

# Enhancing global food security through the introduction of Maximum Sustainable Yield targets in fisheries - Supplementary material

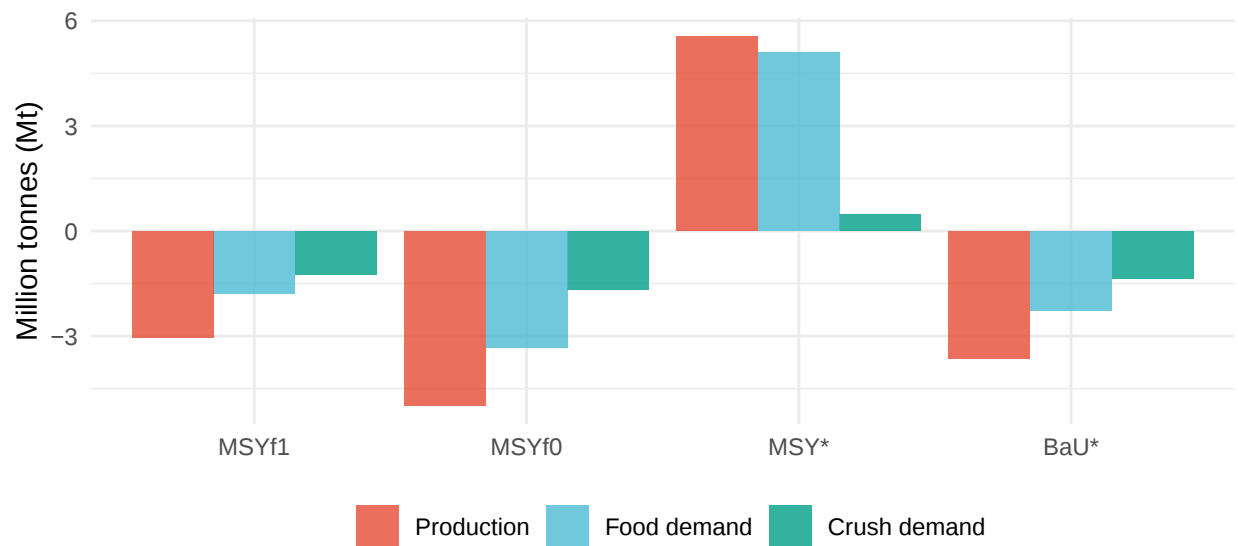


Figure S1: World fish production and demand impacts. Difference from the baseline (2030, Mt). Note: 'MSYf1' denotes the catches resulting from the applying the MSY fishing pressure to overfished stocks. 'MSYf0' denotes the catches resulting from closing the fisheries where stocks are below 80 percent of their MSY levels and where the MSYf1 rule is applied to the stocks that subsequently recover. 'BaU' denotes the catches resulting from applying the most recent estimated fishing pressure to all overfished stocks. 'MSY\*' and 'BaU\*' denote the long term MSY and BaU fishing pressure impacts.

