|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Analysis** | **Fig.** | **Key statistic** | **Value** | **Ref.** | **Full Reference** |
| Scottish salmon production | 1a | Scottish salmon production volume (1999-2020) | Fig. 1 | *47* | Marine Scotland Science. Scottish Fish Farm Production Survey 2019. (2020). https://www.gov.scot/publications/scottish-fish-farm-production-survey-2019/pages/5/ |
| 1a,b | Scottish salmon production volume (2014) | 179,022 t | *47* | Marine Scotland Science. Scottish Fish Farm Production Survey 2019. (2020). https://www.gov.scot/publications/scottish-fish-farm-production-survey-2019/pages/5/ |
| 1b | Fish oil volume in Scottish salmon (2014) | 33,000 t | *16* | Shepherd, C. J., Monroig, O. & Tocher, D. R. Future availability of raw materials for salmon feeds and supply chain implications: The case of Scottish farmed salmon. *Aquaculture.* **467**, 49-62 (2017). |
| Fish meal volume in Scottish salmon (2014) | 55,000 t | *16* | Shepherd, C. J., Monroig, O. & Tocher, D. R. Future availability of raw materials for salmon feeds and supply chain implications: The case of Scottish farmed salmon. *Aquaculture.* **467**, 49-62 (2017). |
| Fish oil yield from wild-caught fish (global industry average) | 4.80% | *17* | IFFO. Fish in: Fish Out (FIFO) ratios for the conversion of wild feed to farmed fish, including salmon. Fish in: Fish Out (FIFO) ratios https://www.iffo.com/fish-fish-out-fifo-ratios-conversion-wild-feed (2017). |
| Fish meal yield from wild-caught fish (global industry average) | 22.5% | *17* | IFFO. Fish in: Fish Out (FIFO) ratios for the conversion of wild feed to farmed fish, including salmon. Fish in: Fish Out (FIFO) ratios https://www.iffo.com/fish-fish-out-fifo-ratios-conversion-wild-feed (2017). |
| Proportion of trimmings in FMFO (global industry average) | 33% | *17* | IFFO. Fish in: Fish Out (FIFO) ratios for the conversion of wild feed to farmed fish, including salmon. Fish in: Fish Out (FIFO) ratios https://www.iffo.com/fish-fish-out-fifo-ratios-conversion-wild-feed (2017). |
| Proportion of trimmings in FMFO (EU average) | 47% | *53* | European Commission. European Market Observatory for Fisheries and Aquaculture Products (EUMOFA) Monthly Highlights No. 1. 2020 (2020). |
| Proportion of trimmings in FMFO (Scottish salmon) | 24% | *48-52* | Calculated (weighted average) using data from the same sources as Table S2. |
| FMFO feed in Scottish salmon | 1c | FMFO volumes in major Scottish salmon feed producers | Table S2 | - | - |
| FMFO species composition in major Scottish salmon feed producers | Table S2 |
| Nutrient composition and production | 2 | Species nutrient concentrations | Table S4 |
| Diet scenarios | 3a | Salmon production and wild-caught fish volumes (2014) | Fig. 1 |
| 3b | Micronutrient concentration of diet scenarios | Fig. 2, Table S4 |
| 3c | Salmon production and wild-caught fish volumes (2014) | Fig. 1 |
