

# **Ecosystem Report of the Sculpin Stock Complex in the Gulf of Alaska, Eastern Bering Sea, and Aleutian Islands**

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## **Executive Summary**

Sculpins are managed as non-target species in the BSAI and GOA, and are taken only as bycatch during directed fishing for other species. In 2020, a final rule was issued which reclassified sculpins as Ecosystem Component category, non-target species in the Bering Sea/Aleutian Islands (BSAI) (Amendment 121) and Gulf of Alaska (Amendment 110) Groundfish Fishery Management Plans ([85 FR 06310](#), March 23, 2020 for the proposed rule, and [85 FR 41427](#), July 10, 2020 for the final rule). Prior to this rule the sculpin complexes were not in the FMPs (i.e. “nonspecified”). Under this rule, sculpins are not allowed to be targeted, and there is a Maximum Retainable Allowance (MRA) of 20% in the BSAI and GOA (Federal Register, Proposed Rules, Vol. 79, No. 93). This rule applies to all vessels processing groundfish harvested in the BSAI or GOA (50 CFR 679) and it prohibits directed fishing.

Stock assessments are not required for Ecosystem Component species. There are no ABC or OFL catch limits adopted in the annual groundfish harvest specifications. This Ecosystem Report for the combined BSAI and GOA is presented for tracking trends in abundance and catch. For the first year of this Ecosystem Component sculpin report, unofficial OFL and ABC values based on the former Tier 5 assessment methods, are provided for comparison as an appendix (Appendix 1). Because overfishing is not defined for an Ecosystem Component, these values are not used for management or for determining if overfishing is occurring.

Through the stock assessment prioritization process, the sculpin report is now on a 4-year cycle. Prior to the shift of sculpins to the Ecosystem Component category, the last full GOA SAFE assessment was completed in 2015, and a partial assessment in 2019. The last full BSAI SAFE assessment was presented in 2016 and a partial assessment in 2019.

New data in this report include: 1) updated catch data through October 16, 2023; 2) survey biomass estimates from the 2022 Aleutian Islands survey, the 2020-2023 Eastern Bering Sea surveys, the 2021 and 2023 Gulf of Alaska surveys and 3) updated GOA and BSAI trawl survey biomass time series estimates through 2023 using a random effects multivariate assessment (REMA) model (Appendix 1).

## **Introduction**

Sculpins are a group of benthic-dwelling predatory teleost fishes that include 48 species in waters off the coast of Alaska (Families Cottidae, Hemitripterae, Psychrolutidae, and Rhamphocottidae). A total of forty-six species of sculpins have been listed as occurring in the GOA, and 39 of these have been identified on NMFS GOA research surveys. Forty-seven species of sculpins have been identified in the Bering Sea Aleutian Islands (BSAI) region. These

species have previously been managed as a complex, and the complex natural mortality ( $M$ ) estimate was based on the biomass of the six most abundant sculpins in the BSAI and the four most common species in the GOA surveys since 1984. In the GOA these species are: bigmouth (*Hemitripterus bolini*), great (*Myoxocephalus polyacanthocephalus*), and plain (*Myoxocephalus jaok*) sculpins, and yellow Irish lord (*Hemilepidotus jordani*). In the BSAI, the six most abundant sculpins in the BSAI: bigmouth (*Hemitripterus bolini*), great (*Myoxocephalus polyacanthocephalus*), plain (*Myoxocephalus jaok*), threaded (*Gymnocanthus pistilliger*), warty (*Myoxocephalus verrucosus*), and yellow Irish lord (*Hemilepidotus jordani*).

Sculpins belong to the superfamily Cottoidea in the order Scorpaeniformes. They are relatively small, benthic-dwelling teleost fish with modified pectoral fins that allow them to grip the substrate, and they lack swim bladders. Most, if not all sculpins, lay adhesive eggs in nests, and many exhibit parental care for eggs (Eschmeyer et al, 1983). Markevich (2000) observed the sea raven, *Hemitripterus villosus*, releasing eggs into crevices of boulders and stones in shallow waters in Peter the Great Bay, Sea of Japan. This type of reproductive strategy may make sculpin populations more sensitive to changes in benthic habitats than other groundfish species such as pollock, which are broadcast spawners with pelagic eggs. In the western Pacific, great sculpins *Myoxocephalus polyacanthocephalus* are reported to have relatively late ages at maturity (5-8 years, Tokranov, 1985) despite being relatively short-lived. Great sculpin length and age at 50% maturity was estimated at 57.2 cm and 6.9 years from data collected in 2006 and 2007 along the eastern Bering Sea shelf (TenBrink and Aydin, 2009). The maximum age for great sculpin from this study was 17 years. Fecundity for the great sculpin off East Kamchatka waters ranged from 48,000 to 415,000 eggs (Tokranov, 1985). In contrast, preliminary information on reproduction for bigmouth sculpin (*Hemitripterus bolini*) in the GOA showed fecundity averaged 2,283 eggs per female (Morgan Busby, AFSC, personal comm.). The diversity of sculpin species in the GOA and BSAI suggests that each sculpin population might respond differently to environmental changes (whether natural or fishing induced). Within each sculpin species, observed spatial differences in fecundity, egg size, and other life history characteristics suggest local population structure (Tokranov, 1985). Information such as depth range, distribution, and maximum length has been collected for several years for many species during research surveys. There is no specific age-and-growth or maturity data for most sculpins.

Biomass calculations for the Gulf of Alaska and Bering Sea and Aleutian Islands sculpin complexes are based on the most common large sculpin species in those regions. These species are from the genera *Myoxocephalus*, *Hemitripterus*, and *Hemilepidotus*, and have been identified to the species level by observers from the North Pacific Groundfish Observer Program since 2008.

## Data

### Fishery

There are no directed fisheries for sculpin species in the BSAI or GOA at this time. Total catch (retained and discarded) has ranged from 2% to 6% of the total estimated biomass. There is no market for sculpins, and there has not been recent interest in marketing sculpin in any product form. Based on data from the NMFS Alaska Regional Office (AKRO) the main gear type catching sculpins is the non-pelagic trawl, and the main fisheries that catch sculpins are flatfish, Pacific cod, and IFQ halibut. Catch and retention data for sculpin is provided in Table 1 for the Bering Sea and Aleutian Islands, and Gulf of Alaska.

## Survey

Aggregate sculpin biomass estimates are derived from the GOA and BSAI bottom trawl surveys that have been conducted since 1982 in the EBS, since 1984 in the GOA and since 1980 in the Aleutian Islands. Survey estimates for the six most abundant sculpin species and “other” sculpin are provided in Table 3 for the eastern Bering Sea, Table 4 for the Aleutian Islands, and Table 5 for the Gulf of Alaska. Random effects biomass estimates (Sullivan et al. 2022) are provided for comparison in Appendix 1. Biomass trends based on the survey time series are provided in Figure 1 for the eastern Bering Sea, Figure 2 for the Aleutian Islands, and Figure 3 for the Gulf of Alaska). Research catch of sculpin are provided in Appendix 2, Table 1.