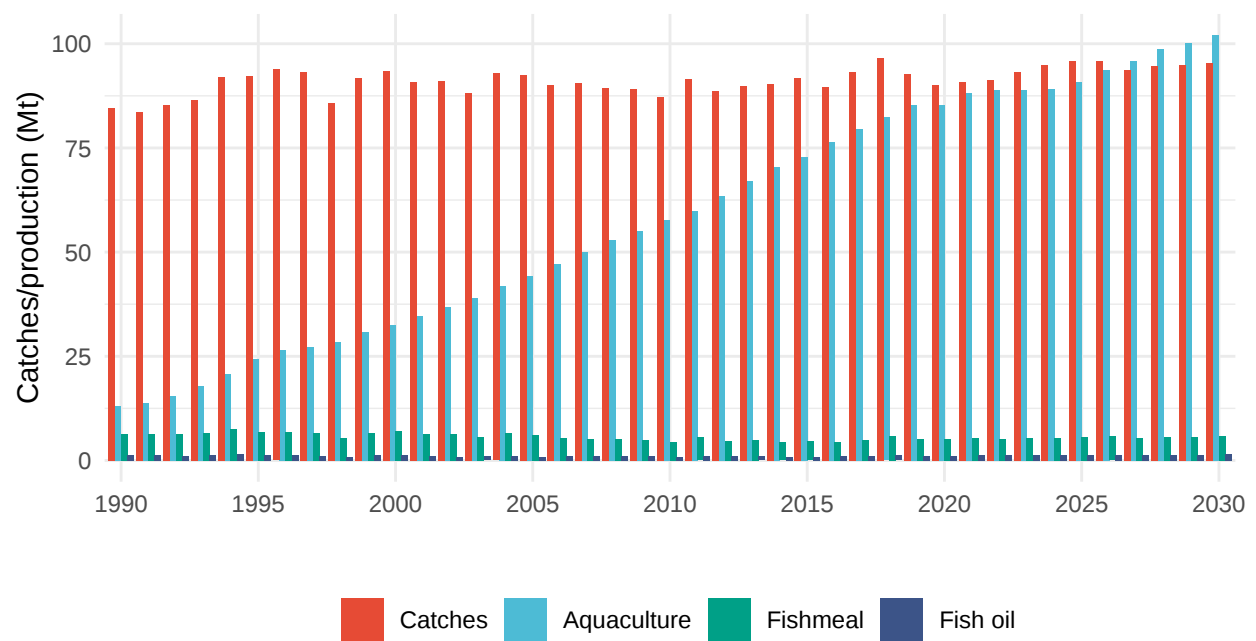


Figure S2: Baseline catches and production. Historical values and projections to 2030