| Global FMFO use | 4a | Wild-caught fish reduced to FMFO (2016) | 15 Mt | *62* | FAO. The State of World Fisheries and Aquaculture 2018 - Meeting the sustainable development goals. (2018). Rome. Licence: CC BY-NC-SA 3.0 IGO. http://www.fao.org/3/I9540EN/i9540en.pdf |
| Wild-caught fish proportion of total fish used in FMFO | 67% | *17* | IFFO. Fish in: Fish Out (FIFO) ratios for the conversion of wild feed to farmed fish, including salmon. Fish in: Fish Out (FIFO) ratios https://www.iffo.com/fish-fish-out-fifo-ratios-conversion-wild-feed (2017). |
| FMFO production and use by aquaculture and other industries (2016) | Table S5 | - |  |
| Seafood production using commercial aquafeed (2016) | Table S6 | - |  |
| 4b | Proportion of fish oil from trimmings | 40% | *1* | FAO. The State of World Fisheries and Aquaculture 2020. (FAO, 2020). doi:10.4060/ca9229en. |
| Proportion of fishmeal from trimmings | 22% | *1* | FAO. The State of World Fisheries and Aquaculture 2020. (FAO, 2020). doi:10.4060/ca9229en. |
| Proportion of wild-fish consumed directly | 24% | Fig. 3 |  |
| Reallocation of FMFO after limiting salmon to trimmings-only FMFO | Table S7 | - |  |

**Table S1** | Data sources and key statistics.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  | *FMFO composition in feed* | |  |  |
| **Species** | **Year** | **Company** | **Fish oil (%)** | **Fishmeal (%)** | Numbered reference | Reference |
| Trimmings | 2016 | Biomar | 44 | 15 | *20* | Seafish. *Fishmeal and fish oil facts and figures.* (2018). https://www.seafish.org/document/?id=1b08b6d5-75d9-4179-9094-840195ceee4b |
| Blue whiting | 5 | 16 |
| Anchovy | 1 | 1 |
| Anchoveta | 12 | 29 |
| Sardine(lla) | 13 | 17 |
| Capelin | 4 | 2 |
| Krill |  | 10 |
| Sand eel | 4 | 2 |
| Sprat | 11 | 4 |
| Herring | 3 |  |
| Menhaden | 2 | 2 |
| Pout |  | 1 |
| Mackerel |  | 1 |
| Hake |  |  |
| Cod |  |  |
| Boarfish |  |  |
| Silver smelt |  |  |
| Other | 2 |  |
| Trimmings | 2018 | 42 | 9 | *51* | [Biomar Group. *Sustainability Report 2018.* https://www.biomar.co.uk/globalassets/.global/pdf-files/biomar-group-sustainability-report-2018.pdf](https://www.biomar.co.uk/globalassets/.global/pdf-files/biomar-group-sustainability-report-2018.pdf) |
| Blue whiting | 6 | 27 |
| Anchovy | 1 | 1 |
| Anchoveta | 11 | 9 |
| Sardine(lla) | 11 | 36 |
| Capelin | 3 | 3 |
| Krill |  |  |
| Sand eel | 4 | 4 |
| Sprat | 5 | 3 |
| Herring | 5 | 3 |
| Menhaden | 7 | 1 |
| Pout | 1 | 1 |
| Mackerel | 1 |  |
| Hake |  |  |
| Cod | 1 |  |
| Boarfish |  |  |
| Silver smelt |  |  |
| Other | 3 | 1 |
| Trimmings | 2019 | 29.5 | 27.9 | *48* | [Biomar Group. *Integrated Sustainability Report 2019.* https://www.biomar.com/globalassets/.global/pdf-files/reports/biomar-sustainability-report-2019.pdf](https://www.biomar.com/globalassets/.global/pdf-files/reports/biomar-sustainability-report-2019.pdf) |
| Blue whiting | 1.5 | 17.3 |
| Anchovy | 4.2 | 0.4 |
| Anchoveta | 21.3 | 22.6 |
| Sardine(lla) | 15 | 1.8 |
| Capelin | 0.3 | 0.2 |
| Krill |  | 8 |
| Sand eel | 2.7 | 4 |
| Sprat | 6.5 | 1.9 |