## Ecosystem Considerations

A determination of ecosystem considerations for sculpins in Alaska is hampered by lack of biological and habitat information for these species and by limited knowledge in general on the diverse environments they inhabit. However, declining trends are apparent in several species. These declines are most apparent in common species in the Aleutian Islands with the exception of the yellow Irish Lord (Figure 2), and in the total sculpin biomass in the eastern Bering Sea (Figure 1).

## Literature cited

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## Tables

Table 1. Total catch in metric tons (t) of sculpin complex retained and discarded, for the eastern Bering Sea and Aleutian Islands, 1999-2023. Percent retained refers to the entire BSAI. Source: NMFS AKRO BLEND/Catch Accounting System, \*complete as of October 16, 2023.

| Year  | EBS sculpin catch | AI sculpin catch | BSAI sculpin catch | % of sculpins retained |
|-------|-------------------|------------------|--------------------|------------------------|
| 1999  | 315               | 90               | 405                | 44.87%                 |
| 2000  | 276               | 77               | 353                | 17.38%                 |
| 2001  | 203               | 9                | 212                | 34.34%                 |
| 2002  | 2,715             | 75               | 2,790              | 3.73%                  |
| 2003  | 5,152             | 669              | 5,821              | 5.33%                  |
| 2004  | 5,087             | 955              | 6,042              | 1.42%                  |
| 2005  | 4,958             | 685              | 5,643              | 1.97%                  |
| 2006  | 4,820             | 909              | 5,729              | 2.91%                  |
| 2007  | 6,677             | 996              | 7,673              | 5.52%                  |
| 2008  | 6,497             | 892              | 7,389              | 6.22%                  |
| 2009  | 5,779             | 1,284            | 7,063              | 9.03%                  |
| 2010  | 4,127             | 1,307            | 5,434              | 4.45%                  |
| 2011  | 4,874             | 503              | 5,377              | 5.42%                  |
| 2012  | 4,991             | 807              | 5,798              | 4.73%                  |
| 2013  | 5,234             | 624              | 5,858              | 2.67%                  |
| 2014  | 4,495             | 384              | 4,879              | 2.46%                  |
| 2015  | 4,062             | 905              | 4,967              | 1.94%                  |
| 2016  | 4,381             | 511              | 4,892              | 1.82%                  |
| 2017  | 4,419             | 887              | 5,306              | 1.21%                  |
| 2018  | 4,323             | 711              | 5,034              | 1.89%                  |
| 2019  | 4,810             | 794              | 5,604              | 0.89%                  |
| 2020  | 4,363             | 818              | 5,181              | 1.24%                  |
| 2021  | 4,878             | 750              | 5,628              | 0.71%                  |
| 2022  | 4,984             | 849              | 5,833              | 3.99%                  |
| 2023* | 3,297             | 490              | 3,787              | 4.49%                  |

\*Current as of October 16, 2023.

Table 2. GOA total sculpin complex catch, retention rate, total Other Species catch (sculpin, sharks, skates, octopus and squid), and sculpin percentage of Other Species catch, 1997-2023. *Source: Other species total catch: AKRO Catch Accounting System, retention rate: estimated from fishery observer data obtained from the AFSC Fishery Monitoring and Analysis program, Sculpin complex total catch Source: NMFS AKRO BLEND/Catch Accounting System, through October 16, 2023.*

| Year              | Sculpin complex total catch | Retention rate | Other species total catch | Percent of Other Species catch |
|-------------------|-----------------------------|----------------|---------------------------|--------------------------------|
| 1997              | 898                         |                | 4,823                     | 19%                            |
| 1998              | 526                         |                | 7,422                     | 7%                             |
| 1999              | 544                         |                | 3,788                     | 14%                            |
| 2000              | 940                         |                | 5,455                     | 17%                            |
| 2001              | 587                         |                | 3,383                     | 17%                            |
| 2002              | 919                         |                | 8,162                     | 11%                            |
| 2003              | 629                         | 7%             | 6,266                     | 10%                            |
| 2004 <sup>+</sup> | 701                         | 9%             | 1,705                     | 41%                            |
| 2005              | 626                         | 16%            | 2,513                     | 25%                            |
| 2006              | 583                         | 16%            | 3,881                     | 15%                            |
| 2007              | 960                         | 19%            | 3,035                     | 32%                            |
| 2008              | 1,925                       | 14%            | 2,967                     | 65%                            |
| 2009              | 1,374                       | 18%            | 3,188                     | 43%                            |
| 2010              | 911                         | 12%            | 1,866                     | 49%                            |
| 2011              | 763                         | 10%            | 1,678                     | 45%                            |
| 2012              | 795                         | 13%            |                           |                                |
| 2013              | 1,966                       | 1%             |                           |                                |
| 2014              | 1,187                       | 3%             |                           |                                |
| 2015              | 1,016                       | 1%             |                           |                                |
| 2016              | 1,330                       | 3%             |                           |                                |
| 2017              | 1,379                       | 1%             |                           |                                |
| 2018              | 635                         | 2%             |                           |                                |
| 2019              | 643                         | 2%             |                           |                                |
| 2020              | 575                         | 1%             |                           |                                |
| 2021              | 859                         | 1%             |                           |                                |
| 2022              | 753                         | 0%             |                           |                                |
| 2023              | 389                         | 1%             |                           |                                |

+ Beginning in 2004, skates were removed from Other Species complex. Sculpin were split out from the Other Species complex in 2011.

Table 2. Survey biomass estimates (t) of bigmouth, great, plain, warty, threaded, yellow Irish lord (YIL), and other sculpins from the eastern Bering Sea survey, 1982 – 2023.