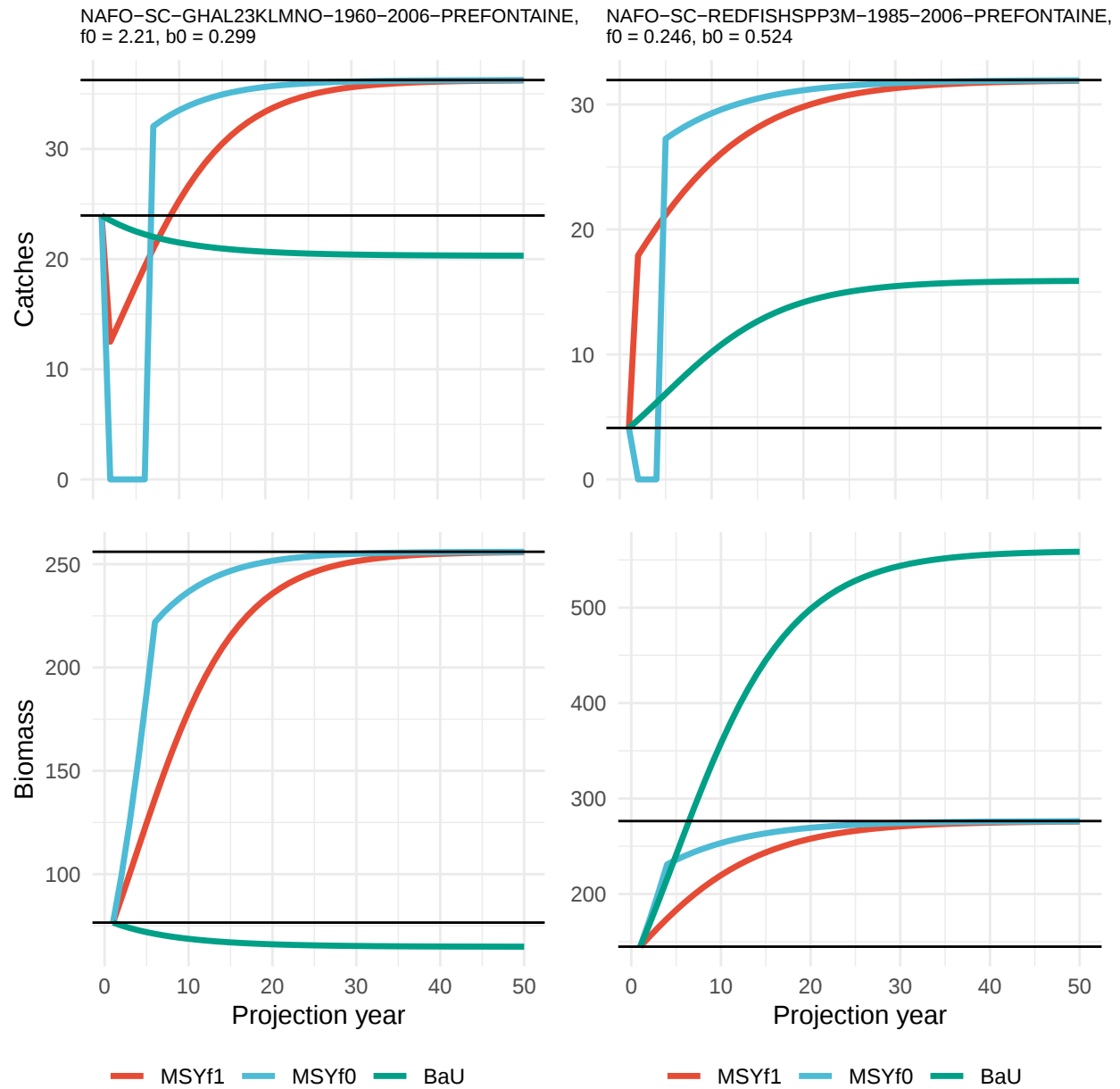


Figure S3: Harvest and stock projections for different fishing pressures. Representative overfished stocks (1000 t). Note: 'MSYf1' denotes the catches resulting from the applying the MSY fishing pressure to overfished stocks. 'MSYf0' denotes the catches resulting from closing the fisheries where stocks are below 80 percent of their MSY levels and where the MSYf1 rule is applied to the stocks that subsequently recover. 'BaU' denotes the catches resulting from applying the most recent estimated fishing pressure to all overfished stocks.