| Herring | 8.8 | 7.6 |
| Menhaden | 0.2 | 2.1 |
| Pout | 0.3 | 0.9 |
| Mackerel | 3.9 | 2.6 |
| Hake |  |  |
| Cod |  |  |
| Boarfish |  |  |
| Silver smelt | 0.1 | 0.1 |
| Other | 6 | 2.5 |
| Trimmings | 2018 | Mowi | 4.9 | 10.2 | *52* | [Mowi. *Integrated Annual Report* 2018. http://hugin.info/209/R/2239765/882920.pdf](http://hugin.info/209/R/2239765/882920.pdf) |
| Blue whiting | 3 | 28.1 |
| Anchovy | 20.1 |  |
| Anchoveta | 8.2 |  |
| Sardine(lla) | 22.6 |  |
| Capelin | 4 | 11 |
| Krill |  |  |
| Sand eel |  | 11 |
| Sprat | 3 | 11 |
| Herring | 3 | 11 |
| Menhaden | 28.9 | 6.7 |
| Pout | 2.3 | 11 |
| Mackerel |  |  |
| Hake |  |  |
| Cod |  |  |
| Boarfish |  |  |
| Silver smelt |  |  |
| Other |  |  |
| Trimmings | 2019 | 4.9 | 10.2 | *50* | [Mowi. *Integrated Annual Report 2019.* https://corpsite.azureedge.net/corpsite/wp-content/uploads/2020/03/Mowi\_Annual\_Report\_2019.pdf](https://corpsite.azureedge.net/corpsite/wp-content/uploads/2020/03/Mowi_Annual_Report_2019.pdf) |
| Blue whiting | 3 | 28.7 |
| Anchovy | 2.8 |  |
| Anchoveta | 40.2 |  |
| Sardine(lla) | 28.2 |  |
| Capelin | 4 | 11 |
| Krill |  |  |
| Sand eel |  | 11 |
| Sprat | 5 | 11 |
| Herring | 5 | 11 |
| Menhaden | 4.5 | 6.1 |
| Pout | 2.4 | 11 |
| Mackerel |  |  |
| Hake |  |  |
| Cod |  |  |
| Boarfish |  |  |
| Silver smelt |  |  |
| Other |  |  |

**Table S2 |** Fish species composition in FMFO from two major feed companies supply Scottish salmon farms. All sardine species were combined as 'sardine(lla)'.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Company** | **FO** | **FO from trimmings** | **FO from whole fish** | **FM** | **FM from trimmings** | **FM from whole fish** | **Ref** | **Full reference** | |
| 2016 | Biomar | 84728.00 | 37068.00 | 47660.00 | 157323.00 | 23011.00 | 134312.00 | *20* | Seafish. Fishmeal and fish oil facts and figures. Seafish March, 1–35 (2018). |
| 2018 | Biomar | 93207.00 | 39557.00 | 53650.00 | 174401.00 | 16556.00 | 157845.00 | *48* | Biomar Group. *Sustainability Report 2018.* (2019). https://www.biomar.co.uk/globalassets/.global/pdf-files/biomar-group-sustainability-report-2018.pdf | |
| 2019 | Biomar | 106041.00 | 31310.00 | 74731.00 | 220640.00 | 61596.00 | 159044.00 | *51* | Biomar Group. *Integrated Sustainability Report 2019.* (2020). https://www.biomar.com/globalassets/.global/pdf-files/reports/biomar-sustainability-report-2019.pdf | |
| 2018 | Mowi | 36126.00 | 1770.17 | 34355.83 | 46508.00 | 4743.82 | 41764.18 | *52* | Mowi. *Integrated Annual Report 2018.* (2019). http://hugin.info/209/R/2239765/882920.pdf | |
| 2019 | Mowi | 44490.00 | 2180.01 | 42309.99 | 52391.00 | 5343.88 | 47047.12 | *50* | Mowi. *Integrated Annual Report 2019.* (2020). https://corpsite.azureedge.net/corpsite/wp-content/uploads/2020/03/Mowi\_Annual\_Report\_2019.pdf | |

