeon-Juvenile	z4,seg8,go	.0092	1	2	1	39	304	-.0390	.0071	0	.0070
Pallid Sturgeon-Juvenile	z4,seg8,gt	.0070	1	2	1	40	315	-.0742	.0055	0	.0054
Pallid Sturgeon-Juvenile	z4,seg9,gg	.0082	1	1	1	20	191	-.0567	.0027	0	.0027
Pallid Sturgeon-Juvenile	z4,seg9,go	.0029	3	2	1	70	567	-.0063	.0018	0	.0018
Pallid Sturgeon-Juvenile	z4,seg9,gt	.0080	3	2	1	74	590	-.0263	.0066	0	.0066
Pallid Sturgeon-Juvenile	z4,sf,go	.0043	3	1	5	122	948	-.0093	.0024	0	.0024
Pallid Sturgeon-Juvenile	z4,sf,gt	.0062	3	1	5	123	914	-.0322	.0046	0	.0046
Pallid Sturgeon-Juvenile	z4,ss,go	.0020	3	1	4	117	946	--	--	.0006	.0020
Pallid Sturgeon-Juvenile	z4,ss,gt	.0043	3	1	4	119	840	-.0105	.0034	0	.0034
Sand Shiner-All	z1,gm	.0070	1	1	1	11	80	-.0092	.0048	0	.0048
Sand Shiner-All	z2,gb	.0525	1	1	2	12	111	--	--	2.8052	.0026
Sand Shiner-All	z2,gm	.4338	2	1	2	20	125	--	--	8.0002	1.4882
Sand Shiner-All	z2,seg5,gb	.0912	1	1	1	7	67	--	--	4.9914	.0025
Sand Shiner-All	z2,seg5,gm	.4904	1	1	1	10	63	--	--	13.4257	2.2493
Sand Shiner-All	z2,seg6,gb	.0137	1	1	1	5	44	-.1043	.0029	0	.0028
Sand Shiner-All	z2,seg6,gm	.3772	1	1	1	10	62	--	--	1.3238	.7220
Sand Shiner-All	z3,gb	.1268	2	1	6	81	557	--	--	.6013	.1626
Sand Shiner-All	z3,gm	1.2183	1	1	6	78	588	--	--	370.2295	32.3389
Sand Shiner-All	z3,seg7,gb	.3708	1	1	1	9	43	--	--	7.9944	1.1773
Sand Shiner-All	z3,seg7,gm	5.7024	1	1	1	12	102	--	--	2183.9003	164.9011
Sand Shiner-All	z4,gb	.0769	3	1	5	94	633	--	--	.1495	.0641
Sand Shiner-All	z4,gm	.3386	2	1	5	94	680	--	--	38.3421	3.9209

Table 8. Model statistics for all models used in the power analysis.—Continued

[z, zone; gt, gear-trammel net; gg, gear-gill net; --, no number required; go, gear-otter trawl; seg, segment; sf, season-fish community; ss, season-sturgeon; gm, gear-mini fyke net; gb, gear-beach seine]

Species	Model type	Yearly catch per unit	Factor levels					Unbound		Bound	
			Year	Season	Segment	Bend	Subsamples	Bend variance component estimate (10^{-3})	Subsample variance component estimate	Bend variance component estimate (10^{-2})	Subsample variance component estimate
Sand Shiner-All	z4,seg10,gb	0.0913	1	1	1	12	97	--	--	0.0901	0.2860
Sand Shiner-All	z4,seg10,gm	.0878	1	1	1	12	96	-1.2935	0.1022	0	.1010
Sand Shiner-All	z4,seg13,gb	.0070	1	1	1	13	68	-.0153	.0006	0	.0006
Sand Shiner-All	z4,seg13,gm	.1095	1	1	1	18	122	--	--	.2799	1.2992
Sand Shiner-All	z4,seg14,gb	.1118	1	1	1	18	75	--	--	4.1365	.0286
Sand Shiner-All	z4,seg14,gm	.4413	1	1	1	21	132	--	--	111.9191	12.5547
Sand Shiner-All	z4,seg8,gb	.0584	1	1	1	17	127	--	--	.1527	.0132
Sand Shiner-All	z4,seg8,gm	.4501	1	1	1	17	129	--	--	51.8456	1.8182
Sand Shiner-All	z4,seg9,gb	.0666	1	1	1	34	266	--	--	.0244	.0287
Sand Shiner-All	z4,seg9,gm	.5177	1	1	1	26	201	--	--	20.2427	3.0511
Sauger-Adult	z1,gm	.0905	1	1	1	11	80	--	--	1.4058	.0610
Sauger-Adult	z1,gt	.1206	1	2	1	24	200	-8.4551	.1487	0	.1412
Sauger-Adult	z1,sf,gt	.1982	1	1	1	12	93	-17.8532	.2896	0	.2746
Sauger-Adult	z1,ss,gt	.0430	1	1	1	12	107	--	--	.0136	.0253
Sauger-Adult	z2,gg	.2258	3	1	2	30	282	--	--	3.8566	.1580
Sauger-Adult	z2,go	.0189	1	2	2	18	124	--	--	.1374	.0062
Sauger-Adult	z2,gt	.0638	3	2	2	54	346	-.9495	.0510	0	.0502
Sauger-Adult	z2,seg5,gg	.2263	1	1	1	16	143	--	--	8.0590	.1630
Sauger-Adult	z2,seg5,go	.0064	1	2	1	10	75	-.0012	.0016	0	.0016
Sauger-Adult	z2,seg5,gt	.0194	3	2	1	29	189	--	--	.0415	.0048
Sauger-Adult	z2,seg6,gg	.2253	1	1	1	14	139	-6.5336	.1585	0	.1523
Sauger-Adult	z2,seg6,go	.0313	1	2	1	8	49	--	--	.3382	.0134
Sauger-Adult	z2,seg6,gt	.1082	3	2	1	25	157	-1.8096	.1062	0	.1049
Sauger-Adult	z2,sf,go	.0108	1	1	2	10	62	-.2210	.0030	0	.0028
Sauger-Adult	z2,sf,gt	.0338	3	1	2	24	170	-.2195	.0141	0	.0139
Sauger-Adult	z2,ss,go	.0269	1	1	2	8	62	--	--	.3191	.0094
Sauger-Adult	z2,ss,gt	.0939	3	1	2	30	176	-1.9237	.0868	0	.0853
Sauger-Adult	z3,gg	.0583	3	1	5	112	943	--	--	.2317	.0327
Sauger-Adult	z3,go	.0051	1	2	6	144	1,157	--	--	.0238	.0032
Sauger-Adult	z3,gt	.0123	2	2	6	211	1,591	--	--	.0860	.0120
Sauger-Adult	z3,seg7,gg	.0200	1	1	1	7	48	-.3208	.0125	0	.0123
Sauger-Adult	z3,seg7,go	.0252	1	1	1	11	85	--	--	.4444	.0128
Sauger-Adult	z3,seg7,gt	.0406	1	2	1	22	175	--	--	.1819	.0601

Table 8. Model statistics for all models used in the power analysis.—Continued

[z, zone; gt, gear-trammel net; gg, gear-gill net; --, no number required; go, gear-otter trawl; seg, segment; sf, season-fish community; ss, season-sturgeon; gm, gear-mini fyke net; gb, gear-beach seine]

Species	Model type	Yearly catch per unit	Factor levels					Unbound		Bound	
			Year	Season	Segment	Bend	Subsamples	Bend variance component estimate (10^{-3})	Subsample variance component estimate	Bend variance component estimate (10^{-2})	Subsample variance component estimate
Sauger-Adult	z3,sf,go	0.0078	1	1	6	81	640	--	--	0.0445	0.0050
Sauger-Adult	z3,sf,gt	.0155	2	1	6	108	830	--	--	.1659	.0167
Sauger-Adult	z3,ss,go	.0023	1	1	4	63	517	-0.0005	0.0010	0	.0010
Sauger-Adult	z3,ss,gt	.0092	2	1	5	103	761	--	--	.0038	.0069
Sauger-Adult	z4,gg	.0609	3	1	4	105	895	--	--	.2457	.0338
Sauger-Adult	z4,gt	.0075	3	2	5	242	1,754	--	--	.0619	.0052
Sauger-Adult	z4,seg13,gg	.0717	1	1	1	48	336	--	--	.3181	.0438
Sauger-Adult	z4,seg13,gt	.0069	3	2	1	56	360	--	--	.0138	.0022
Sauger-Adult	z4,seg14,gg	.0604	1	1	1	22	192	--	--	.4362	.0357
Sauger-Adult	z4,seg14,gt	.0065	3	2	1	60	393	-.0520	.0024	0	.0023
Sauger-Adult	z4,seg8,gg	.0352	1	1	1	12	116	-.2995	.0121	0	.0118
Sauger-Adult	z4,seg8,gt	.0209	1	2	1	40	315	--	--	.1482	.0165
Sauger-Adult	z4,seg9,gg	.0586	1	1	1	23	251	--	--	.0615	.0293
Sauger-Adult	z4,seg9,gt	.0072	3	2	1	74	590	--	--	.1006	.0038
Sauger-Adult	z4,sf,gt	.0096	3	1	5	123	914	--	--	.1105	.0071
Sauger-Adult	z4,ss,gt	.0053	3	1	4	119	840	--	--	.0111	.0031
Sauger-All	z1,gb	.0166	1	1	1	11	69	-.0442	.0032	0	.0032
Sauger-All	z1,gm	.7457	1	1	1	11	80	--	--	37.9428	1.0581
Sauger-All	z1,go	.0209	1	1	1	12	95	-.0180	.0068	0	.0068
Sauger-All	z1,gt	.1249	1	2	1	24	200	-8.3717	.1518	0	.1442
Sauger-All	z1,sf,gt	.2068	1	1	1	12	93	-17.7438	.2964	0	.2811
Sauger-All	z1,ss,gt	.0430	1	1	1	12	107	--	--	.0136	.0253
Sauger-All	z2,gg	.2258	3	1	2	30	282	--	--	3.8566	.1580
Sauger-All	z2,go	.0337	1	2	2	18	124	--	--	.3325	.0113
Sauger-All	z2,gt	.0638	3	2	2	54	346	-.9495	.0510	0	.0502
Sauger-All	z2,seg5,gg	.2263	1	1	1	16	143	--	--	8.0590	.1630
Sauger-All	z2,seg5,go	.0115	1	2	1	10	75	--	--	.0470	.0044
Sauger-All	z2,seg5,gt	.0194	3	2	1	29	189	--	--	.0415	.0048
Sauger-All	z2,seg6,gg	.2253	1	1	1	14	139	-6.5336	.1585	0	.1523
Sauger-All	z2,seg6,go	.0559	1	2	1	8	49	--	--	.7468	.0220
Sauger-All	z2,seg6,gt	.1082	3	2	1	25	157	-1.8096	.1062	0	.1049
Sauger-All	z2,sf,go	.0327	1	1	2	10	62	--	--	.0604	.0104
Sauger-All	z2,sf,gt	.0338	3	1	2	24	170	-.2195	.0141	0	.0139