| Year | Bigmouth | Great  | Plain   | Warty  | Threaded | YIL    | Other   | Total   |
|------|----------|--------|---------|--------|----------|--------|---------|---------|
| 1982 | 21,808   | 5,809  | 56,401  | 0      | 3,429    | 50,682 | 56,167  | 194,296 |
| 1983 | 18,611   | 36,373 | 81,224  | 1,884  | 389      | 43,652 | 62,721  | 244,855 |
| 1984 | 25,695   | 17,945 | 54,084  | 51,151 | 217      | 29,626 | 52,003  | 230,721 |
| 1985 | 14,162   | 30,220 | 37,373  | 265    | 5        | 13,139 | 61,537  | 156,702 |
| 1986 | 10,474   | 53,096 | 45,671  | 275    | 119      | 24,217 | 164,633 | 298,485 |
| 1987 | 22,918   | 48,439 | 56,177  | 3,924  | 150      | 41,738 | 13,678  | 187,025 |
| 1988 | 21,869   | 40,251 | 49,459  | 3,482  | 291      | 24,957 | 56,428  | 196,737 |
| 1989 | 16,457   | 36,209 | 57,883  | 0      | 72       | 22,128 | 29,076  | 161,824 |
| 1990 | 16,014   | 34,064 | 36,136  | 0      | 0        | 10,234 | 44,955  | 141,402 |
| 1991 | 20,402   | 65,039 | 113,943 | 3,306  | 93       | 10,281 | 54,992  | 268,056 |
| 1992 | 18,200   | 91,263 | 74,140  | 0      | 282      | 17,156 | 22,998  | 224,039 |
| 1993 | 19,633   | 64,104 | 88,264  | 50     | 0        | 22,175 | 17,758  | 211,984 |
| 1994 | 28,296   | 93,900 | 97,116  | 0      | 0        | 17,976 | 20,907  | 258,194 |
| 1995 | 29,404   | 87,437 | 67,659  | 0      | 0        | 19,191 | 12,505  | 216,196 |
| 1996 | 31,221   | 84,941 | 52,220  | 0      | 0        | 14,571 | 2,604   | 185,558 |
| 1997 | 29,538   | 78,429 | 70,204  | 3,906  | 3,905    | 23,837 | 6,439   | 216,258 |
| 1998 | 36,256   | 62,918 | 57,535  | 8,770  | 1,820    | 13,974 | 4,223   | 185,495 |
| 1999 | 24,599   | 43,593 | 45,753  | 10,538 | 3,609    | 13,274 | 5,553   | 146,919 |
| 2000 | 26,148   | 60,982 | 43,975  | 11,728 | 1,714    | 11,290 | 6,028   | 161,864 |
| 2001 | 25,683   | 39,874 | 48,837  | 15,016 | 428      | 9,153  | 4,827   | 143,817 |
| 2002 | 31,904   | 64,879 | 52,918  | 9,514  | 1,577    | 9,420  | 5,167   | 175,377 |
| 2003 | 29,205   | 63,824 | 74,042  | 7,004  | 1,165    | 14,443 | 3,645   | 193,329 |
| 2004 | 34,367   | 58,051 | 69,881  | 10,054 | 1,309    | 33,778 | 3,035   | 210,475 |
| 2005 | 31,256   | 56,361 | 76,937  | 25,141 | 1,997    | 27,484 | 7,288   | 226,464 |
| 2006 | 30,073   | 54,606 | 67,215  | 16,063 | 2,409    | 31,860 | 6,956   | 209,184 |
| 2007 | 27,736   | 63,371 | 78,487  | 13,333 | 4,169    | 23,740 | 5,451   | 216,286 |
| 2008 | 30,778   | 67,905 | 57,014  | 11,323 | 2,196    | 32,563 | 4,681   | 206,461 |
| 2009 | 20,027   | 43,327 | 47,682  | 7,932  | 1,173    | 23,187 | 5,787   | 149,115 |
| 2010 | 32,219   | 48,890 | 55,648  | 6,929  | 1,680    | 21,636 | 6,487   | 173,489 |
| 2011 | 31,074   | 52,230 | 59,733  | 6,450  | 971      | 20,341 | 7,514   | 178,313 |
| 2012 | 23,998   | 39,311 | 53,605  | 6,459  | 5,043    | 22,296 | 4,982   | 155,695 |
| 2013 | 26,132   | 30,679 | 47,685  | 4,044  | 1,230    | 8,033  | 3,113   | 120,915 |
| 2014 | 23,295   | 43,259 | 70,500  | 7,144  | 565      | 9,258  | 3,840   | 157,862 |
| 2015 | 27,911   | 34,517 | 60,815  | 10,352 | 407      | 29,032 | 5,538   | 168,571 |
| 2016 | 36,880   | 49,851 | 53,691  | 15,964 | 91       | 30,915 | 3,608   | 191,000 |
| 2017 | 38,127   | 47,296 | 34,172  | 11,257 | 393      | 32,538 | 3,420   | 167,203 |
| 2018 | 37,861   | 49,450 | 37,502  | 7,800  | 96       | 31,807 | 1,871   | 166,388 |
| 2019 | 34,322   | 84,086 | 50,585  | 8,580  | 191      | 41,781 | 1,878   | 221,423 |
| 2021 | 25,212   | 45,593 | 37,180  | 2,128  | 678      | 18,355 | 3,160   | 132,307 |
| 2022 | 18,546   | 62,922 | 39,123  | 560    | 430      | 25,819 | 1,982   | 149,382 |
| 2023 | 22,364   | 39,459 | 26,678  | 546    | 599      | 21,028 | 2,881   | 113,555 |

Table 4. Survey biomass estimates (t) of bigmouth, great, plain, warty, threaded, yellow Irish lord (YIL), and other sculpins from the Aleutian Islands survey, 1980 – 2022.

| Year | Bigmouth | Great  | Plain | Warty   | Threaded | YIL  | Other   | Total   |
|------|----------|--------|-------|---------|----------|------|---------|---------|
| 1980 | 1429.6   | 8749   | 0     | 2462    | 0        | 0    | 3263.9  | 15904.5 |
| 1983 | 8169.9   | 11967  | 0     | 5047.5  | 0        | 0    | 4760.6  | 29945   |
| 1986 | 2549.8   | 6300.7 | 0     | 9876.3  | 317.9    | 11.4 | 13983.5 | 33039.6 |
| 1991 | 993.5    | 4117.2 | 0     | 3813    | 2.6      | 0    | 7534.4  | 16460.7 |
| 1994 | 1830.1   | 2328.7 | 0     | 7227.2  | 11.8     | 0    | 5828.7  | 17226.5 |
| 1997 | 1617     | 2137.5 | 0     | 4668.1  | 0        | 8.1  | 5281    | 13711.7 |
| 2000 | 1005.3   | 1167.7 | 0     | 6710.6  | 0        | 0    | 4078.9  | 12962.5 |
| 2002 | 1191.2   | 1560.2 | 32.1  | 4307.6  | 0        | 0    | 7195.8  | 14286.9 |
| 2004 | 789.5    | 1518.6 | 0     | 8357    | 0        | 0    | 8428.3  | 19093.4 |
| 2006 | 1649.2   | 2141.4 | 0     | 10797.2 | 0        | 0    | 6290.9  | 20878.7 |
| 2010 | 791.3    | 1071   | 0     | 15416.1 | 0        | 4.2  | 7541.3  | 24823.9 |
| 2012 | 338.8    | 1929.8 | 0     | 14165.8 | 0        | 0    | 5871.1  | 22305.5 |
| 2014 | 708.7    | 805    | 0     | 13916   | 0        | 0.5  | 4517    | 19947.2 |
| 2016 | 450.5    | 1266.6 | 0.8   | 10097.1 | 0        | 0    | 4000    | 15815   |
| 2018 | 132.9    | 1211.1 | 10.5  | 12372.1 | 0        | 0.4  | 2867.4  | 16594.4 |
| 2022 | 255.2    | 944.4  | 0     | 14048.6 | 0        | 0.4  | 2775.2  | 18023.8 |

