Appendix A
Statistical Methodology

The purpose of a census is to enumerate all objects with a defined characteristic. For the census of aquaculture, that goal is to account for any farm or operation from which $1,000 or more of aquaculture products were produced and sold, or produced and distributed for restoration, conservation, enhancement, or recreational purposes during the census year. To do this, NASS creates a mail list of aquaculture operations that potentially meet the farm definition, collects aquaculture information from those operations, reviews the data, corrects or completes the requested information, and combines the data to provide information on the characteristics of aquaculture farm operations at the national and State levels. In this appendix, these census processes are described.

THE CENSUS POPULATION

The target population for the census of aquaculture was composed of all aquaculture farm operations that reported any amount of aquaculture activity on their 2017 Census of Agriculture report form. An effort was made to identify additional aquaculture operations of significance from new sources.

DATA COLLECTION

Method of Enumeration

The 2018 Census of Aquaculture was conducted primarily by mail. It was supplemented with Electronic Data Reporting (EDR) via the Internet, telephone calls, and personal enumeration. Enumeration methods were similar to those used in the 2013 Census of Aquaculture.

Report Forms

One version of the report form was used in all States. A 16-page 2018 Census of Aquaculture report form was designed to collect data from operations producing or distributing aquaculture. It was designed to collect data that also supported the agricultural surveys conducted for catfish and trout production which are part of the National Agricultural Statistics Service's (NASS) Estimates Program. See Appendix B for changes since the last aquaculture census and a copy of the report form.

Report Form Mailings and Respondent Follow-up

The initial mailout took place in December 2018. Mail packets were mailed to approximately 3,800 farms thought to have produced aquaculture in 2017. The initial mail packets included a labeled report form, an instruction sheet, a letter that requested a prompt response and included instructions for completing the form via Internet, and a postage-paid return envelope. Mailout packet preparation, initial mailout, and one follow-up mailing to nonrespondents were handled by the Census Bureau's National Processing Center (NPC) in Jeffersonville, IN. Telephone follow-ups, conducted from a NASS Data Collection Center, began in February 2019 to nonrespondents who were mailed a report form from NPC.

Data were collected for a select group of operations by the NASS field offices. To minimize the number of agency contacts, operations included in this group were flagged for contact by NASS for other agricultural surveys. Report forms were labeled at the NPC and sent to field offices in November 2018. Field office staff collected data by personal enumeration or by phone from December 2018 through May 2019. For a description of the adjustment for nonresponse, see Estimation.

REPORT FORM PROCESSING

Data Capture

All report forms returned to the NPC were immediately checked in using bar codes printed on the mailing label. This check-in process removed the responding farms from follow-up mailings. All forms were reviewed prior to data keying to identify inconsistencies and ensure that the data could be keyed. Major inconsistencies, respondent remarks, blank report forms, and large aquaculture cases were reviewed by analysts and adjusted prior to data keying, as needed. All forms with any data were scanned and an image was created for each page of a report form.

Data Editing and Analysis

Data from each report form were processed through a computer edit which flagged inconsistent entries. Each flagged entry was reviewed by staff. Reported data that were obviously incorrect due to misinterpretation of a question were either corrected or deleted prior to the computer edit. In some cases, respondents may have failed to provide all of the information requested, only indicating the presence of an item but not the amount. Some data were estimated by the analyst based on other responses in the geographic area and by similarly sized farms.

Prior to publication, tabulated totals were reviewed to identify and resolve remaining inconsistencies and potential coverage problems. Comparisons were made to 2017 Census of Agriculture data, 2013 Census of Aquaculture data, and other available check data. The data were processed through a disclosure program to prevent data from being published that could be sourced back to an individual operation.

ESTIMATION

Estimates were produced for the Nation and for each of the 50 States. All respondents to the 2017 Census of Agriculture that reported involvement with an aquaculture enterprise, regardless of its economic size, were included on the 2018 Census of Aquaculture mailing list.

The estimation methodology consisted of two weighting components. The first component was the fully adjusted weight pulled in from the 2017 Census of Agriculture. In processing the 2017 Census of Agriculture data, statistical weights were applied to each responding record. These weights were designed to account for 2017 Census of Agriculture mail list nonrespondents, farms that existed but were not included on the 2017 Census of Agriculture mail list, and various farm classification errors.

The second weighting component was from a 2018 Census of Aquaculture nonresponse adjustment factor. In spite of a determined effort to obtain aquaculture information from every operation on the 2018 Census of Aquaculture mailing list, not all operations responded. A nonresponse adjustment factor was used to account for active aquaculture operations on the list that did not respond to the 2018 Census of Aquaculture.