Table 8. Model statistics for all models used in the power analysis.—Continued

[z, zone; gt, gear-trammel net; gg, gear-gill net; --, no number required; go, gear-otter trawl; seg, segment; sf, season-fish community; ss, season-sturgeon; gm, gear-mini fyke net; gb, gear-beach seine]

Species	Model type	Yearly catch per unit	Factor levels					Unbound		Bound	
			Year	Season	Segment	Bend	Subsamples	Bend variance component estimate (10^{-3})	Subsample variance component estimate	Bend variance component estimate (10^{-2})	Subsample variance component estimate
Sauger-All	z2,ss,go	0.0347	1	1	2	8	62	--	--	0.6216	0.0122
Sauger-All	z2,ss,gt	.0939	3	1	2	30	176	-1.9237	0.0868	0	.0853
Sauger-All	z3,gb	.0071	2	1	6	81	557	-.0004	.0003	0	.0003
Sauger-All	z3,gg	.0585	3	1	5	112	943	--	--	.2253	.0328
Sauger-All	z3,gm	.0135	3	1	6	130	941	--	--	.0381	.0096
Sauger-All	z3,go	.0081	2	2	6	197	1,582	--	--	.0178	.0118
Sauger-All	z3,gt	.0099	3	2	6	264	1,929	--	--	.0702	.0103
Sauger-All	z3,seg7,gb	.0118	1	1	1	9	43	--	--	.0250	.0007
Sauger-All	z3,seg7,gg	.0200	1	1	1	7	48	-.3208	.0125	0	.0123
Sauger-All	z3,seg7,gm	.0377	1	1	1	12	102	--	--	.2874	.0321
Sauger-All	z3,seg7,go	.0280	1	1	1	11	85	--	--	.4242	.0135
Sauger-All	z3,seg7,gt	.0406	1	2	1	22	175	--	--	.1819	.0601
Sauger-All	z3,sf,go	.0076	2	1	6	106	828	--	--	.0514	.0067
Sauger-All	z3,sf,gt	.0127	3	1	6	135	1,006	--	--	.1349	.0143
Sauger-All	z3,ss,go	.0087	2	1	4	91	754	-.0496	.0174	0	.0174
Sauger-All	z3,ss,gt	.0070	3	1	5	129	923	--	--	.0034	.0058
Sauger-All	z4,gg	.0610	3	1	4	105	895	--	--	.2389	.0339
Sauger-All	z4,gm	.0120	3	1	5	118	839	--	--	.0015	.0069
Sauger-All	z4,go	.0073	2	2	5	186	1,497	--	--	.0058	.0117
Sauger-All	z4,gt	.0079	3	2	5	242	1,754	--	--	.0612	.0053
Sauger-All	z4,seg10,gm	.0114	1	1	1	12	96	-.0912	.0072	0	.0072
Sauger-All	z4,seg10,go	.0029	1	1	1	12	96	$-1.4x10^{-17}$	.0008	0	.0008
Sauger-All	z4,seg13,gg	.0721	1	1	1	48	336	--	--	.3012	.0440
Sauger-All	z4,seg13,go	.0122	2	2	1	38	327	--	--	.0015	.0383
Sauger-All	z4,seg13,gt	.0075	3	2	1	56	360	--	--	.0101	.0023
Sauger-All	z4,seg14,gg	.0604	1	1	1	22	192	--	--	.4362	.0357
Sauger-All	z4,seg14,gm	.0147	1	1	1	30	183	-.2996	.0094	0	.0091
Sauger-All	z4,seg14,go	.0038	2	2	1	42	321	-.0165	.0016	0	.0016
Sauger-All	z4,seg14,gt	.0073	3	2	1	60	393	-.0647	.0026	0	.0025
Sauger-All	z4,seg8,gg	.0352	1	1	1	12	116	-.2995	.0121	0	.0118
Sauger-All	z4,seg8,gm	.0142	1	1	1	17	129	-.1011	.0072	0	.0071
Sauger-All	z4,seg8,go	.0166	1	2	1	39	304	--	--	.0425	.0131
Sauger-All	z4,seg8,gt	.0209	1	2	1	40	315	--	--	.1482	.0165

Table 8. Model statistics for all models used in the power analysis.—Continued

[z, zone; gt, gear-trammel net; gg, gear-gill net; --, no number required; go, gear-otter trawl; seg, segment; sf, season-fish community; ss, season-sturgeon; gm, gear-mini fyke net; gb, gear-beach seine]

Species	Model type	Yearly catch per unit	Factor levels					Unbound		Bound	
			Year	Season	Segment	Bend	Subsamples	Bend variance component estimate (10^{-3})	Subsample variance component estimate	Bend variance component estimate (10^{-2})	Subsample variance component estimate
Sauger-All	z4,seg9,gg	0.0586	1	1	1	23	251	--	--	0.0615	0.0293
Sauger-All	z4,seg9,gm	.0047	1	1	1	34	267	-0.0584	0.0056	0	.0056
Sauger-All	z4,seg9,gt	.0072	3	2	1	74	590	--	--	.1006	.0038
Sauger-All	z4,sf,go	.0059	2	1	5	95	743	--	--	.0199	.0058
Sauger-All	z4,sf,gt	.0105	3	1	5	123	914	--	--	.1093	.0072
Sauger-All	z4,ss,go	.0087	2	1	4	91	754	-.0496	.0174	0	.0174
Sauger-All	z4,ss,gt	.0053	3	1	4	119	840	--	--	.0111	.0031
Sauger-Juvenile	z1,gb	.0166	1	1	1	11	69	-.0442	.0032	0	.0032
Sauger-Juvenile	z1,gm	.6552	1	1	1	11	80	--	--	23.9585	.9744
Sauger-Juvenile	z1,go	.0160	1	1	1	12	95	--	--	.0159	.0045
Sauger-Juvenile	z2,gb	.0010	1	1	2	23	172	-.0031	$7.1x10^{-5}$	0	$6.75x10^{-5}$
Sauger-Juvenile	z2,gm	.0094	2	1	2	20	125	-.1106	.0079	0	.0079
Sauger-Juvenile	z2,go	.0148	1	2	2	18	124	--	--	.0076	.0054
Sauger-Juvenile	z2,seg5,go	.0051	1	2	1	10	75	--	--	.0013	.0032
Sauger-Juvenile	z2,seg6,gb	.0019	1	1	1	10	65	-.0028	.0002	0	.0002
Sauger-Juvenile	z2,seg6,gm	.0187	1	1	1	10	62	-.2244	.0160	0	.0158
Sauger-Juvenile	z2,seg6,go	.0246	1	2	1	8	49	--	--	.0223	.0088
Sauger-Juvenile	z2,sf,go	.0219	1	1	2	10	62	-.1516	.0092	0	.0090
Sauger-Juvenile	z2,ss,go	.0078	1	1	2	8	62	--	--	.0270	.0017
Sauger-Juvenile	z3,gb	.0071	2	1	6	81	557	-.0004	.0003	0	.0003
Sauger-Juvenile	z3,gm	.0140	2	1	6	102	747	--	--	.0539	.0094
Sauger-Juvenile	z3,go	.0055	2	2	6	197	1,582	-.0192	.0095	0	.0095
Sauger-Juvenile	z3,seg7,gb	.0118	1	1	1	9	43	--	--	.0250	.0007
Sauger-Juvenile	z3,seg7,gm	.0377	1	1	1	12	102	--	--	.2874	.0321
Sauger-Juvenile	z3,seg7,go	.0028	1	1	1	11	85	-.0004	.0007	0	.0007
Sauger-Juvenile	z3,sf,go	.0037	2	1	6	106	828	-.0309	.0031	0	.0030
Sauger-Juvenile	z3,ss,go	.0073	2	1	4	91	754	-.0151	.0167	0	.0166
Sauger-Juvenile	z4,gb	.0062	2	1	5	72	514	-.0064	.0002	0	.0002
Sauger-Juvenile	z4,gm	.0116	2	1	5	90	645	--	--	.0142	.0058
Sauger-Juvenile	z4,go	.0055	2	2	5	186	1,497	-.0207	.0100	0	.0100
Sauger-Juvenile	z4,seg10,gm	.0062	1	1	1	12	96	-.0117	.0046	0	.0046
Sauger-Juvenile	z4,seg13,gm	.0222	1	1	1	15	96	--	--	.1871	.0092
Sauger-Juvenile	z4,seg13,go	.0113	2	2	1	38	327	--	--	.0091	.0380