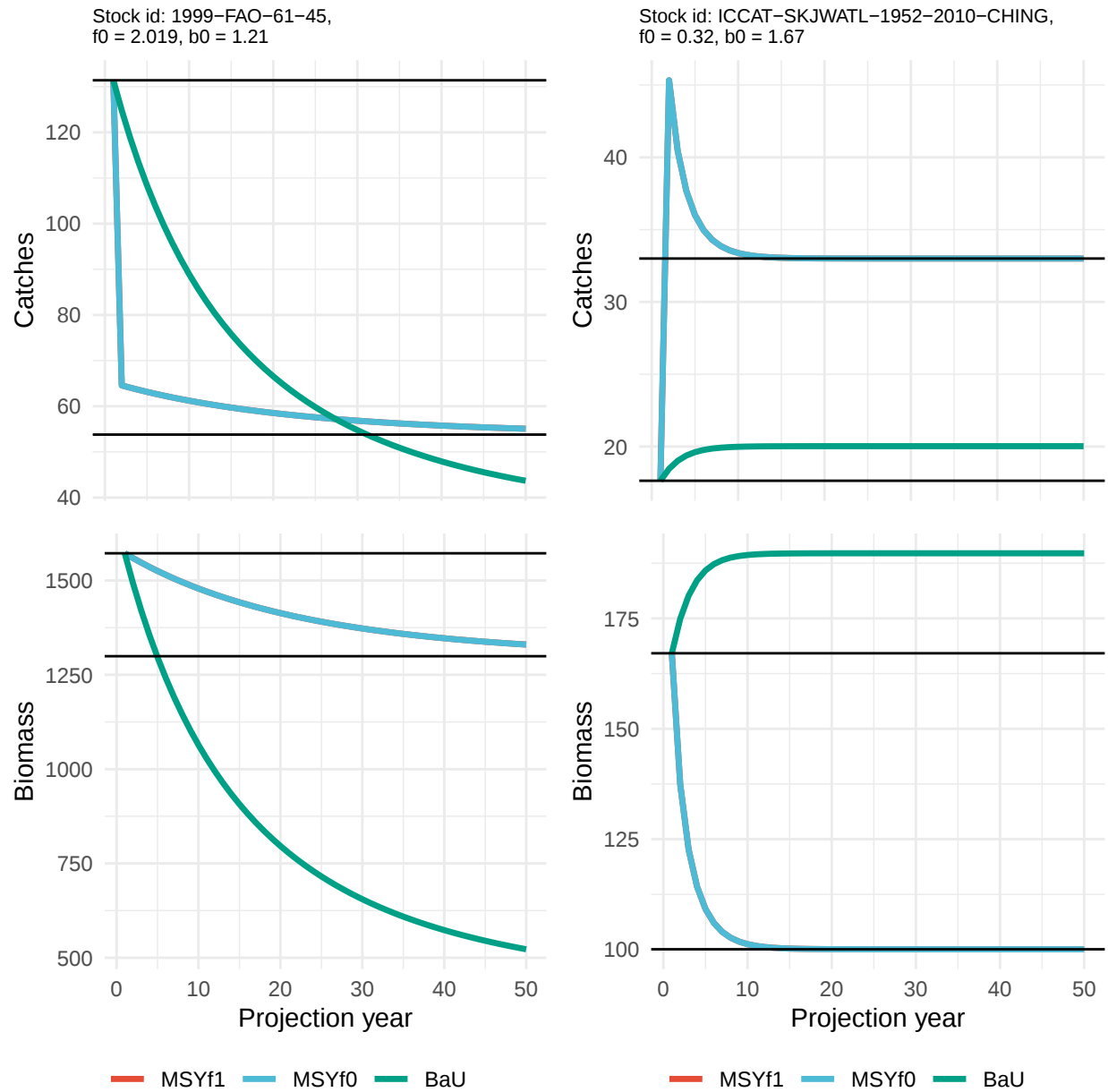


Figure S4: Harvest and stock projections for different fishing pressures. Representative underutilized stocks (1000 t). Note: 'MSYf1' denotes the catches resulting from the applying the MSY fishing pressure to overfished stocks. 'MSYf0' denotes the catches resulting from closing the fisheries where stocks are below 80 percent of their MSY levels and where the MSYf1 rule is applied to the stocks that subsequently recover. 'BaU' denotes the catches resulting from applying the most recent estimated fishing pressure to all overfished stocks.