Together these two weighting components compensate for aquaculture farm data that were not obtained from either the 2017 Census of Agriculture or the 2018 Census of Aquaculture. Each farm on the 2018 Census of Aquaculture mail list was put into a weight adjustment group. All weight adjustment groups were formed within a given State. These groups were based on the economic size of the farm's aquaculture enterprise as indicated by the data obtained from the 2017 Census of Agriculture. The weights that were carried over from the 2017 Census of Agriculture were summed across every record within each aquaculture weight adjustment group. The resulting weight sum was the best available estimate of the number of aquaculture farms that existed for a given State in 2017. The number of aquaculture farms for the weight adjustment group was divided equally among all aquaculture census respondents within the group. The resulting value became the statistically fully-adjusted weight for each respondent in the weight adjustment group. The sum of the adjusted weights across all respondents in the group necessarily equaled the target value.

The fully-adjusted weights applied to respondents on the 2018 Census of Aquaculture mail list were integerized using a random process. This process rounded each raw weight upwards to the smallest integer that exceeded the fully-adjusted raw weight using a probability equal to the non-integer portion of the raw weight, otherwise, the weight would have been rounded downwards to the largest integer that was less than the raw weight.

Example: The raw weight for a record is 1.75. It will be rounded up to 2.0 with a probability of 0.75 and rounded down to 1.0 with a probability of 0.25.

The State total for a particular characteristic being estimated was obtained by multiplying each record's value for the characteristic by the record's integerized weight. The weighted values were then summed up over all the responding records in that State to obtain the State-level estimate.

DATA COMPARABILITY

Data definitions are comparable between the 2018 and 2013 aquaculture censuses, with the exception that during the 2018 Census of Aquaculture questions pertaining to water source, size of operation, and methods of production in the report form were asked of all operations and not just operations with sales. In 2013, operations that solely produced and distributed aquaculture for restoration, conservation, enhancement, or recreational purposes were instructed to complete only Section 13, Aquaculture Produced and Distributed. Specific data changes from 2018 are listed in Appendix B. Dollar figures are expressed in current dollars and have not been adjusted for inflation or deflation.

The census of aquaculture data are not directly comparable to the census of agriculture data, due to different priorities and data definitions. A census of agriculture priority is the value of production of all agriculture (including aquaculture) at the county level. A census of aquaculture priority is a more specific look at U.S. and State-level aquaculture sales and aquaculture distributed for restoration, conservation, enhancement, or recreational purposes.

In the 2017 Census of Agriculture, all agriculture production moved off the farm had a value of sales reported or assigned. Aquaculture which was moved for distribution, restoration, conservation, enhancement, or recreational purposes was assigned a value. In the 2018 Census of Aquaculture, farms with aquaculture which was produced and sold are included in tables 1 through 9, 13 through 21, and 24. Aquaculture which was not sold, but distributed for conservation is included in tables 22 and 23. Tables 10, 11, and 12 are not comparable to the 2013 Census of Aquaculture. In 2018, farms with aquaculture sales and/or distributed aquaculture products for conservation, recreation, enhancement, or recreational purposes are included. In 2013, only operations that had aquaculture sales were included in tables 10 through 12.

Differing priorities between the census of agriculture and the census of aquaculture explain some of the farm count differences between the two censuses. For the 2017 Census of Agriculture, there were several large farms that span across county lines. To capture the agricultural production in the correct county, these farms were split into multiple records. These operations were weighted and summarized as individual farms for the 2017 Census of Agriculture. The census of aquaculture allowed one respondent to report for multiple locations within the same State. All production, sales, and distributed aquaculture data may have been tabulated as one farm. As a result, farm counts were reduced in Tables 1 – 20, and 22 – 24 by a maximum of 349 farms throughout the United States. The 349 total farms are distributed as follows: Arkansas – 1 farm, Idaho – 26 farms, Louisiana – 5 farms, Mississippi – 2 farms, Oregon – 38 farms, Pennsylvania – 134 farms, and Washington – 143 farms.

Another difference with the census of agriculture is the minimum level of production. The census of agriculture has a minimum of $1,000 of production or potential production of all agriculture items. For example, a farm with $200 of crayfish and $900 of rice is included. The census of aquaculture minimum is $1,000 worth of aquaculture production either sold, or distributed for restoration, conservation, enhancement, or recreational purposes, which could reduce the number of farms. The last difference is that the census of agriculture food fish category excludes catfish and trout. The census of aquaculture includes catfish and trout in the food fish totals.