Table 8. Model statistics for all models used in the power analysis.—Continued

[z, zone; gt, gear-trammel net; gg, gear-gill net; --, no number required; go, gear-otter trawl; seg, segment; sf, season-fish community; ss, season-sturgeon; gm, gear-mini fyke net; gb, gear-beach seine]

Species	Model type	Yearly catch per unit	Factor levels					Unbound		Bound	
			Year	Season	Segment	Bend	Subsamples	Bend variance component estimate (10^{-3})	Subsample variance component estimate	Bend variance component estimate (10^{-2})	Subsample variance component estimate
Sauger-Juvenile	z4,seg14,gm	0.0058	1	1	1	20	121	--	--	0.0140	0.0020
Sauger-Juvenile	z4,seg14,go	.0023	2	2	1	42	321	-0.0175	0.0010	0	.0010
Sauger-Juvenile	z4,seg8,gb	.0014	1	1	1	17	127	--	--	.0003	$5.97x10^{-5}$
Sauger-Juvenile	z4,seg8,gm	.0100	1	1	1	17	129	-.0181	.0047	0	.0047
Sauger-Juvenile	z4,seg8,go	.0092	1	2	1	39	304	-.0906	.0075	0	.0074
Sauger-Juvenile	z4,seg9,gb	.0065	1	1	1	26	203	-.0195	.0005	0	.0005
Sauger-Juvenile	z4,seg9,gm	.0071	1	1	1	26	203	-.0867	.0074	0	.0073
Sauger-Juvenile	z4,sf,go	.0038	2	1	5	95	743	-.0347	.0033	0	.0033
Sauger-Juvenile	z4,ss,go	.0073	2	1	4	91	754	-.0151	.0167	0	.0166
Shovelnose Sturgeon-Adult	z1,go	.0541	1	1	1	12	95	--	--	.2823	.0254
Shovelnose Sturgeon-Adult	z1,gt	.1690	1	2	1	24	200	--	--	1.1744	.2367
Shovelnose Sturgeon-Adult	z1,sf,gt	.3218	1	1	1	12	93	--	--	2.3300	.5016
Shovelnose Sturgeon-Adult	z1,ss,gt	.0162	1	1	1	12	107	--	--	.0220	.0079
Shovelnose Sturgeon-Adult	z2,gg	.2517	3	1	2	30	282	--	--	.8981	.3632
Shovelnose Sturgeon-Adult	z2,go	.0251	1	2	2	18	124	-.2993	.0084	0	.0082
Shovelnose Sturgeon-Adult	z2,gt	.1002	3	2	2	54	346	--	--	.3013	.0514
Shovelnose Sturgeon-Adult	z2,seg5,gg	.3633	1	1	1	16	143	-8.3528	.5316	0	.5250
Shovelnose Sturgeon-Adult	z2,seg5,gt	.0879	3	2	1	29	189	-2.3672	.0465	0	.0447
Shovelnose Sturgeon-Adult	z2,seg6,gg	.1402	1	1	1	14	139	--	--	2.2468	.1915
Shovelnose Sturgeon-Adult	z2,seg6,go	.0412	1	2	1	8	49	-.5791	.0175	0	.0170
Shovelnose Sturgeon-Adult	z2,seg6,gt	.1126	3	2	1	25	157	--	--	.9681	.0570
Shovelnose Sturgeon-Adult	z2,sf,go	.0094	1	1	2	10	62	-.0704	.0029	0	.0029
Shovelnose Sturgeon-Adult	z2,sf,gt	.1165	3	1	2	24	170	--	--	.7610	.0608
Shovelnose Sturgeon-Adult	z2,ss,go	.0408	1	1	2	8	62	-.5280	.0139	0	.0135
Shovelnose Sturgeon-Adult	z2,ss,gt	.0840	3	1	2	30	176	-1.3958	.0426	0	.0415
Shovelnose Sturgeon-Adult	z3,gg	2.8017	3	1	5	112	943	--	--	170.1082	10.3424
Shovelnose Sturgeon-Adult	z3,go	.2395	3	2	6	250	1,979	--	--	1.2817	.4241
Shovelnose Sturgeon-Adult	z3,gt	.6866	3	2	6	264	1,929	--	--	17.0243	3.4987
Shovelnose Sturgeon-Adult	z3,seg7,gg	.2856	1	1	1	7	48	--	--	6.1592	.4573
Shovelnose Sturgeon-Adult	z3,seg7,go	.1411	1	1	1	11	85	--	--	3.7299	.2834
Shovelnose Sturgeon-Adult	z3,seg7,gt	.7091	1	2	1	22	175	--	--	10.8847	1.9028
Shovelnose Sturgeon-Adult	z3,sf,go	.2362	3	1	6	133	1,033	--	--	.5835	.4852
Shovelnose Sturgeon-Adult	z3,sf,gt	.7970	3	1	6	135	1,006	--	--	7.5316	4.3669

Table 8. Model statistics for all models used in the power analysis.—Continued

[z, zone; gt, gear-trammel net; gg, gear-gill net; --, no number required; go, gear-otter trawl; seg, segment; sf, season-fish community; ss, season-sturgeon; gm, gear-mini fyke net; gb, gear-beach seine]

Species	Model type	Yearly catch per unit	Factor levels					Unbound		Bound	
			Year	Season	Segment	Bend	Subsamples	Bend variance component estimate (10^{-3})	Subsample variance component estimate	Bend variance component estimate (10^{-2})	Subsample variance component estimate
Shovelnose Sturgeon-Adult	z3,ss,go	0.2427	3	1	4	117	946	--	--	1.8163	0.3592
Shovelnose Sturgeon-Adult	z3,ss,gt	.5762	3	1	5	129	923	--	--	27.9269	2.5473
Shovelnose Sturgeon-Adult	z4,gg	2.8998	3	1	4	105	895	--	--	181.1319	10.8579
Shovelnose Sturgeon-Adult	z4,go	.2426	3	2	5	239	1,894	--	--	1.1845	.4303
Shovelnose Sturgeon-Adult	z4,gt	.6841	3	2	5	242	1,754	--	--	17.5500	3.6586
Shovelnose Sturgeon-Adult	z4,seg10,go	.3045	1	1	1	12	96	--	--	1.9444	.2920
Shovelnose Sturgeon-Adult	z4,seg10,gt	.9238	1	1	1	12	96	--	--	20.1985	2.5592
Shovelnose Sturgeon-Adult	z4,seg13,gg	3.4281	1	1	1	48	336	--	--	410.5212	17.8063
Shovelnose Sturgeon-Adult	z4,seg13,go	.2854	3	2	1	57	471	-0.2158	0.3088	0	.3086
Shovelnose Sturgeon-Adult	z4,seg13,gt	.8732	3	2	1	56	360	--	--	13.0833	3.3152
Shovelnose Sturgeon-Adult	z4,seg14,gg	2.1109	1	1	1	22	192	--	--	9.3237	7.2521
Shovelnose Sturgeon-Adult	z4,seg14,go	.2784	3	2	1	61	456	--	--	1.6949	.5527
Shovelnose Sturgeon-Adult	z4,seg14,gt	.6940	3	2	1	60	393	--	--	24.8172	1.8350
Shovelnose Sturgeon-Adult	z4,seg8,gg	.6395	1	1	1	12	116	--	--	8.9134	.9583
Shovelnose Sturgeon-Adult	z4,seg8,go	.1150	1	2	1	39	304	--	--	.5906	.1156
Shovelnose Sturgeon-Adult	z4,seg8,gt	.4360	1	2	1	40	315	-131.5959	7.3320	0	7.2064
Shovelnose Sturgeon-Adult	z4,seg9,gg	2.7482	1	1	1	23	251	--	--	87.4410	8.8014
Shovelnose Sturgeon-Adult	z4,seg9,go	.2013	3	2	1	70	567	--	--	1.9483	.6256
Shovelnose Sturgeon-Adult	z4,seg9,gt	.5405	3	2	1	74	590	--	--	33.3341	3.2768
Shovelnose Sturgeon-Adult	z4,sf,go	.2424	3	1	5	122	948	--	--	.2849	.5034
Shovelnose Sturgeon-Adult	z4,sf,gt	.7957	3	1	5	123	914	--	--	7.0569	4.5628
Shovelnose Sturgeon-Adult	z4,ss,go	.2427	3	1	4	117	946	--	--	1.8163	.3592
Shovelnose Sturgeon-Adult	z4,ss,gt	.5724	3	1	4	119	840	--	--	29.6663	2.6680
Shovelnose Sturgeon-All	z1,go	.2503	1	1	1	12	95	--	--	4.0773	.0928
Shovelnose Sturgeon-All	z1,gt	.2676	1	2	1	24	200	--	--	.5897	.4727
Shovelnose Sturgeon-All	z1,sf,gt	.4799	1	1	1	12	93	--	--	1.3229	.9811
Shovelnose Sturgeon-All	z1,ss,gt	.0553	1	1	1	12	107	-.8876	.0318	0	.0309
Shovelnose Sturgeon-All	z2,gg	.2639	3	1	2	30	282	--	--	.8136	.3641
Shovelnose Sturgeon-All	z2,go	.0251	1	2	2	18	124	-.2993	.0084	0	.0082
Shovelnose Sturgeon-All	z2,gt	.1002	3	2	2	54	346	--	--	.3013	.0514
Shovelnose Sturgeon-All	z2,seg5,gg	.3838	1	1	1	16	143	-9.7559	.5309	0	.5234
Shovelnose Sturgeon-All	z2,seg5,gt	.0879	3	2	1	29	189	-2.3672	.0465	0	.0447
Shovelnose Sturgeon-All	z2,seg6,gg	.1441	1	1	1	14	139	--	--	2.1877	.1942