Table S1: Global fish stocks by FAO region. Summary statistics

|                             | N    | MSY   | H     | b p25 | b p50 | b p75 | pr(b<0.8) | f p25 | f p50 | f p75 | pr(f>1) |
|-----------------------------|------|-------|-------|-------|-------|-------|-----------|-------|-------|-------|---------|
| Atlantic Antarctic          | 7    | 2     | 2     | 0.69  | 0.94  | 0.99  | 0.29      | 0.75  | 1.75  | 2.88  | 0.57    |
| Eastern Central Atlantic    | 546  | 4193  | 3226  | 0.54  | 0.70  | 1.01  | 0.58      | 0.87  | 1.77  | 3.14  | 0.72    |
| Eastern Central Pacific     | 186  | 1321  | 1310  | 0.46  | 0.69  | 1.15  | 0.60      | 0.77  | 2.47  | 3.47  | 0.71    |
| Eastern Indian Ocean        | 248  | 2937  | 2762  | 0.54  | 0.80  | 1.23  | 0.50      | 0.74  | 1.50  | 3.38  | 0.66    |
| Indian Ocean Antarctic      | 11   | 35    | 6     | 0.85  | 0.91  | 1.01  | 0.18      | 1.26  | 3.13  | 4.00  | 0.73    |
| Mediterranean and Black Sea | 578  | 919   | 712   | 0.54  | 0.79  | 1.12  | 0.52      | 0.73  | 1.40  | 2.57  | 0.63    |
| Northeast Atlantic          | 774  | 8631  | 5131  | 0.52  | 0.81  | 1.22  | 0.47      | 0.52  | 1.17  | 2.35  | 0.56    |
| Northeast Pacific           | 120  | 5947  | 4237  | 0.75  | 1.19  | 1.59  | 0.30      | 0.25  | 0.49  | 1.09  | 0.28    |
| Northwest Atlantic          | 198  | 2529  | 1456  | 0.38  | 0.67  | 1.11  | 0.61      | 0.40  | 0.86  | 1.78  | 0.44    |
| Northwest Pacific           | 273  | 19263 | 13972 | 0.50  | 0.75  | 1.18  | 0.55      | 0.51  | 1.17  | 2.08  | 0.58    |
| Pacific Antarctic           | 5    | 3     | 3     | 0.56  | 0.78  | 0.90  | 0.60      | 1.17  | 1.77  | 4.00  | 0.80    |
| Southeast Atlantic          | 98   | 1279  | 1172  | 0.53  | 0.69  | 1.06  | 0.61      | 0.66  | 1.71  | 2.56  | 0.66    |
| Southeast Pacific           | 159  | 13024 | 8433  | 0.48  | 0.72  | 1.07  | 0.57      | 0.72  | 1.42  | 2.77  | 0.62    |
| Southwest Atlantic          | 194  | 2674  | 1618  | 0.55  | 0.90  | 1.18  | 0.44      | 0.79  | 1.74  | 2.97  | 0.68    |
| Southwest Pacific           | 169  | 843   | 511   | 0.63  | 0.99  | 1.44  | 0.38      | 0.43  | 1.02  | 2.50  | 0.51    |
| Western Central Atlantic    | 365  | 1110  | 1007  | 0.54  | 0.70  | 0.96  | 0.62      | 1.06  | 2.08  | 3.44  | 0.77    |
| Western Central Pacific     | 330  | 8393  | 8150  | 0.54  | 0.75  | 1.21  | 0.56      | 0.81  | 1.75  | 3.38  | 0.71    |
| Western Indian Ocean        | 441  | 3466  | 4173  | 0.58  | 0.78  | 1.06  | 0.56      | 1.25  | 2.47  | 3.77  | 0.80    |
| Total                       | 4702 | 76568 | 57878 | 0.54  | 0.78  | 1.16  | 0.53      | 0.68  | 1.50  | 3.03  | 0.65    |

Note: 'N' is the number of fish stocks. 'MSY' is the maximum sustainable yield. 'H' is the implied harvest. 'bxx' and 'fxx' are the xxth percentile of the MSY-scaled stock sizes and fishing pressures. 'pr(b<0.8)' is the proportion of stocks that are below 80 percent of their MSY sizes. 'pr(f>1)' is the proportion of stocks where the fishing pressure is higher than the MSY level. Based on Costello et al. (2016)

Table S2: Impacts on world prices and production. BaU assumption about underutilized stocks

| Commodity             | Prices (% change) |      |      |      |      | Production (change in Mt) |       |       |      |       |
|-----------------------|-------------------|------|------|------|------|---------------------------|-------|-------|------|-------|
|                       | MSY1              | MSY0 | BaU  | MSY* | BaU* | MSY1                      | MSY0  | BaU   | MSY* | BaU*  |
| <b>Meat and fish</b>  |                   |      |      |      |      |                           |       |       |      |       |
| Beef and Veal         | 1.6               | 2.2  | 2.0  | -0.4 | 2.1  | 0.2                       | 0.3   | 0.3   | -0.1 | 0.3   |
| Pork                  | 2.8               | 4.2  | 3.4  | -0.4 | 3.6  | 0.5                       | 0.7   | 0.6   | -0.2 | 0.7   |
| Poultry               | 1.4               | 1.8  | 1.8  | -0.7 | 2.0  | 0.5                       | 0.7   | 0.6   | 0.0  | 0.6   |
| Fish                  | 14.5              | 20.2 | 17.7 | -3.3 | 19.0 | -6.3                      | -8.0  | -7.3  | 0.9  | -7.8  |
| Fish from aquaculture |                   |      |      |      |      | 3.5                       | 5.4   | 4.0   | -2.3 | 4.5   |
| Fish from capture     |                   |      |      |      |      | -9.8                      | -13.4 | -11.3 | 3.2  | -12.3 |
| <b>Grains</b>         |                   |      |      |      |      |                           |       |       |      |       |
| Wheat                 | 1.5               | 2.2  | 1.9  | -0.6 | 2.0  | 1.2                       | 1.9   | 1.3   | -0.9 | 1.5   |
| Maize                 | 1.7               | 2.2  | 2.1  | -0.5 | 2.2  | 4.3                       | 7.0   | 4.7   | -3.5 | 5.2   |
| Other coarse grains   | 2.1               | 2.9  | 2.6  | -0.9 | 2.7  | 0.4                       | 0.7   | 0.5   | -0.4 | 0.6   |
| Rice                  | 0.5               | 0.8  | 0.7  | -0.2 | 0.7  | 0.3                       | 0.5   | 0.3   | -0.1 | 0.4   |
| Soybean               | 1.7               | 2.3  | 2.0  | -0.5 | 2.1  | 1.3                       | 1.9   | 1.4   | -0.6 | 1.6   |
| <b>Other</b>          |                   |      |      |      |      |                           |       |       |      |       |
| Total Protein Meal    | 3.5               | 4.7  | 4.2  | -1.3 | 4.5  | 1.1                       | 1.6   | 1.3   | -0.4 | 1.4   |
| Vegetable oils        | -0.2              | -0.2 | -0.2 | 0.2  | -0.2 | 0.3                       | 0.4   | 0.3   | -0.1 | 0.3   |
| Fish meal             | 38.4              | 53.2 | 43.9 | -2.1 | 47.8 | -0.6                      | -0.8  | -0.7  | -0.1 | -0.7  |