Table 5. Survey biomass estimates (t) of bigmouth, great, plain, warty, threaded, yellow Irish lord (YIL), and other sculpins from the Gulf of Alaska survey, 1984 – 2023

| Year | Bigmouth | Great | Plain | YIL    | Other | Total  |
|------|----------|-------|-------|--------|-------|--------|
| 1984 | 15,871   | 8,833 | 0     | 14,439 | 5,087 | 44,229 |
| 1987 | 10,196   | 6,007 | 403   | 13,592 | 1,581 | 31,779 |
| 1990 | 8,600    | 3,815 | 433   | 11,701 | 2,205 | 26,755 |
| 1993 | 5,612    | 5,846 | 461   | 11,661 | 1,784 | 25,363 |
| 1996 | 4,246    | 7,326 | 1,015 | 17,804 | 1,276 | 31,667 |
| 1999 | 3,983    | 3,913 | 1,692 | 20,255 | 989   | 30,832 |
| 2001 | 3,471    | 3,540 | 932   | 20,945 | 1,640 | 30,528 |
| 2003 | 5,767    | 6,037 | 1,220 | 12,064 | 1,381 | 26,468 |
| 2005 | 5,543    | 6,542 | 3,913 | 15,943 | 1,864 | 33,804 |
| 2007 | 3,128    | 7,970 | 4,548 | 15,508 | 1,565 | 32,719 |
| 2009 | 3,154    | 8,215 | 2,562 | 25,219 | 1,447 | 40,597 |
| 2011 | 3,591    | 8,384 | 3,160 | 15,771 | 794   | 31,700 |
| 2013 | 3,947    | 6,282 | 3,036 | 19,841 | 866   | 33,972 |
| 2015 | 4,783    | 9,128 | 508   | 29,532 | 1,227 | 45,177 |
| 2017 | 4,430    | 5,877 | 1,844 | 17,333 | 768   | 30,252 |
| 2019 | 5,559    | 5,643 | 1,658 | 14,964 | 2,054 | 29,879 |
| 2021 | 3,210    | 5,113 | 2,752 | 12,242 | 827   | 24,145 |
| 2023 | 2,857    | 3,828 | 2,375 | 14,264 | 569   | 23,893 |



## Figures

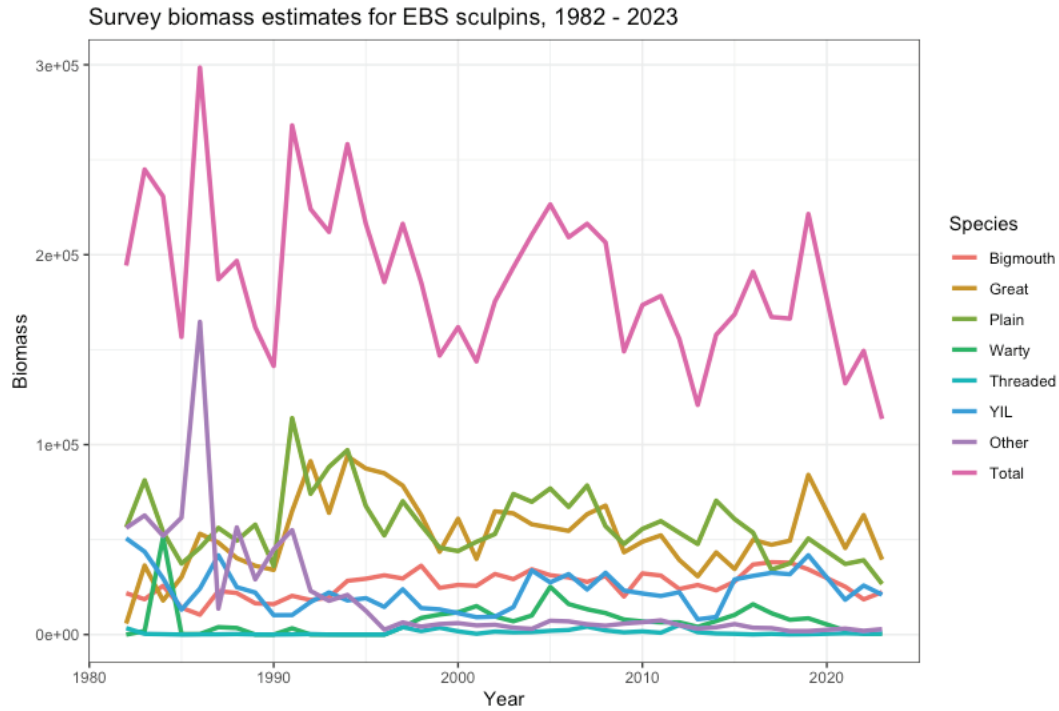


Figure 1. Survey biomass estimates (t) for the most abundant sculpin species in the eastern Bering Sea, 1982 – 2023.

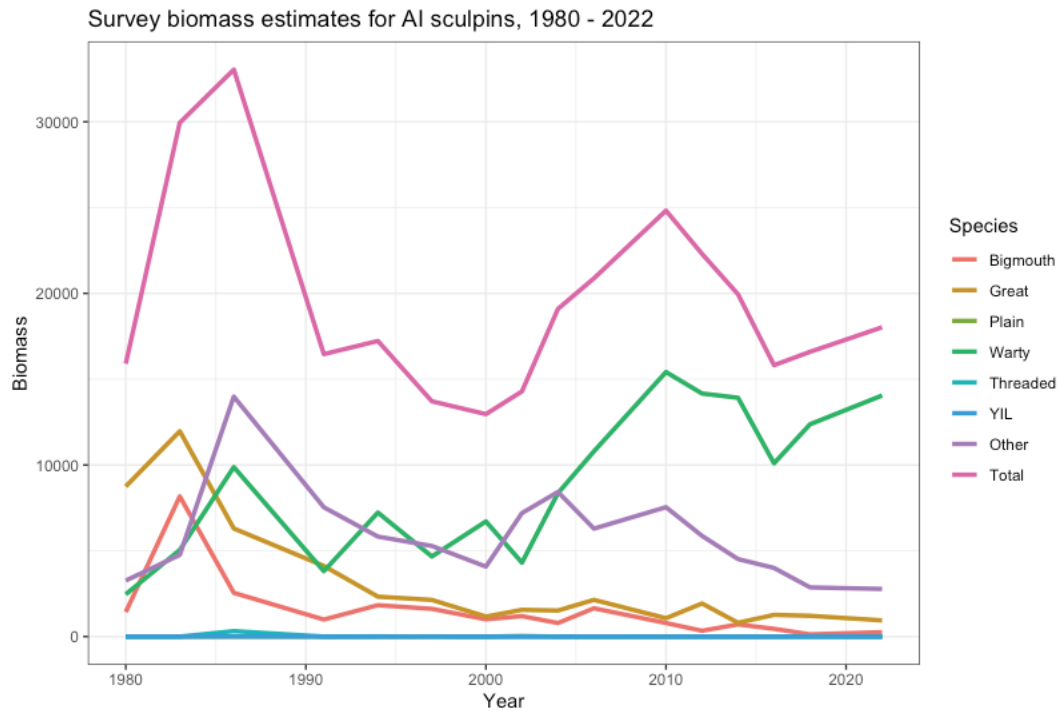


Figure 2. Survey biomass estimates (t) for the most abundant sculpin species in the Aleutian Islands, 1980 – 2022.