Table 8. Model statistics for all models used in the power analysis.—Continued

[z, zone; gt, gear-trammel net; gg, gear-gill net; --, no number required; go, gear-otter trawl; seg, segment; sf, season-fish community; ss, season-sturgeon; gm, gear-mini fyke net; gb, gear-beach seine]

Species	Model type	Yearly catch per unit	Factor levels					Unbound		Bound	
			Year	Season	Segment	Bend	Subsamples	Bend variance component estimate (10^{-3})	Subsample variance component estimate	Bend variance component estimate (10^{-2})	Subsample variance component estimate
Shovelnose Sturgeon-All	z2,seg6,go	0.0412	1	2	1	8	49	-0.5791	0.0175	0	0.0170
Shovelnose Sturgeon-All	z2,seg6,gt	.0180	1	1	1	25	157	--	--	.9681	.0570
Shovelnose Sturgeon-All	z2,sf,go	.0094	1	1	2	10	62	-.0704	.0029	0	.0029
Shovelnose Sturgeon-All	z2,sf,gt	.1165	3	1	2	24	170	--	--	.7610	.0608
Shovelnose Sturgeon-All	z2,ss,go	.0408	1	1	2	8	62	-.5280	.0139	0	.0135
Shovelnose Sturgeon-All	z2,ss,gt	.0840	3	1	2	30	176	-1.3958	.0426	0	.0415
Shovelnose Sturgeon-All	z3,gg	4.2201	3	1	5	112	943	--	--	322.6201	20.7945
Shovelnose Sturgeon-All	z3,go	.5248	3	2	6	250	1,979	--	--	4.5604	1.0714
Shovelnose Sturgeon-All	z3,gt	1.2460	3	2	6	264	1,929	--	--	39.8733	10.1271
Shovelnose Sturgeon-All	z3,seg7,gg	.5080	1	1	1	7	48	--	--	9.8779	1.6645
Shovelnose Sturgeon-All	z3,seg7,go	.3119	1	1	1	11	85	--	--	15.5393	.7892
Shovelnose Sturgeon-All	z3,seg7,gt	1.3246	1	2	1	22	175	--	--	15.4957	5.5994
Shovelnose Sturgeon-All	z3,sf,go	.5499	3	1	6	133	1,033	--	--	3.7899	1.1857
Shovelnose Sturgeon-All	z3,sf,gt	1.4934	3	1	6	135	1,006	--	--	16.3381	14.3883
Shovelnose Sturgeon-All	z3,ss,go	.4996	3	1	4	117	946	--	--	5.1422	.9486
Shovelnose Sturgeon-All	z3,ss,gt	.9986	3	1	5	129	923	--	--	66.6461	5.4696
Shovelnose Sturgeon-All	z4,gg	4.3567	3	1	4	105	895	--	--	343.4610	21.7928
Shovelnose Sturgeon-All	z4,go	.5329	3	2	5	239	1,894	--	--	4.0924	1.0838
Shovelnose Sturgeon-All	z4,gt	1.2393	3	2	5	242	1,754	--	--	42.0978	10.5805
Shovelnose Sturgeon-All	z4,seg10,go	.7404	1	1	1	12	96	--	--	13.3789	.7322
Shovelnose Sturgeon-All	z4,seg10,gt	1.7509	1	1	1	12	96	--	--	17.2154	7.5280
Shovelnose Sturgeon-All	z4,seg13,gg	4.6996	1	1	1	48	336	--	--	795.0996	31.6441
Shovelnose Sturgeon-All	z4,seg13,go	.6268	3	2	1	57	471	--	--	.5356	.8430
Shovelnose Sturgeon-All	z4,seg13,gt	1.4690	3	2	1	56	360	--	--	20.9254	7.5750
Shovelnose Sturgeon-All	z4,seg14,gg	2.7593	1	1	1	22	192	--	--	18.2968	12.0402
Shovelnose Sturgeon-All	z4,seg14,go	.5408	3	2	1	61	456	--	--	5.1702	1.4927
Shovelnose Sturgeon-All	z4,seg14,gt	1.1542	3	2	1	60	393	--	--	61.6753	3.5070
Shovelnose Sturgeon-All	z4,seg8,gg	1.2589	1	1	1	12	116	--	--	37.9416	3.2965
Shovelnose Sturgeon-All	z4,seg8,go	.2854	1	2	1	39	304	--	--	5.6102	.3339
Shovelnose Sturgeon-All	z4,seg8,gt	.9609	1	2	1	40	315	-500.7315	26.7224	0	26.2443
Shovelnose Sturgeon-All	z4,seg9,gg	4.6875	1	1	1	23	251	--	--	205.5812	24.1214
Shovelnose Sturgeon-All	z4,seg9,go	.5034	3	2	1	70	567	--	--	4.2273	1.4141
Shovelnose Sturgeon-All	z4,seg9,gt	1.1415	3	2	1	74	590	--	--	98.3213	8.9282

Table 8. Model statistics for all models used in the power analysis.—Continued

[z, zone; gt, gear-trammel net; gg, gear-gill net; --, no number required; go, gear-otter trawl; seg, segment; sf, season-fish community; ss, season-sturgeon; gm, gear-mini fyke net; gb, gear-beach seine]

Species	Model type	Yearly catch per unit	Factor levels					Unbound		Bound	
			Year	Season	Segment	Bend	Subsamples	Bend variance component estimate (10^{-3})	Subsample variance component estimate	Bend variance component estimate (10^{-2})	Subsample variance component estimate
Shovelnose Sturgeon-All	z4,sf,go	0.5663	3	1	5	122	948	--	--	2.6601	1.2217
Shovelnose Sturgeon-All	z4,sf,gt	1.4860	3	1	5	123	914	--	--	17.3666	15.0376
Shovelnose Sturgeon-All	z4,ss,go	.4996	3	1	4	117	946	--	--	5.1422	.9486
Shovelnose Sturgeon-All	z4,ss,gt	.9927	3	1	4	119	840	--	--	70.4866	5.7133
Shovelnose Sturgeon-Juvenile	z1,go	.1962	1	1	1	12	95	--	--	2.9183	.0771
Shovelnose Sturgeon-Juvenile	z1,gt	.0986	1	2	1	24	200	-5.0708	0.0987	0	.0941
Shovelnose Sturgeon-Juvenile	z1,sf,gt	.1580	1	1	1	12	93	-9.1037	.1896	0	.1816
Shovelnose Sturgeon-Juvenile	z1,ss,gt	.0391	1	1	1	12	107	-1.1414	.0192	0	.0182
Shovelnose Sturgeon-Juvenile	z2,gg	.0122	3	1	2	30	282	--	--	.0087	.0059
Shovelnose Sturgeon-Juvenile	z2,seg5,gg	.0205	1	1	1	16	143	--	--	.0120	.0089
Shovelnose Sturgeon-Juvenile	z2,seg6,gg	.0039	1	1	1	14	139	--	--	.0022	.0029
Shovelnose Sturgeon-Juvenile	z3,gg	1.4184	3	1	5	112	943	--	--	25.6773	2.6697
Shovelnose Sturgeon-Juvenile	z3,go	.2853	3	2	6	250	1,979	--	--	.8743	.2944
Shovelnose Sturgeon-Juvenile	z3,gt	.5594	3	2	6	264	1,929	--	--	7.3587	2.3814
Shovelnose Sturgeon-Juvenile	z3,seg7,gg	.2224	1	1	1	7	48	-.3705	.4907	0	.4904
Shovelnose Sturgeon-Juvenile	z3,seg7,go	.1709	1	1	1	11	85	--	--	3.6214	.1827
Shovelnose Sturgeon-Juvenile	z3,seg7,gt	.6155	1	2	1	22	175	-14.1263	1.5643	0	1.5514
Shovelnose Sturgeon-Juvenile	z3,sf,go	.3137	3	1	6	133	1,033	--	--	1.1345	.3077
Shovelnose Sturgeon-Juvenile	z3,sf,gt	.6964	3	1	6	135	1,006	--	--	2.6617	3.6866
Shovelnose Sturgeon-Juvenile	z3,ss,go	.2569	3	1	4	117	946	--	--	.6200	.2797
Shovelnose Sturgeon-Juvenile	z3,ss,gt	.4224	3	1	5	129	923	--	--	12.2963	.9585
Shovelnose Sturgeon-Juvenile	z4,gg	1.4569	3	1	4	105	895	--	--	27.3304	2.7839
Shovelnose Sturgeon-Juvenile	z4,go	.2904	3	2	5	239	1,894	--	--	.7508	.2994
Shovelnose Sturgeon-Juvenile	z4,gt	.5553	3	2	5	242	1,754	--	--	8.2349	2.4628
Shovelnose Sturgeon-Juvenile	z4,seg10,go	.4359	1	1	1	12	96	--	--	3.6181	.2263
Shovelnose Sturgeon-Juvenile	z4,seg10,gt	.8271	1	1	1	12	96	-32.8622	2.0672	0	2.0367
Shovelnose Sturgeon-Juvenile	z4,seg13,gg	1.2714	1	1	1	48	336	--	--	61.5203	3.0455
Shovelnose Sturgeon-Juvenile	z4,seg13,go	.3414	3	2	1	57	471	--	--	.6653	.2922
Shovelnose Sturgeon-Juvenile	z4,seg13,gt	.5958	3	2	1	56	360	--	--	.7362	1.4910
Shovelnose Sturgeon-Juvenile	z4,seg14,gg	.6484	1	1	1	22	192	--	--	2.1968	.9160
Shovelnose Sturgeon-Juvenile	z4,seg14,go	.2624	3	2	1	61	456	--	--	.3330	.3793
Shovelnose Sturgeon-Juvenile	z4,seg14,gt	.4602	3	2	1	60	393	--	--	8.5680	.5781
Shovelnose Sturgeon-Juvenile	z4,seg8,gg	.6195	1	1	1	12	116	--	--	10.6737	.8705