**Table S3 |** Fish oil and fish meal production for two major feed producers used in farmed Scottish salmon. Units are tonnes. FO = fish oil; FM = fishmeal.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | **Database ID** | **Calcium** | | **Iron** | | **Selenium** | | **Zinc** | | **Vitamin A (retinol)** | | **Vitamin D** | | **Vitamin B-12** | | **20:5 n-3 (EPA)** | | **22:6 n-3 (DHA)** | |
| **Product** | **Common name** | **Species** |  | **mg** | **Source** | **mg** | **Source** | **µg** | **Source** | **mg** | **Source** | **µg** | **Source** | **µg** | **Source** | **µg** | **Source** | **g** | **Source** | **g** | **Source** |
| Anchovy, canned | Anchoveta | *Engraulis ringens* | FDC ID: 1098766 | 232 | *3* | 4.6 | *3* | 68.1 | *3* | 2.4 | *3* | 12 | *3* | 1.7 | *3* | 0.88 | *3* | 0.763 | *3* | 1.292 | *3* |
| Anchovy, canned | Anchovy | *Engraulis encrasicolus* | FDC ID: 1098766 | 232 | *3* | 4.6 | *3* | 68.1 | *3* | 2.4 | *3* | 12 | *3* | 1.7 | *3* | 0.88 | *3* | 0.763 | *3* | 1.292 | *3* |
| Whiting | Blue whiting | *Micromesistius poutassou* | BEDCA ID: 1236 | 16 | *4* | 0.3 | *4* | 28 | *4* | 0.4 | *4* | 0 | *4* | 0 | *4* | 2 | *4* | 0.11 | *4* | 0.14 | *4* |
| Whiting, poached | Whiting | *Merlangius merlangus* | Foods No. 1338 | 84 | *7* | 0.5 | *7* | 41.2 | *7* | 0.83 | *7* | 4.9 | *7* | 0.92 | *7* | 0.86 | *7* | 0.07 | *7* | 0.13 | *7* |
| Capelin, raw | Capelin | *Mallotus villosus* | FDC ID: 175147 | 81 | *1* | 0.18 | *1* | 15.2 | *1* | 0.44 | *1* | 4.37 | *1* | 0\* | *3* | 3.44\* | *3* | 0.6 | *6* | 0.5 | *6* |
| Carp, cooked, dry heat | Common Carp | *Cyprinus carpio* | FDC ID: 174185 | 52 | *3* | 1.59 | *3* | 16.2 | *3* | 1.9 | *3* | 9.6 | *3* | 31.3\*\* | *3* | 1.47 | *3* | 0.305 | *3* | 0.146 | *3* |
| Kippers (herring), grilled, flesh only | Herring | *Clupea harengus* | Sample No. 26 | 39 | *2* | 1.5 | *2* | 57 | *2* | 1.1 | *2* | 26 | *2* | 10.1 | *2* | 11.12 | *2* | 1.0974 | *2* | 1.2819 | *2* |
| Mackerel (grilled, flesh only) | Mackerel | *Scomber scombrus* | Sample No. 23 | 17 | *2* | 1.3 | *2* | 60 | *2* | 0.8 | *2* | 61 | *2* | 8.5 | *2* | 9.08 | *2* | 0.163 | *2* | 0.251 | *2* |
| Mussels, purchased cooked | Mussels | *Mytulis edulis* | Sample No. 19 | 40 | *2* | 3.3 | *2* | 66 | *2* | 3.4 | *2* | 117 | *2* | 0 | *2* | 10.56 | *2* | 0.3395 | *2* | 0.1261 | *2* |
| **Salmon, hot smoked** | **Atlantic salmon** | ***Salmo salar*** | **Sample No. 45** | **8** | ***2*** | **0.34** | ***2*** | **24** | ***2*** | **0.49** | ***2*** | **28** | ***2*** | **11** | ***2*** | **4.19** | ***2*** | **0.7914** | ***2*** | **0.7287** | ***2*** |
| Sardines, canned in brine | Sardine | *Sardina pilchardus* | Sample No. 55 | 679 | *2* | 2.7 | *2* | 41 | *2* | 2.2 | *2* | 10 | *2* | 3.3 | *2* | 10.81 | *2* | 1.1045 | *2* | 0.9244 | *2* |
| Sardines, canned in brine | Sardinella | *Sardina sp.* | Sample No. 55 | 679 | *2* | 2.7 | *2* | 41 | *2* | 2.2 | *2* | 10 | *2* | 3.3 | *2* | 10.81 | *2* | 1.1045 | *2* | 0.9244 | *2* |
| Sprat, raw\*\*\* | Sprat | *Sprattus sprattus* | Food Code 16-218 | 178 | *1* | 0.379 | *1* | 4.19 | *1* | 0.529 | *1* | 60 | *5* | 13 | *5* | 7 | *5* | 0.5 | *5* | 0.8 | *5* |