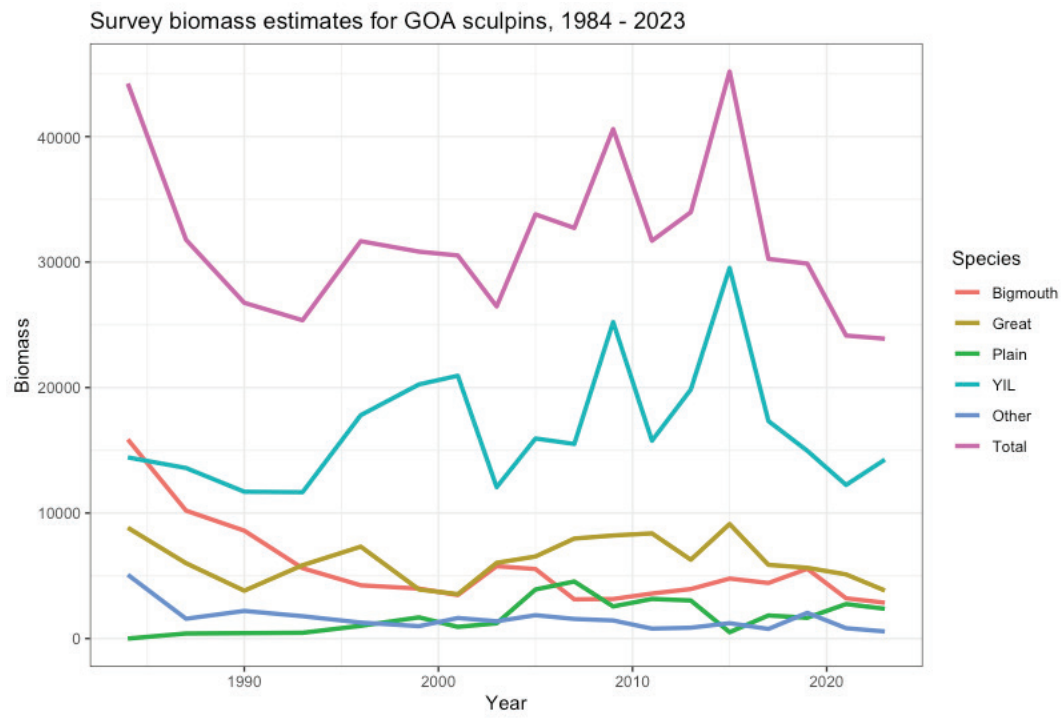


Figure 3. Survey biomass estimates (t) for the most abundant sculpin species in the Gulf of Alaska, 1984 – 2023.

**Appendix 1.** This appendix provides unofficial reference points for the sculpin complexes and describes the methodology used.

### Summary of Results

Updated unofficial calculations of maximum allowable ABC for 2024 is 29,417 t in the BSAI and 3,968 mt in the GOA. Compared to the last full assessments completed in 2016 (BSAI) and 2015 (GOA), this is a 42% decrease in the BSAI and a 24% decrease in the GOA. The corresponding reference values for the sculpin complex are summarized in the following tables, with the updated unofficial **ABC and OFL values in bold**. Overfishing is not occurring in either the BSAI or GOA. Catches are not approaching unofficial OFLs. The estimated OFLs and ABCs in the tables presented below are much larger than the mean catches for the sculpin complexes and also much larger than the catch in any single year (Table 1). Detailed REMA biomass estimates (Sullivan et al. 2022) are provided in Tables A1, A2, and A3.

#### Gulf of Alaska Sculpin Complex

| Quantity  | As estimated or specified in the <i>last</i> SAFE <sup>1</sup> for: |        | As estimated or recommended <i>this</i> year for: |        |
|---|---|--------|---|--------|
|   | 2023  | 2024   | 2024  | 2025   |
| $M$ (natural mortality)                             | 0.21  | 0.21   | 0.21  | 0.21   |
| Specified/recommended Tier                          | 5   | 5      | 5   | 5      |
| Biomass (mt)  | 33,010  | 33,010 | 25,192  | 25,192 |
| $F_{OFL}$ (F=M)                                     | 0.21  | 0.21   | 0.21  | 0.21   |
| $maxF_{ABC}$ (maximum allowable = $0.75x F_{OFL}$ ) | 0.1575  | 0.1575 | 0.1575  | 0.1575 |
| $F_{ABC}$   | 0.1575  | 0.1575 | 0.1575  | 0.1575 |
| OFL (t)   | 6,932   | 6,932  | <b>5,290</b>                                      | 5,290  |
| maxABC (t)  | 5,199   | 5,199  | <b>3,968</b>                                      | 3,968  |
| ABC (t)   | 5,199   | 5,199  | <b>3,968</b>                                      | 3,968  |
| Status  | As determined in the <i>last</i> SAFE for:                          |        | As determined <i>this</i> year for:               |        |
|   | 2021  | 2022   | 2022  | 2023   |
| Overfishing   | No  | n/a    | No  | n/a    |

<sup>1</sup>The last full assessment was in the 2015 SAFE..

The sculpin complex is an Ecosystem Component and, therefore, ABCs or OFLs are not used for catch specification.

#### Bering Sea and Aleutian Islands Sculpin Complex

| Quantity   | As estimated or specified in the <i>last</i> SAFE <sup>1</sup> for: |         | As estimated or recommended <i>this</i> year for: |         |
|--|---|---------|---|---------|
|  | 2023  | 2024    | 2024  | 2025    |
| <i>M</i> (natural mortality)   | 0.282   | 0.282   | 0.282   | 0.282   |
| Specified/recommended Tier   | 5   | 5       | 5   | 5       |
| Biomass (t)  | 240,487   | 240,487 | 139,087   | 139,087 |
| <i>F</i> <sub>OFL</sub> (F=M)  | 0.282   | 0.282   | 0.282   | 0.282   |
| <i>maxF</i> <sub>ABC</sub> (maximum allowable = 0.75 <i>x F</i> <sub>OFL</sub> ) | 0.2115  | 0.2115  | 0.2115  | 0.2115  |
| <i>F</i> <sub>ABC</sub>  | 0.2115  | 0.2115  | 0.2115  | 0.2115  |
| OFL (mt)   | 67,817  | 67,817  | <b>39,223</b>                                     | 39,223  |
| maxABC (mt)  | 50,863  | 50,863  | <b>29,417</b>                                     | 29,417  |
| ABC (mt)   | 50,863  | 50,863  | <b>29,417</b>                                     | 29,417  |
| Status   | As determined in the <i>last</i> SAFE for:                          |         | As determined <i>this</i> year for:               |         |
|  | 2021  | 2022    | 2022  | 2023    |
| Overfishing  | No  | n/a     | No  | n/a     |

<sup>1</sup>The last full assessment was in the 2016 SAFE.

The sculpin stock complex is an Ecosystem Component and, therefore, ABCs or OFLs are not used for catch specification.