Table 8. Model statistics for all models used in the power analysis.—Continued

[z, zone; gt, gear-trammel net; gg, gear-gill net; --, no number required; go, gear-otter trawl; seg, segment; sf, season-fish community; ss, season-sturgeon; gm, gear-mini fyke net; gb, gear-beach seine]

Species	Model type	Yearly catch per unit	Factor levels					Unbound		Bound	
			Year	Season	Segment	Bend	Subsamples	Bend variance component estimate (10^{-3})	Subsample variance component estimate	Bend variance component estimate (10^{-2})	Subsample variance component estimate
Shovelnose Sturgeon-Juvenile	z4,seg8,go	0.1704	1	2	1	39	304	--	--	2.1622	0.1542
Shovelnose Sturgeon-Juvenile	z4,seg8,gt	.5249	1	2	1	40	315	-105.0062	6.5286	0	6.4283
Shovelnose Sturgeon-Juvenile	z4,seg9,gg	1.9393	1	1	1	23	251	--	--	26.8043	4.6407
Shovelnose Sturgeon-Juvenile	z4,seg9,go	.3021	3	2	1	70	567	--	--	.0785	.3302
Shovelnose Sturgeon-Juvenile	z4,seg9,gt	.6010	3	2	1	74	590	--	--	23.9351	2.1935
Shovelnose Sturgeon-Juvenile	z4,sf,go	.3239	3	1	5	122	948	--	--	.8926	.3190
Shovelnose Sturgeon-Juvenile	z4,sf,gt	.6903	3	1	5	123	914	--	--	3.7816	3.8093
Shovelnose Sturgeon-Juvenile	z4,ss,go	.2569	3	1	4	117	946	--	--	.6200	.2797
Shovelnose Sturgeon-Juvenile	z4,ss,gt	.4202	3	1	4	119	840	--	--	12.9292	.9969
Sicklefin Chub-All	z1,go	.7925	1	1	1	12	95	--	--	11.6251	.6711
Sicklefin Chub-All	z3,gm	.3486	2	1	3	52	353	--	--	3.8193	10.4717
Sicklefin Chub-All	z3,go	.3073	3	2	6	250	1,979	--	--	10.6366	1.8239
Sicklefin Chub-All	z3,seg7,go	.0042	1	1	1	11	85	-.0009	.0016	0	.0016
Sicklefin Chub-All	z3,sf,go	.4207	3	1	6	133	1,033	--	--	12.2692	2.9939
Sicklefin Chub-All	z3,ss,go	.1940	3	1	4	117	946	--	--	8.6096	.5501
Sicklefin Chub-All	z4,gm	.3486	2	1	3	52	353	--	--	3.8193	10.4717
Sicklefin Chub-All	z4,go	.3192	3	2	5	239	1,894	--	--	11.1290	1.9055
Sicklefin Chub-All	z4,seg10,go	.3573	1	1	1	12	96	--	--	5.9539	.3924
Sicklefin Chub-All	z4,seg13,gm	.7181	1	1	1	17	110	--	--	14.5246	31.6324
Sicklefin Chub-All	z4,seg13,go	.5274	3	2	1	57	471	--	--	39.6772	3.0978
Sicklefin Chub-All	z4,seg14,gm	.3277	1	1	1	19	113	-23.7426	1.9600	0	1.9386
Sicklefin Chub-All	z4,seg14,go	.4145	3	2	1	61	456	--	--	5.1632	.7914
Sicklefin Chub-All	z4,seg8,go	.0494	1	2	1	39	304	--	--	.7868	.0384
Sicklefin Chub-All	z4,seg9,go	.1481	3	2	1	70	567	--	--	1.7009	3.0589
Sicklefin Chub-All	z4,sf,go	.4444	3	1	5	122	948	--	--	13.3740	3.2621
Sicklefin Chub-All	z4,ss,go	.1940	3	1	4	117	946	--	--	8.6096	.5501
Speckled Chub-All	z3,gb	.0379	2	1	6	95	612	--	--	.7021	.0062
Speckled Chub-All	z3,gm	.2724	3	1	6	130	941	--	--	12.2385	1.8438
Speckled Chub-All	z3,go	.4300	3	2	6	250	1,979	--	--	16.0893	2.3298
Speckled Chub-All	z3,seg7,go	.0034	1	1	1	11	85	-.0006	.0010	0	.0010
Speckled Chub-All	z3,sf,go	.3875	3	1	6	133	1,033	--	--	23.9295	1.4137
Speckled Chub-All	z3,ss,go	.4726	3	1	4	117	946	--	--	7.2391	3.3294
Speckled Chub-All	z4,gb	.0401	2	1	5	86	569	--	--	.7836	.0067

Table 8. Model statistics for all models used in the power analysis.—Continued

[z, zone; gt, gear-trammel net; gg, gear-gill net; --, no number required; go, gear-otter trawl; seg, segment; sf, season-fish community; ss, season-sturgeon; gm, gear-mini fyke net; gb, gear-beach seine]

Species	Model type	Yearly catch per unit	Factor levels					Unbound		Bound	
			Year	Season	Segment	Bend	Subsamples	Bend variance component estimate (10^{-3})	Subsample variance component estimate	Bend variance component estimate (10^{-2})	Subsample variance component estimate
Speckled Chub-All	z4,gm	0.2917	3	1	5	118	839	--	--	13.5104	2.0701
Speckled Chub-All	z4,go	.4428	3	2	5	239	1,894	--	--	16.8327	2.4341
Speckled Chub-All	z4,seg10,gm	.1375	1	1	1	12	96	--	--	2.1497	.1566
Speckled Chub-All	z4,seg10,go	.2279	1	1	1	12	96	-9.7996	0.3582	0	.3491
Speckled Chub-All	z4,seg13,gb	.0510	1	1	1	13	68	--	--	1.5305	.0049
Speckled Chub-All	z4,seg13,gm	.6133	1	1	1	25	164	--	--	56.7270	9.1555
Speckled Chub-All	z4,seg13,go	.4691	3	2	1	57	471	--	--	17.2265	.8724
Speckled Chub-All	z4,seg14,gb	.0881	1	1	1	18	75	--	--	2.4636	.0380
Speckled Chub-All	z4,seg14,gm	.3534	1	1	1	30	183	--	--	9.1302	1.0537
Speckled Chub-All	z4,seg14,go	.4639	3	2	1	61	456	--	--	22.4519	1.4163
Speckled Chub-All	z4,seg8,go	.1180	1	2	1	39	304	--	--	.5326	.1612
Speckled Chub-All	z4,seg9,gm	.0919	1	1	1	34	267	--	--	.8998	.1314
Speckled Chub-All	z4,seg9,go	.5549	3	2	1	70	567	--	--	24.4162	6.1184
Speckled Chub-All	z4,sf,go	.4130	3	1	5	122	948	--	--	26.0916	1.5403
Speckled Chub-All	z4,ss,go	.4726	3	1	4	117	946	--	--	7.2391	3.3294
Sturgeon Chub-All	z1,gm	.0804	1	1	1	11	80	--	--	2.6267	.0324
Sturgeon Chub-All	z1,go	.2503	1	1	1	12	95	--	--	4.2028	1.3926
Sturgeon Chub-All	z3,go	.5248	3	2	6	250	1,979	-.7104	.1131	0	.1125
Sturgeon Chub-All	z3,seg7,go	.3119	1	1	1	11	85	--	--	.0003	.0007
Sturgeon Chub-All	z3,sf,go	.5499	3	1	6	133	1,033	--	--	.2452	.0461
Sturgeon Chub-All	z3,ss,go	.4996	3	1	4	117	946	-4.0998	.1862	0	.1824
Sturgeon Chub-All	z4,go	.5329	3	2	5	239	1,894	-.7451	.1182	0	.1175
Sturgeon Chub-All	z4,seg10,go	.7404	1	1	1	12	96	-.2837	.0257	0	.0254
Sturgeon Chub-All	z4,seg13,go	.6268	3	2	1	57	471	--	--	.2164	.0401
Sturgeon Chub-All	z4,seg14,go	.5408	3	2	1	61	456	--	--	.3145	.0194
Sturgeon Chub-All	z4,seg8,go	.2854	1	2	1	39	304	-.0768	.0062	0	.0061
Sturgeon Chub-All	z4,seg9,go	.5034	3	2	1	70	567	-6.2852	.3378	0	.3320
Sturgeon Chub-All	z4,sf,go	.5663	3	1	5	122	948	--	--	.2673	.0502
Sturgeon Chub-All	z4,ss,go	.4996	3	1	4	117	946	-4.0998	.1862	.0000	.1824