MEASURES OF CENSUS QUALITY

There are two main types of estimation error that affect all estimates obtained from almost any survey. These errors make it unlikely that estimates obtained from the 2018 Census of Aquaculture will exactly match the true value in the population for a given farm characteristic.

The first type of error, referred to as nonobservation error, occurs in any estimate generated from a survey in which nonresponse occurs or data are not potentially obtainable from every unit in the target population. Statistical weighting as described in the Estimation section is used to reduce the effects of this type of error.

The second type of error is called nonsampling error. There are many sources of nonsampling error. Respondent reporting errors, data collection errors, data keying errors, and data editing errors are all examples of errors of this type. Quality controlled data processing is used to keep the effect of nonsampling errors to a minimum.

Census Response Rate

The response rate is one indicator of the quality of a data collection. It is generally assumed that if a response rate is close to a full participation level of 100 percent, the potential for nonresponse bias is small. Because the aquaculture mail list contained both farm and nonfarm records, the response rate is an indicator of replying to the data collection effort, but does not reflect whether those responding records qualified for data summarization. The U.S. response rate for the 2018 Census of Aquaculture is 83.7 percent. The U.S. response rate for the 2013 Census of Aquaculture was 90.2.

MEASURES OF PRECISION

Under the guidance of the Statistical Policy Office of the Office of Management and Budget (OMB), NASS provides data users with quality metrics for its published data series. The accuracy of data products may be evaluated through sampling and nonsampling error. The measurement of error due to sampling in the current period is evaluated by the coefficient of variation (CV) for each estimated item. Nonsampling error is evaluated by response rates and the percent of the estimate from respondents.

Coefficient of variation is a measure of the relative amount of error associated with a sample estimate. Specifically, it is the standard error of a point estimate divided by that estimate, generally multiplied times 100 so that it can be reported as a percentage. This relative measure allows the reliability of a range of estimates to be compared. For example, the standard error is often larger for large population estimates than for small population estimates, but the large population estimates may have a smaller CV, indicating a more reliable estimate. Every estimate for the 2018 Census of Aquaculture has a corresponding CV published with it. NASS has identified the following index to use when evaluating coefficient of variation for the 2018 Census of Aquaculture. The coefficient of variation is used as an indicator of the precision in the census estimates and is reported for some census items in Table A.

- **Low Reliability Estimate.** Coefficient of Variation (CV) 30 percent or higher. Caution should be used when using this estimate in any form. Please consult NASS for more information or guidance.

- **Medium Reliability Estimate.** Coefficient of Variation (CV) between 15 percent and 29.9 percent.

- **High Reliability Estimate.** Coefficient of Variation (CV) less than 15 percent.

Table A. **Coefficient of Variation: 2018**

[For meaning of abbreviations and symbols, see introductory text.]

Geographic area	Farms	Coefficient of variation (percent)	Value ($1,000)	Coefficient of variation (percent)
CATFISH				
United States	531	7.2	366,843	0.6
Alabama	96	7.2	92,139	0.9
Arizona	3	(L)	(D)	(D)
Arkansas	34	18.9	23,263	3.8
California	35	45.3	10,319	8.5
Colorado	2	67.1	(D)	(D)
Florida	18	29.8	302	4.9
Georgia	25	34.4	1,108	4.6
Hawaii	9	73.0	158	82.2
Idaho	2	(L)	(D)	(D)
Illinois	11	45.6	378	20.3
Iowa	1	(L)	(D)	(D)
Kansas	4	(L)	637	(L)
Kentucky	14	43.4	855	57.0
Louisiana	7	38.3	(D)	(D)
Michigan	4	82.2	30	44.8
Mississippi	161	5.0	(D)	(D)
Missouri	8	31.4	(D)	(D)
Nebraska	3	89.4	13	(H)
North Carolina	17	45.7	3,353	23.0
Ohio	11	22.8	180	22.3
Oklahoma	2	(H)	(D)	(D)
Oregon	3	94.9	1	25.4
Pennsylvania	6	67.1	6	(H)
Tennessee	11	73.7	179	60.5
Texas	37	19.7	20,862	0.5
Virginia	4	67.1	14	86.5
West Virginia	1	(L)	(D)	(D)
Wisconsin	2	94.9	(D)	(D)
BAITFISH				
United States	168	7.0	32,778	3.7
Alabama	3	77.5	24	(H)
Arkansas	29	5.7	22,159	0.7
California	2	(H)	(D)	(D)
Colorado	2	94.9	(D)	(D)
Delaware	1	(H)	(D)	(D)
Florida	5	82.7	(D)	(D)
Georgia	2	67.1	(D)	(D)
Illinois	6	47.4	(D)	(D)
Indiana	1	(L)	(D)	(D)
Iowa	6	63.2	124	(H)
Kansas	3	(L)	(D)	(D)
Kentucky	1	(L)	(D)	(D)
Louisiana	3	63.2	241	94.7
Maine	2	(H)	(D)	(D)
Michigan	4	88.7	267	(H)
Minnesota	9	38.0	1,583	30.3
Mississippi	5	82.7	144	98.5
Missouri	11	36.6	982	2.7
Nebraska	4	97.8	(D)	(D)
New Jersey	2	(L)	(D)	(D)
New York	8	47.4	125	89.7
North Carolina	11	60.4	258	75.6
Ohio	14	26.2	2,131	26.6