Tier 5 computations for sculpin OFL and ABC (t) are summarized by region (AI = Aleutian Islands, EBS = Eastern Bering Sea, GOA = Gulf of Alaska) for 2023:

#### BSAI and GOA Sculpin

| Area        | Biomass | Natural            | OFL                | ABC    |            |         |
|-------------|---------|--------------------|--------------------|--------|------------|---------|
|             |         | mortality <i>M</i> | definition         | OFL    | definition | ABC     |
| EBS         | 121,407 | 0.282              | biomass x <i>M</i> | 34,237 | OFL x 0.75 | 25,678  |
| AI          | 17,680  | 0.282              | biomass x <i>M</i> | 4,986  | OFL x 0.75 | 3,940   |
| BSAI total  | 139,087 |                    |                    | 39,223 |            | 29,417* |
| GOA         | 25,192  | 0.21               | biomass x <i>M</i> | 5,290  | OFL x 0.75 | 3,968   |
| Grand total | 164,279 |                    |                    | 44,513 |            | 33,385  |

The sculpin stock complex is an Ecosystem Component therefore, ABCs or OFLs are not used for catch specifications.

\*Depending on order of operations, rounding error can result in 29,418 or 29,417. For the ABC we combined the EBS+AI estimates first and only rounded once, resulting in 29,417.

## Methodology

Biomass estimates were performed using the REMA method (<https://afsc-assessments.github.io/rema/>) (Sullivan et al. 2022). Biomass was calculated separately for the three large marine ecosystems: the Aleutian Islands, eastern Bering Sea, and the Gulf of Alaska. Within each large marine ecosystem, the most prominent species were enumerated separately, and the remaining species were combined into an “other” sculpin category. In the AI and EBS, REMA estimates were performed for the 6 most common sculpins: bigmouth sculpin

(*Hemitripteris bolini*), great sculpin (*Myoxocephalus polyacanthocephalus*), plain sculpin (*Myoxocephalus jaok*), threaded sculpin (*Gymnocanthus pistilliger*), warty sculpin (*Myoxocephalus verrucosus/scorpius*), and yellow Irish lord (*Hemilepidotus jordani*). There were 4 sculpin species considered the most abundant in the Gulf of Alaska. These were the yellow Irish lord (*Hemilepidotus jordani*), bigmouth sculpin (*Hemitripteris bolini*), great sculpin (*Myoxocephalus polyacanthocephalus*), plain sculpin (*Myoxocephalus jaok*), and yellow Irish lord (*Hemilepidotus jordani*). Data that was input into the REMA model were annual survey biomass estimates (by species), and estimates of the uncertainty (coefficient of variance). Therefore, estimates of six species + “other” sculpins were performed for the Aleutian Islands and eastern Bering Sea, and four species + “other” sculpins. These estimates were combined in each region to estimate annual sculpin biomass. The Bering Sea and Aleutian Islands estimates were further combined for a BSAI biomass estimate.

Table A1.1. Biomass estimates (t) for sculpin in the eastern Bering Sea using REMA. Biomass estimates for the six most abundant sculpin species are listed (YIL= yellow Irish lord), as well as “other” species of sculpin and the total estimate.

| Year | Bigmouth | Great  | Plain   | Warty  | Threaded | YIL    | other  | TOTAL   |
|------|----------|--------|---------|--------|----------|--------|--------|---------|
| 1982 | 19,917   | 12,842 | 60,970  | 3,959  | 1,891    | 39,160 | 62,312 | 201,051 |
| 1983 | 19,495   | 21,045 | 66,270  | 3,959  | 433      | 33,788 | 62,599 | 207,588 |
| 1984 | 19,311   | 24,325 | 53,260  | 28,634 | 200      | 26,475 | 61,386 | 213,591 |
| 1985 | 17,715   | 32,317 | 41,079  | 1,261  | 48       | 19,439 | 60,610 | 172,468 |
| 1986 | 17,281   | 47,515 | 46,049  | 538    | 109      | 21,964 | 50,574 | 184,031 |
| 1987 | 18,825   | 46,640 | 53,628  | 3,521  | 147      | 23,426 | 34,541 | 180,727 |
| 1988 | 18,983   | 41,167 | 52,329  | 3,462  | 181      | 20,921 | 32,905 | 169,947 |
| 1989 | 18,578   | 39,262 | 57,972  | 3,168  | 117      | 16,800 | 30,602 | 166,499 |
| 1990 | 18,768   | 44,559 | 64,418  | 2,898  | 130      | 11,962 | 29,076 | 171,812 |
| 1991 | 19,682   | 61,016 | 101,785 | 2,652  | 145      | 11,716 | 27,164 | 224,159 |
| 1992 | 20,454   | 78,557 | 82,271  | 730    | 273      | 15,429 | 22,839 | 220,555 |
| 1993 | 21,985   | 70,547 | 87,551  | 201    | 457      | 17,141 | 19,194 | 217,076 |
| 1994 | 24,772   | 88,874 | 91,209  | 422    | 763      | 17,494 | 16,156 | 239,691 |
| 1995 | 26,900   | 86,480 | 69,552  | 887    | 1,274    | 17,456 | 13,114 | 215,663 |
| 1996 | 28,148   | 82,710 | 56,912  | 1,863  | 2,129    | 16,091 | 10,654 | 198,507 |
| 1997 | 28,618   | 73,247 | 66,675  | 3,914  | 3,555    | 17,662 | 9,316  | 202,987 |
| 1998 | 28,695   | 60,695 | 57,208  | 8,307  | 1,982    | 14,970 | 8,187  | 180,043 |
| 1999 | 27,339   | 48,450 | 47,659  | 10,494 | 3,353    | 13,318 | 7,615  | 158,229 |
| 2000 | 27,237   | 51,027 | 45,025  | 11,767 | 1,647    | 11,913 | 7,112  | 155,729 |
| 2001 | 27,548   | 50,602 | 49,308  | 14,769 | 544      | 11,476 | 6,809  | 161,057 |
| 2002 | 28,822   | 59,164 | 56,364  | 9,569  | 1,198    | 12,542 | 6,546  | 174,204 |
| 2003 | 29,787   | 60,732 | 70,874  | 7,139  | 1,189    | 16,050 | 6,364  | 192,136 |
| 2004 | 31,190   | 58,217 | 70,788  | 10,159 | 1,334    | 22,801 | 6,228  | 200,716 |
| 2005 | 30,720   | 56,531 | 74,814  | 20,274 | 1,964    | 25,479 | 6,161  | 215,943 |
| 2006 | 29,884   | 55,826 | 69,401  | 16,103 | 2,437    | 26,487 | 6,080  | 206,217 |
| 2007 | 28,934   | 61,731 | 72,820  | 13,345 | 3,455    | 25,771 | 5,984  | 212,040 |
| 2008 | 28,486   | 61,756 | 58,696  | 11,200 | 2,171    | 26,264 | 5,904  | 194,478 |
| 2009 | 26,727   | 47,251 | 49,907  | 8,028  | 1,288    | 23,808 | 5,842  | 162,851 |
| 2010 | 28,961   | 48,279 | 54,930  | 6,962  | 1,596    | 21,793 | 5,789  | 168,309 |
| 2011 | 28,851   | 47,698 | 58,352  | 6,473  | 1,123    | 19,998 | 5,727  | 168,222 |
| 2012 | 26,684   | 39,979 | 54,582  | 6,319  | 3,843    | 18,285 | 5,357  | 155,048 |
| 2013 | 26,447   | 35,034 | 53,683  | 4,171  | 1,291    | 15,911 | 5,015  | 141,552 |
| 2014 | 26,500   | 39,709 | 66,118  | 7,097  | 602      | 18,167 | 4,828  | 163,021 |
| 2015 | 29,342   | 37,443 | 57,670  | 10,342 | 375      | 23,134 | 4,661  | 162,967 |
| 2016 | 33,774   | 46,887 | 48,981  | 14,842 | 171      | 27,505 | 4,450  | 176,609 |
| 2017 | 35,716   | 47,908 | 37,958  | 11,206 | 352      | 29,866 | 4,258  | 167,263 |
| 2018 | 35,165   | 52,521 | 39,267  | 7,962  | 133      | 30,203 | 4,090  | 169,341 |
| 2019 | 32,300   | 66,288 | 48,063  | 8,197  | 202      | 29,342 | 3,959  | 188,350 |
| 2020 | 28,446   | 56,798 | 43,230  | 4,063  | 348      | 25,576 | 3,866  | 162,326 |
| 2021 | 25,051   | 48,667 | 38,882  | 2,013  | 600      | 22,294 | 3,775  | 141,283 |
| 2022 | 21,936   | 49,206 | 36,819  | 708    | 459      | 23,096 | 3,698  | 135,921 |
| 2023 | 22,083   | 42,276 | 29,848  | 559    | 569      | 22,427 | 3,645  | 121,407 |