[1] Bend covariance parameter for this model was zero under unbound conditions.

Table 9. Zone 1 summary of the different bend/subsample levels needed to reach a power of 0.8 when detecting a 5 percent change for each gear type in the Pallid Sturgeon Population Assessment Program.

[--, species did not reach minimum catch criteria and power was not calculated; >, greater than]

Species	Bend/subsample level when detecting a 5 percent change over 10 years				Bend/subsample level when detecting a 5 percent change over 20 years			
	Beach seine	Mini-Fyke net	Otter trawl	Trammel net	Beach seine	Mini-Fyke net	Otter trawl	Trammel net
Blue Sucker-All	--	--	>24/16	>24/16[1]	--	--	>24/16	>24/16[1]
Blue Sucker-Adult	--	--	--	>24/16[1]	--	--	--	>24/16[1]
Blue Sucker-Juvenile	--	--	>24/16	--	--	--	>24/16	--
Pallid Sturgeon-All	--	--	>24/16[1]	>24/16[1]	--	--	>24/16[1]	18/16[1]
Pallid Sturgeon-Adult	--	--	--	>24/16[1]	--	--	--	>24/16[1]
Pallid Sturgeon-Juvenile	--	--	>24/16[1]	>24/16	--	--	>24/16[1]	18/16
Sand Shiner-All	--	>24/16[1]	--	--	--	>24/16[1]	--	--
Sauger-All	>24/16[1]	>24/16	>24/16[1]	>24/16[1]	24/16[1]	>24/16	>24/16[1]	12/12[1]
Sauger-Adult	--	>24/16	--	>24/16[1]	--	>24/16	--	12/16[1]
Sauger-Juvenile	>24/16[1]	>24/16[1]	>24/16	--	24/16[1]	24/12[1]	>24/16	--
Shovelnose Sturgeon-All	--	--	>24/16	>24/16	--	--	24/12	12/12
Shovelnose Sturgeon-Adult	--	--	>24/16	>24/16	--	--	>24/16	18/12
Shovelnose Sturgeon-Juvenile	--	--	>24/16	>24/16[1]	--	--	>24/16	12/16[1]
Sicklefin Chub-All	--	--	>24/16	--	--	--	12/8	--
Speckled Chub-All	--	--	--	--	--	--	--	--
Sturgeon Chub-All	--	>24/16	>24/16	--	--	>24/16	>24/16	--

[1] Models with an initial negative bend variance component estimate were re-estimated using standard REML estimation methods.

Table 10. Zone 1 summary of the range of bends and percent annual decrease needed to reach a power of 0.8 for each gear type in five years of the Pallid Sturgeon Population Assessment Program.

[--, species did not reach minimum catch criteria and power was not calculated; >, greater than]

Species	Bend/subsample level when detecting a 5 percent change over 10 years				Bend/subsample level when detecting a 5 percent change over 20 years			
	Beach seine	Mini-Fyke net	Otter trawl	Trammel net	Beach seine	Mini-Fyke net	Otter trawl	Trammel net
Blue Sucker-All	--	--	>60	>60[1]	--	--	>45	>45[1]
Blue Sucker-Adult	--	--	--	>60[1]	--	--	--	>45[1]
Blue Sucker-Juvenile	--	--	>60	--	--	--	>45	--
Pallid Sturgeon-All	--	--	>60[1]	>60[1]	--	--	>45[1]	>45[1]
Pallid Sturgeon-Adult	--	--	--	>60[1]	--	--	--	>45[1]
Pallid Sturgeon-Juvenile	--	--	>60[1]	>60	--	--	>45[1]	>45
Sand Shiner-All	--	>60[1]	--	--	--	>45[1]	--	--
Sauger-All	>60[1]	>60	>60[1]	>60[1]	>45[1]	>45	>45[1]	>45[1]
Sauger-Adult	--	>60	--	>60[1]	--	>45	--	>45[1]
Sauger-Juvenile	>60[1]	>60[1]	>60	--	>45[1]	>45[1]	>45	--
Shovelnose Sturgeon-All	--	--	>60	>60	--	--	>45	35–40
Shovelnose Sturgeon-Adult	--	--	>60	>60	--	--	>45	>45
Shovelnose Sturgeon-Juvenile	--	--	>60	>60[1]	--	--	>45	>45[1]
Sicklefin Chub-All	--	--	>60	--	--	--	25–30	--
Speckled Chub-All	--	--	--	--	--	--	--	--
Sturgeon Chub-All	--	>60	>60	--	--	--	>45	>45

[1] Models with an initial negative bend variance component estimate were re-estimated using standard REML estimation methods.

Table 11. Zone 1 summary of the range of years needed to reach a power of 0.8 for each gear type in five years of the Pallid Sturgeon Population Assessment Program.

[--, species did not reach minimum catch criteria and power was not calculated; >, greater than]

Species	Range of years at a 12 bend/8 subsample level of effort			
	Beach seine	Mini-Fyke net	Otter trawl	Trammel net
Blue Sucker-All	--	--	>100	>100[1]
Blue Sucker-Adult	--	--	--	>100[1]
Blue Sucker-Juvenile	--	--	>100	--
Pallid Sturgeon-All	--	--	>100[1]	35–40[1]
Pallid Sturgeon-Adult	--	--	--	>100[1]
Pallid Sturgeon-Juvenile	--	--	>100[1]	35-40
Sand Shiner-All	--	>100[1]	--	--
Sauger-All	50–75[1]	35–40	>100[1]	25–30[1]
Sauger-Adult	--	>100	--	25–30[1]
Sauger-Juvenile	50–75[1]	30–35[1]	>100	--
Shovelnose Sturgeon-All	--	--	30-35	20–25
Shovelnose Sturgeon-Adult	--	--	>100	25–30
Shovelnose Sturgeon-Juvenile	--	--	35-40	25–30[1]
Sicklefin Chub-All	--	--	15-20	--
Speckled Chub-All	--	--	--	--
Sturgeon Chub-All	--	>100	>100	--

[1] Models with an initial negative bend variance component estimate were re-estimated using standard REML estimation methods.

Table 12. Zone 2 summary of the different bend/subsample levels needed to reach a power of 0.8 when detecting a 5 percent change for each gear type in the Pallid Sturgeon Population Assessment Program.

[--, species did not reach minimum catch criteria and power was not calculated; >, greater than]

Species	Bend/subsample level when detecting a 5 percent change over 10 years					Bend/subsample level when detecting a 5 percent change over 20 years				
	Beach seine	Gill net	Mini-Fyke net	Otter trawl	Trammel net	Beach seine	Gill net	Mini-Fyke net	Otter trawl	Trammel net
Blue Sucker-All	--	>24/16	--	>24/16[1]	--	--	>24/16	--	>24/16[1]	--
Blue Sucker-Adult	--	>24/16	--	>24/16[1]	--	--	>24/16	--	>24/16[1]	--
Blue Sucker-Juvenile	--	--	--	--	--	--	--	--	--	--
Pallid Sturgeon-All	--	>24/16	--	>24/16	>24/16	--	>24/16	--	>24/16	24/16
Pallid Sturgeon-Adult	--	>24/16	--	--	--	--	>24/16	--	--	--
Pallid Sturgeon-Juvenile	--	>24/16	--	>24/16	>24/16	--	>24/16	--	>24/16	24/16
Sand Shiner-All	>24/16	--	>24/16	--	--	>24/16	--	18/12	--	--
Sauger-All	--	>24/16	--	>24/16	24/16[1]	--	18/8	--	>24/16	6/16[1]
Sauger-Adult	--	>24/16	--	>24/16	24/16[1]	--	18/8	--	>24/16	6/16[1]
Sauger-Juvenile	>24/161	--	>24/16[1]	>24/16	--	>24/16[1]	--	>24/16[1]	18/12	--
Shovelnose Sturgeon-All	--	>24/16	--	24/16[1]	18/16	--	12/8	--	12/8[1]	6/12
Shovelnose Sturgeon-Adult	--	>24/16	--	24/16[1]	18/16	--	12/12	--	12/8[1]	6/12
Shovelnose Sturgeon-Juvenile	--	>24/16	--	--	--	--	>24/16	--	--	--
Sicklefin Chub-All	--	--	--	--	--	--	--	--	--	--
Speckled Chub-All	--	--	--	--	--	--	--	--	--	--
Sturgeon Chub-All	--	--	--	--	--	--	--	--	--	--

[1] Models with an initial negative bend variance component estimate were re-estimated using standard REML estimation methods.