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Table A. **Coefficient of Variation: 2018** (continued)

[For meaning of abbreviations and symbols, see introductory text.]

Geographic area	Farms	Coefficient of variation (percent)	Value ($1,000)	Coefficient of variation (percent)
BAITFISH - Con.				
Oklahoma	1	(H)	(D)	(D)
Pennsylvania	11	28.6	231	14.4
South Carolina	3	89.4	22	(H)
South Dakota	2	(L)	(D)	(D)
Tennessee	2	(H)	(D)	(D)
Texas	6	67.1	30	71.4
West Virginia	2	82.2	(D)	(D)
Wisconsin	7	44.9	2,038	8.9
CRUSTACEANS				
United States	560	5.7	100,365	7.2
Alabama	2	(H)	(D)	(D)
California	1	(H)	(D)	(D)
Colorado	1	(L)	(D)	(D)
Delaware	1	(H)	(D)	(D)
Florida	15	41.5	14,267	1.7
Georgia	2	(H)	(D)	(D)
Hawaii	12	61.2	24,957	20.1
Idaho	1	(L)	(D)	(D)
Iowa	2	(H)	(D)	(D)
Kentucky	6	63.2	88	76.3
Louisiana	450	6.4	50,322	7.2
Maryland	2	47.4	(D)	(D)
Michigan	2	(H)	(D)	(D)
Minnesota	1	(L)	(D)	(D)
Missouri	4	(H)	(D)	(D)
Nebraska	1	(H)	(D)	(D)
New Hampshire	3	(H)	(D)	(D)
New Jersey	2	(L)	(D)	(D)
North Carolina	7	48.9	108	72.5
Ohio	8	83.0	85	(H)
Pennsylvania	1	(L)	(D)	(D)
South Carolina	7	44.9	1,436	1.4
Tennessee	1	(L)	(D)	(D)
Texas	20	41.9	7,732	4.6
Virginia	8	47.4	(D)	(D)
ORNAMENTAL FISH				
United States	263	11.0	43,534	4.3
Alabama	2	(L)	(D)	(D)
Arkansas	6	35.4	(D)	(D)
California	7	79.0	(D)	(D)
Connecticut	6	90.8	69	(H)
Florida	109	9.2	28,721	3.2
Hawaii	15	29.7	(D)	(D)
Idaho	2	(L)	(D)	(D)
Illinois	3	70.7	40	20.7
Indiana	3	63.2	(D)	(D)
Iowa	1	(L)	(D)	(D)
Kentucky	6	98.7	(D)	(D)
Louisiana	4	85.5	(D)	(D)
Maryland	3	94.9	232	(H)
Michigan	4	71.2	(D)	(D)
Minnesota	1	(H)	(D)	(D)
Missouri	5	73.5	(D)	(D)

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Table A. **Coefficient of Variation: 2018** (continued)

[For meaning of abbreviations and symbols, see introductory text.]

Geographic area	Farms	Coefficient of variation (percent)	Value ($1,000)	Coefficient of variation (percent)
ORNAMENTAL FISH - Con.				
Nebraska	3	(H)	2	(H)
New Hampshire	1	(L)	(D)	(D)
New Jersey	5	60.0	202	14.9
New York	8	(H)	108	(H)
North Carolina	7	71.7	(D)	(D)
Ohio	13	88.8	144	15.4
Oklahoma	1	(H)	(D)	(D)
Oregon	3	94.9	18	(H)
Pennsylvania	8	71.2	808	47.1
Rhode Island	2	(L)	(D)	(D)
South Carolina	4	75.0	(D)	(D)
Tennessee	6	65.2	(D)	(D)
Texas	15	39.5	636	34.7
Virginia	6	47.4	(D)	(D)
West Virginia	1	(L)	(D)	(D)
Wisconsin	3	94.9	(D)	(D)