Table A1.2. Biomass estimates (t) for sculpin in the Aleutian Islands using REMA. Biomass estimates for the six most abundant sculpin species are listed (YIL= yellow Irish lord), “other” species of sculpin, and the total estimate.

| Year | Bigmouth | Great | Plain | Warty | Threaded | YIL    | other | TOTAL  |
|------|----------|-------|-------|-------|----------|--------|-------|--------|
| 1980 | 2,423    | 8,686 | 28    | 294   | 10       | 2,959  | 3,620 | 18,019 |
| 1981 | 2,957    | 8,612 | 28    | 294   | 10       | 3,437  | 3,896 | 19,234 |
| 1982 | 3,609    | 8,539 | 28    | 294   | 10       | 3,991  | 4,194 | 20,665 |
| 1983 | 4,404    | 8,466 | 28    | 294   | 10       | 4,636  | 4,515 | 22,353 |
| 1984 | 3,684    | 7,649 | 28    | 294   | 10       | 5,176  | 4,765 | 21,605 |
| 1985 | 3,081    | 6,910 | 28    | 294   | 10       | 5,779  | 5,029 | 21,131 |
| 1986 | 2,577    | 6,242 | 28    | 294   | 10       | 6,452  | 5,307 | 20,911 |
| 1987 | 2,189    | 5,624 | 28    | 122   | 10       | 5,915  | 5,100 | 18,988 |
| 1988 | 1,859    | 5,066 | 28    | 51    | 9        | 5,423  | 4,901 | 17,338 |
| 1989 | 1,578    | 4,564 | 28    | 21    | 9        | 4,972  | 4,709 | 15,883 |
| 1990 | 1,340    | 4,112 | 28    | 9     | 9        | 4,559  | 4,525 | 14,582 |
| 1991 | 1,138    | 3,704 | 28    | 4     | 9        | 4,179  | 4,348 | 13,411 |
| 1992 | 1,260    | 3,217 | 28    | 5     | 8        | 4,590  | 4,639 | 13,748 |
| 1993 | 1,395    | 2,795 | 28    | 7     | 8        | 5,041  | 4,949 | 14,223 |
| 1994 | 1,545    | 2,427 | 28    | 11    | 8        | 5,536  | 5,279 | 14,834 |
| 1995 | 1,531    | 2,274 | 28    | 11    | 8        | 5,471  | 5,228 | 14,551 |
| 1996 | 1,518    | 2,131 | 28    | 11    | 7        | 5,406  | 5,178 | 14,280 |
| 1997 | 1,505    | 1,996 | 28    | 11    | 7        | 5,343  | 5,128 | 14,018 |
| 1998 | 1,367    | 1,812 | 28    | 11    | 7        | 5,599  | 4,991 | 13,815 |
| 1999 | 1,241    | 1,645 | 28    | 11    | 6        | 5,868  | 4,858 | 13,657 |
| 2000 | 1,127    | 1,494 | 28    | 11    | 6        | 6,150  | 4,728 | 13,543 |
| 2001 | 1,121    | 1,529 | 28    | 11    | 5        | 5,549  | 5,563 | 13,805 |
| 2002 | 1,114    | 1,564 | 28    | 11    | 5        | 5,006  | 6,546 | 14,275 |
| 2003 | 1,032    | 1,602 | 23    | 11    | 4        | 6,271  | 6,934 | 15,878 |
| 2004 | 957      | 1,641 | 19    | 11    | 4        | 7,856  | 7,344 | 17,831 |
| 2005 | 1,081    | 1,734 | 15    | 11    | 4        | 9,013  | 6,909 | 18,766 |
| 2006 | 1,221    | 1,832 | 12    | 11    | 3        | 10,341 | 6,500 | 19,919 |
| 2007 | 1,068    | 1,689 | 10    | 11    | 3        | 11,074 | 6,572 | 20,426 |
| 2008 | 934      | 1,557 | 8     | 11    | 3        | 11,860 | 6,645 | 21,017 |
| 2009 | 817      | 1,435 | 6     | 11    | 3        | 12,702 | 6,718 | 21,693 |
| 2010 | 715      | 1,323 | 5     | 11    | 2        | 13,603 | 6,793 | 22,453 |
| 2011 | 592      | 1,332 | 4     | 11    | 2        | 13,743 | 6,205 | 21,889 |
| 2012 | 490      | 1,342 | 3     | 11    | 1        | 13,885 | 5,668 | 21,400 |
| 2013 | 516      | 1,221 | 3     | 11    | 1        | 13,586 | 5,065 | 20,402 |
| 2014 | 544      | 1,111 | 2     | 11    | 1        | 13,293 | 4,526 | 19,488 |
| 2015 | 474      | 1,135 | 2     | 11    | 1        | 12,035 | 4,168 | 17,825 |
| 2016 | 413      | 1,160 | 1     | 11    | 1        | 10,895 | 3,838 | 16,319 |
| 2017 | 342      | 1,150 | 3     | 11    | 1        | 11,522 | 3,470 | 16,499 |
| 2018 | 282      | 1,141 | 7     | 11    | 1        | 12,185 | 3,138 | 16,764 |
| 2019 | 278      | 1,113 | 7     | 11    | 1        | 12,507 | 3,060 | 16,976 |
| 2020 | 274      | 1,087 | 7     | 11    | 1        | 12,837 | 2,984 | 17,199 |
| 2021 | 269      | 1,061 | 7     | 11    | 0        | 13,176 | 2,911 | 17,434 |
| 2022 | 265      | 1,035 | 7     | 11    | 0        | 13,523 | 2,838 | 17,680 |
| 2023 | 265      | 1,035 | 7     | 11    | 0        | 13,523 | 2,838 | 17,680 |