Table 13. Zone 2 summary of the range of bends and percent annual decrease needed to reach a power of 0.8 for each gear type in five years of the Pallid Sturgeon Population Assessment Program.

[--, species did not reach minimum catch criteria and power was not calculated; >, greater than]

Species	Range of bends needed in five years for each season and segment at a 8 subsample level of effort					Range of percent annual decrease needed in five years at a 12 bend/8 subsample level of effort				
	Beach seine	Gill net	Mini-Fyke net	Otter trawl	Trammel net	Beach seine	Gill net	Mini-Fyke net	Otter trawl	Trammel net
Blue Sucker-All	--	>60	--	>60[1]	--	--	>45	--	>45[1]	--
Blue Sucker-Adult	--	>60	--	>60[1]	--	--	>45	--	>45[1]	--
Blue Sucker-Juvenile	--	--	--	--	--	--	--	--	--	--
Pallid Sturgeon-All	--	>60	--	>60	>60	--	>45	--	>45	>45
Pallid Sturgeon-Adult	--	>60	--	--	--	--	>45	--	--	--
Pallid Sturgeon-Juvenile	--	>60	--	>60	>60	--	>45	--	>45	>45
Sand Shiner-All	>60	--	>60	--	--	>45	--	>45	--	--
Sauger-All	--	>60	--	>60	>60[1]	--	>45	--	>45	30–35[1]
Sauger-Adult	--	>60	--	>60	>60[1]	--	>45	--	>45	30–35[1]
Sauger-Juvenile	>601	--	>60[1]	>60	--	>45[1]	--	>45[1]	>45	--
Shovelnose Sturgeon-All	--	>60	--	>60[1]	>60	--	30–35	--	30–35[1]	20–25
Shovelnose Sturgeon-Adult	--	>60	--	>60[1]	>60	--	35–40	--	30–35[1]	20–25
Shovelnose Sturgeon-Juvenile	--	>60	--	--	--	--	>45	--	--	--
Sicklefin Chub-All	--	--	--	--	--	--	--	--	--	--
Speckled Chub-All	--	--	--	--	--	--	--	--	--	--
Sturgeon Chub-All	--	--	--	--	--	--	--	--	--	--

[1] Models with an initial negative bend variance component estimate were re-estimated using standard REML estimation methods.

Table 14. Zone 2 summary of the range of years needed to reach a power of 0.8 for each gear type in five years of the Pallid Sturgeon Population Assessment Program.

[--, species did not reach minimum catch criteria and power was not calculated; >, greater than]

Species	Range of years at a 12 bend/8 subsample level of effort				
	Beach seine	Gill net	Mini-Fyke net	Otter trawl	Trammel net
Blue Sucker-All	--	>100	--	>100[1]	--
Blue Sucker-Adult	--	>100	--	>100[1]	--
Blue Sucker-Juvenile	--	--	--	--	--
Pallid Sturgeon-All	--	75–100	--	75–100	40–45
Pallid Sturgeon-Adult	--	>100	--	--	--
Pallid Sturgeon-Juvenile	--	>100	--	75–100	35–40
Sand Shiner-All	>100	--	25–30	--	--
Sauger-All	--	20–25	--	35–40	15–20[1]
Sauger-Adult	--	20–25	--	50–75	15–20[1]
Sauger-Juvenile	>100[1]	--	>100[1]	30–35	--
Shovelnose Sturgeon-All	--	15–20	--	15–20[1]	10–15
Shovelnose Sturgeon-Adult	--	20–25	--	15–20[1]	10–15
Shovelnose Sturgeon-Juvenile	--	>100	--	--	--
Sicklefin Chub-All	--	--	--	--	--
Speckled Chub-All	--	--	--	--	--
Sturgeon Chub-All	--	--	--	--	--

[1] Models with an initial negative bend variance component estimate were re-estimated using standard REML estimation methods.

Table 15. Zone 3 summary of the different bend/subsample levels needed to reach a power of 0.8 when detecting a 5 percent change for each gear type in the Pallid Sturgeon Population Assessment Program.

[--, species did not reach minimum catch criteria and power was not calculated; >, greater than]

Species	Bend/subsample level when detecting a 5 percent change over 10 years					Bend/subsample level when detecting a 5 percent change over 20 years				
	Beach seine	Gill net	Mini-Fyke net	Otter trawl	Trammel net	Beach seine	Gill net	Mini-Fyke net	Otter trawl	Trammel net
Blue Sucker-All	--	>24/16	--	>24/16	24/16	--	18/16	--	18/12	6/16
Blue Sucker-Adult	--	>24/16	--	>24/16	24/16	--	18/8	--	24/12	12/8
Blue Sucker-Juvenile	--	>24/16[1]	--	>24/16	>24/16	--	18/16[1]	--	12/12	12/16
Pallid Sturgeon-All	--	>24/16[1]	--	>24/16[1]	>24/161	--	18/16[1]	--	>24/16[1]	24/16[1]
Pallid Sturgeon-Adult	--	>24/16	--	>24/16[2]	>24/162	--	>24/16	--	>24/16[2]	>24/16[2]
Pallid Sturgeon-Juvenile	--	>24/16[1]	--	>24/16[1]	>24/161	--	>24/16[1]	--	>24/16[1]	24/16[1]
Sand Shiner-All	24/1[2]	--	>24/16	--	--	6/16	--	24/12	--	--
Sauger-All	12/12[1]	>24/16	>24/16	>24/16	>24/16	12/4[1]	12/8	>24/16	>24/16	>24/16
Sauger-Adult	--	>24/16	--	>24/16	>24/16	--	12/8	--	>24/16	>24/16
Sauger-Juvenile	12/12[1]	--	>24/16	>24/16[1]	--	6/8[1]	--	>24/16	>24/16[1]	--
Shovelnose Sturgeon-All	--	6/16	--	6/12	12/8	--	6/4	--	6/4	6/4
Shovelnose Sturgeon-Adult	--	12/8	--	12/8	12/12	--	6/4	--	6/4	6/4
Shovelnose Sturgeon-Juvenile	--	6/12	--	6/8	12/8	--	6/4	--	6/4	6/4
Sicklefin Chub-All	--	--	>24/16	24/16	--	--	--	>24/16	6/16	--
Speckled Chub-All	>24/16	--	>24/16	18/16	--	>24/16	--	18/16	6/8	--
Sturgeon Chub-All	--	--	--	6/41	--	--	--	--	6/4[1]	--

[1] Models with an initial negative bend variance component estimate were re-estimated using standard REML estimation methods.

[2] Only Sturgeon Season.

Table 16. Zone 3 summary of the range of bends and percent annual decrease needed to reach a power of 0.8 for each gear type in five years of the Pallid Sturgeon Population Assessment Program.

[--, species did not reach minimum catch criteria and power was not calculated; >, greater than]

Species	Range of bends needed in five years for each season and segment at a 8 subsample level of effort					Range of percent annual decrease needed in five years at a 12 bend/8 subsample level of effort				
	Beach seine	Gill net	Mini-Fyke net	Otter trawl	Trammel net	Beach seine	Gill net	Mini-Fyke net	Otter trawl	Trammel net
Blue Sucker-All	--	>60	--	>60	>60	--	>45	--	>45	20–25
Blue Sucker-Adult	--	>60	--	>60	>60	--	>45	--	>45	25–30
Blue Sucker-Juvenile	--	>60[1]	--	>60	>60	--	>45[1]	--	>45	>45
Pallid Sturgeon-All	--	>60[1]	--	>60[1]	>60[1]	--	>45[1]	--	>45[1]	>45[1]
Pallid Sturgeon-Adult	--	>60	--	>60[2]	>60[2]	--	>45	--	>45[2]	>45[2]
Pallid Sturgeon-Juvenile	--	>60[1]	--	>60[1]	>60[1]	--	>45[1]	--	>45[1]	>45[1]
Sand Shiner-All	>60	--	>60	--	--	20–25	--	>45	--	--
Sauger-All	>60[1]	>60	>60	>60	>60	10–15[1]	30-35	>45	>45	>45
Sauger-Adult	--	>60	--	>60	>60	--	30-35	--	>45	>45
Sauger-Juvenile	>60[1]	--	>60	>60[1]	--	10-15[1]	--	>45	>45[1]	--
Shovelnose Sturgeon-All	--	35–40	--	30–35	45–50	--	5–10	--	5–10	10–15
Shovelnose Sturgeon-Adult	--	15–20	--	15–20	20–25	--	10–15	--	10–15	10–15
Shovelnose Sturgeon-Juvenile	--	30–35	--	25–30	50-55	--	5–10	--	5–10	10–15
Sicklefin Chub-All	--	--	>60	>60	--	--	--	>45	20-25	--
Speckled Chub-All	>60	--	>60	>60	--	>45	--	>45	15-20	--
Sturgeon Chub-All	--	--	--	<5[1]	--	--	--	--	1–3[1]	--

[1] Models with an initial negative bend variance component estimate were re-estimated using standard REML estimation methods.