Table A1.3. Biomass estimates (t) for sculpin in the Gulf of Alaska using REMA. Biomass estimates for the four most abundant sculpin species are listed (YIL= yellow Irish lord), “other” species of sculpin, and the total estimate.

| Year | Bigmouth | Great | Plain | YIL    | Other | TOTAL  |
|------|----------|-------|-------|--------|-------|--------|
| 1984 | 15,040   | 7,482 | 436   | 14,163 | 4,237 | 41,358 |
| 1985 | 13,280   | 7,106 | 436   | 14,082 | 3,235 | 38,138 |
| 1986 | 11,725   | 6,749 | 436   | 14,001 | 2,470 | 35,380 |
| 1987 | 10,353   | 6,409 | 436   | 13,920 | 1,886 | 33,003 |
| 1988 | 9,512    | 6,193 | 448   | 13,877 | 1,946 | 31,976 |
| 1989 | 8,740    | 5,984 | 460   | 13,834 | 2,009 | 31,027 |
| 1990 | 8,031    | 5,781 | 473   | 13,791 | 2,073 | 30,149 |
| 1991 | 7,193    | 5,771 | 500   | 13,888 | 1,962 | 29,314 |
| 1992 | 6,443    | 5,760 | 528   | 13,986 | 1,858 | 28,575 |
| 1993 | 5,772    | 5,750 | 557   | 14,084 | 1,759 | 27,921 |
| 1994 | 5,342    | 5,719 | 657   | 14,562 | 1,599 | 27,880 |
| 1995 | 4,944    | 5,689 | 776   | 15,055 | 1,454 | 27,919 |
| 1996 | 4,576    | 5,659 | 916   | 15,566 | 1,323 | 28,040 |
| 1997 | 4,435    | 5,393 | 1,018 | 16,021 | 1,252 | 28,119 |
| 1998 | 4,299    | 5,140 | 1,131 | 16,488 | 1,185 | 28,243 |
| 1999 | 4,166    | 4,899 | 1,257 | 16,970 | 1,122 | 28,413 |
| 2000 | 4,172    | 4,963 | 1,227 | 16,646 | 1,281 | 28,290 |
| 2001 | 4,179    | 5,028 | 1,198 | 16,329 | 1,463 | 28,197 |
| 2002 | 4,554    | 5,427 | 1,349 | 15,857 | 1,440 | 28,628 |
| 2003 | 4,963    | 5,857 | 1,519 | 15,399 | 1,418 | 29,156 |
| 2004 | 4,881    | 6,193 | 2,091 | 15,753 | 1,587 | 30,505 |
| 2005 | 4,800    | 6,549 | 2,879 | 16,115 | 1,775 | 32,117 |
| 2006 | 4,237    | 6,926 | 3,070 | 16,546 | 1,667 | 32,446 |
| 2007 | 3,740    | 7,325 | 3,273 | 16,989 | 1,566 | 32,894 |
| 2008 | 3,604    | 7,523 | 2,994 | 17,863 | 1,479 | 33,462 |
| 2009 | 3,473    | 7,725 | 2,738 | 18,782 | 1,397 | 34,115 |
| 2010 | 3,569    | 7,732 | 2,711 | 18,403 | 1,111 | 33,527 |
| 2011 | 3,668    | 7,739 | 2,685 | 18,031 | 884   | 33,008 |
| 2012 | 3,833    | 7,475 | 2,299 | 18,363 | 893   | 32,863 |
| 2013 | 4,004    | 7,220 | 1,968 | 18,702 | 903   | 32,797 |
| 2014 | 4,221    | 7,366 | 1,391 | 18,776 | 1,025 | 32,779 |
| 2015 | 4,450    | 7,514 | 983   | 18,851 | 1,164 | 32,962 |
| 2016 | 4,447    | 6,975 | 1,217 | 17,986 | 1,004 | 31,629 |
| 2017 | 4,445    | 6,475 | 1,506 | 17,160 | 866   | 30,452 |
| 2018 | 4,455    | 6,118 | 1,621 | 16,336 | 1,151 | 29,680 |
| 2019 | 4,464    | 5,781 | 1,745 | 15,551 | 1,530 | 29,071 |
| 2020 | 4,048    | 5,482 | 1,938 | 14,954 | 1,138 | 27,561 |
| 2021 | 3,671    | 5,199 | 2,153 | 14,380 | 847   | 26,250 |
| 2022 | 3,461    | 4,944 | 2,218 | 14,361 | 713   | 25,697 |
| 2023 | 3,264    | 4,701 | 2,285 | 14,342 | 600   | 25,192 |



## Appendix 2.

Table A2.1.—Research catches (kg) of sculpin compiled by NMFS Alaska Region: Sourced by the AKR.V\_NONCOMMERCIAL\_FISHERY\_CATCH table.

| Year | ADFG  | IPHC   | NMFS   | Total  |
|------|-------|--------|--------|--------|
| 1988 | 0     | 0      | 145    | 145    |
| 1989 | 0     | 0      | 82     | 82     |
| 1990 | 0     | 0      | 53     | 53     |
| 1991 | 0     | 0      | 102    | 102    |
| 1992 | 0     | 0      | 45     | 45     |
| 1993 | 0     | 0      | 23     | 23     |
| 1994 | 0     | 0      | 33     | 33     |
| 1995 | 0     | 0      | 43     | 43     |
| 1996 | 0     | 0      | 1,186  | 1,186  |
| 1997 | 0     | 0      | 43     | 43     |
| 1998 | 693   | 0      | 716    | 1,409  |
| 1999 | 1,029 | 0      | 50     | 1,079  |
| 2000 | 1,410 | 0      | 662    | 2,072  |
| 2001 | 1,014 | 0      | 42     | 1,056  |
| 2002 | 1,674 | 0      | 618    | 2,292  |
| 2003 | 1,710 | 0      | 43     | 1,753  |
| 2004 | 2,058 | 0      | 1,041  | 3,099  |
| 2005 | 2,388 | 0      | 55     | 2,443  |
| 2006 | 1,258 | 0      | 983    | 2,241  |
| 2007 | 1,869 | 0      | 101    | 1,970  |
| 2008 | 1,071 | 0      | 906    | 1,977  |
| 2009 | 1,350 | 0      | 220    | 1,570  |
| 2010 | 406   | 8,174  | 19,001 | 27,581 |
| 2011 | 1,441 | 6,547  | 18,803 | 26,791 |
| 2012 | 1,391 | 4,367  | 13,341 | 19,099 |
| 2013 | 2,268 | 7,809  | 6,550  | 16,627 |
| 2014 | 171   | 9,550  | 10,394 | 20,115 |
| 2015 | 175   | 9,482  | 9,563  | 19,220 |
| 2016 | 630   | 5,319  | 12,985 | 18,934 |
| 2017 | 3,638 | 6,958  | 12,937 | 23,533 |
| 2018 | 1,963 | 7,570  | 12,448 | 21,981 |
| 2019 | 730   | 13,078 | 12,268 | 26,076 |
| 2020 | 315   | 2,340  | 2,052  | 4,707  |
| 2021 | 265   | 8,263  | 7,474  | 16,002 |