[2] Only Sturgeon Season.

Table 17. Zone 3 summary of the range of years needed to reach a power of 0.8 for each gear type in five years of the Pallid Sturgeon Population Assessment Program.

[--, species did not reach minimum catch criteria and power was not calculated; >, greater than]

Species	Range of years at a 12 bend/8 subsample level of effort				
	Beach seine	Gill net	Mini-Fyke net	Otter trawl	Trammel net
Blue Sucker-All	--	20–25	--	25–30	15–20
Blue Sucker-Adult	--	25–30	--	30–35	15–20
Blue Sucker-Juvenile	--	40–45[1]	--	20–25	20–25
Pallid Sturgeon-All	--	35–40[1]	--	>100[1]	50–75[1]
Pallid Sturgeon-Adult	--	>100	--	>100[2]	>100[2]
Pallid Sturgeon-Juvenile	--	>100[1]	--	>100[1]	50–75[1]
Sand Shiner-All	15–20	--	30–35	--	--
Sauger-All	10–15[1]	15–20	50–75	>100	50–75
Sauger-Adult	--	15–20	--	>100	45–50
Sauger-Juvenile	10–15[1]	--	50–75	>100[1]	--
Shovelnose Sturgeon-All	--	5–10	--	5–10	5–10
Shovelnose Sturgeon-Adult	--	5–10	--	5–10	10–15
Shovelnose Sturgeon-Juvenile	--	5–10	--	5–10	5–10
Sicklefin Chub-All	--	--	>100	15–20	--
Speckled Chub-All	30–35	--	30–35	10–15	--
Sturgeon Chub-All	--	--	--	<3[1]	--

[1] Models with an initial negative bend variance component estimate were re-estimated using standard REML estimation methods.

[2] Only Sturgeon Season.

Table 18. Zone 4 summary of the different bend/subsample levels needed to reach a power of 0.8 when detecting a 5 percent change for each gear type in the Pallid Sturgeon Population Assessment Program.

[--, species did not reach minimum catch criteria and power was not calculated; >, greater than]

Species	Bend/subsample level when detecting a 5 percent change over 10 years					Bend/subsample level when detecting a 5 percent change over 20 years				
	Beach seine	Gill net	Mini-Fyke net	Otter trawl	Trammel net	Beach seine	Gill net	Mini-Fyke net	Otter trawl	Trammel net
Blue Sucker-All	--	>24/16	--	>24/16	>24/16	--	18/16	--	18/16	12/8
Blue Sucker-Adult	--	>24/16	--	>24/16	>24/16	--	24/8	--	24/16	12/8
Blue Sucker-Juvenile	--	>24/16[1]	--	>24/16	>24/16	--	18/16[1]	--	12/16	18/12
Pallid Sturgeon-All	--	>24/16[1]	--	>24/16[1]	>24/16[1]	--	18/16[1]	--	>24/16[1]	>24/16[1]
Pallid Sturgeon-Adult	--	>24/16	--	>24/16[2]	>24/16[2]	--	>24/16	--	>24/16[2]	>24/16[2]
Pallid Sturgeon-Juvenile	--	>24/16[1]	--	>24/16[1]	>24/16[1]	--	>24/16[1]	--	>24/16[1]	>24/16[1]
Sand Shiner-All	24/16	--	>24/16	--	--	6/16	--	>24/16	--	--
Sauger-All	--	>24/16	>24/16	>24/16	>24/16	--	12/12	24/16	>24/16	>24/16
Sauger-Adult	--	>24/16	--	--	>24/16	--	12/12	--	--	>24/16
Sauger-Juvenile	12/12[1]	--	>24/16	>24/16[1]	--	6/8[1]	--	24/16	>24/16[1]	--
Shovelnose Sturgeon-All	--	12/8	--	6/12	12/12	--	6/4	--	6/4	6/4
Shovelnose Sturgeon-Adult	--	12/8	--	12/12	12/12	--	6/4	--	6/4	6/8
Shovelnose Sturgeon-Juvenile	--	12/8	--	6/12	12/12	--	6/4	--	6/4	6/8
Sicklefin Chub-All	--	--	>24/16	>24/16	--	--	--	>24/16	12/8	--
Speckled Chub-All	>24/16	--	>24/16	24/12	--	>24/16	--	24/12	6/12	--
Sturgeon Chub-All	--	--	--	6/4[1]	--	--	--	--	6/4[1]	--

[1] Models with an initial negative bend variance component estimate were re-estimated using standard REML estimation methods.

[2] Only Sturgeon Season.

Table 19. Zone 4 summary of the range of bends and percent annual decrease needed to reach a power of 0.8 for each gear type in five years of the Pallid Sturgeon Population Assessment Program.

[--, species did not reach minimum catch criteria and power was not calculated; >, greater than]

Species	Range of bends needed in five years for each season and segment at a 8 subsample level of effort					Range of percent annual decrease needed in five years at a 12 bend/8 subsample level of effort				
	Beach seine	Gill net	Mini-Fyke net	Otter trawl	Trammel net	Beach seine	Gill net	Mini-Fyke net	Otter trawl	Trammel net
Blue Sucker-All	--	>60	--	>60	>60	--	>45	--	>45	25–30
Blue Sucker-Adult	--	>60	--	>60	>60	--	>45	--	>45	25–30
Blue Sucker-Juvenile	--	>60[1]	--	>60	>60	--	>45[1]	--	>45	>45
Pallid Sturgeon-All	--	>60[1]	--	>60[1]	>60[1]	--	>45[1]	--	>45[1]	>45[1]
Pallid Sturgeon-Adult	--	>60	--	>60[2]	>60[2]	--	>45	--	>45[2]	>45[2]
Pallid Sturgeon-Juvenile	--	>60[1]	--	>60[1]	>60[1]	--	>45[1]	--	>45[1]	>45[1]
Sand Shiner-All	>60	--	>60	--	--	25–30	--	40–45	--	--
Sauger-All	--	>60	>60	>60	>60	--	35–40	>45	>45	>45
Sauger-Adult	--	>60	--	--	>60	--	35–40	--	--	>45
Sauger-Juvenile	>601	--	>60	>60[1]	--	10–15[1]	--	>45	>45[1]	--
Shovelnose Sturgeon-All	--	45–50	--	30–35	>60	--	10–15	--	5–10	10–15
Shovelnose Sturgeon-Adult	--	20–25	--	30–35	25–30	--	10–15	--	10–15	10–15
Shovelnose Sturgeon-Juvenile	--	40–45	--	25–30	>60	--	10–15	--	5–10	10–15
Sicklefin Chub-All	--	--	>60	>60	--	--	--	>45	25–30	--
Speckled Chub-All	>60	--	>60	>60	--	>45	--	>45	20–25	--
Sturgeon Chub-All	--	--	--	<5[1]	--	--	--	--	1–3[1]	--

[1] Models with an initial negative bend variance component estimate were re-estimated using standard REML estimation methods.

[2] Only Sturgeon Season.

Table 20. Zone 4 summary of the range of years needed to reach a power of 0.8 for each gear type in five years of the Pallid Sturgeon Population Assessment Program.

[--, species did not reach minimum catch criteria and power was not calculated; >, greater than]

Species	Range of years at a 12 bend/8 subsample level of effort				
	Beach seine	Gill net	Mini-Fyke net	Otter trawl	Trammel net
Blue Sucker-All	--	25–30	--	30–35	15–20
Blue Sucker-Adult	--	25–30	--	35–40	15–20
Blue Sucker-Juvenile	--	45–50[1]	--	25–30	25–30
Pallid Sturgeon-All	--	35–40[1]	--	>100[1]	75–100[1]
Pallid Sturgeon-Adult	--	>100	--	>100[2]	>100[2]
Pallid Sturgeon-Juvenile	--	>100[1]	--	>100[1]	75–100[1]
Sand Shiner-All	15–20	--	50–75	--	--
Sauger-All	--	20–25	40–45	>100	>100
Sauger-Adult	--	20–25	--	--	>100
Sauger-Juvenile	10–15[1]	--	45-50	>100[1]	--
Shovelnose Sturgeon-All	--	5–10	--	5–10	10–15
Shovelnose Sturgeon-Adult	--	5–10	--	10v15	10–15
Shovelnose Sturgeon-Juvenile	--	5–10	--	5v10	10–15
Sicklefin Chub-All	--	--	>100	15–20	--
Speckled Chub-All	35–40	--	30–35	10–15	--
Sturgeon Chub-All	--	--	--	<3[1]	--

[1] Models with an initial negative bend variance component estimate were re-estimated using standard REML estimation methods.

[2] Only Sturgeon Season.

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Bryan and others—**The Power to Detect Trends in Missouri River Fish Populations within the Pallid Sturgeon Population Assessment Program**—Open-File Report 2010–1020