Note: 'MSYf1' denotes the catches resulting from the applying the MSY fishing pressure to overfished stocks. 'MSYf0' denotes the catches resulting from closing the fisheries where stocks are below 80 percent of their MSY levels and where the MSYf1 rule is applied to the stocks that subsequently recover. 'BaU' denotes the catches resulting from applying the most recent estimated fishing pressure to all overfished stocks. 'MSY\*' and 'BaU\*' denote the long term MSY and BaU fishing pressure impacts.

Table S3: Impacts on world prices and production. Management of all fish stocks

| Commodity             | Prices (% change) |       |      |       |      | Production (change in Mt) |      |       |       |       |
|-----------------------|-------------------|-------|------|-------|------|---------------------------|------|-------|-------|-------|
|                       | MSY1              | MSY0  | BaU  | MSY*  | BaU* | MSY1                      | MSY0 | BaU   | MSY*  | BaU*  |
| <b>Meat and fish</b>  |                   |       |      |       |      |                           |      |       |       |       |
| Beef and Veal         | -1.5              | -1.0  | 2.0  | -2.7  | 2.1  | -0.3                      | -0.2 | 0.3   | -0.5  | 0.3   |
| Pork                  | -2.3              | -1.2  | 3.4  | -4.2  | 3.6  | -0.7                      | -0.5 | 0.6   | -1.1  | 0.7   |
| Poultry               | -1.5              | -1.1  | 1.8  | -3.0  | 2.0  | -0.5                      | -0.3 | 0.6   | -0.8  | 0.6   |
| Fish                  | -13.6             | -9.5  | 17.7 | -22.8 | 19.0 | 6.5                       | 4.2  | -7.3  | 12.4  | -7.8  |
| Fish from aquaculture |                   |       |      |       |      | -5.3                      | -3.9 | 4.0   | -8.2  | 4.5   |
| Fish from capture     |                   |       |      |       |      | 11.8                      | 8.1  | -11.3 | 20.6  | -12.3 |
| <b>Grains</b>         |                   |       |      |       |      |                           |      |       |       |       |
| Wheat                 | -1.6              | -1.1  | 1.9  | -3.0  | 2.0  | -1.5                      | -1.0 | 1.3   | -2.6  | 1.5   |
| Maize                 | -2.0              | -1.5  | 2.1  | -3.8  | 2.2  | -6.0                      | -3.7 | 4.7   | -10.8 | 5.2   |
| Other coarse grains   | -2.2              | -1.6  | 2.6  | -4.1  | 2.7  | -0.6                      | -0.4 | 0.5   | -1.0  | 0.6   |
| Rice                  | -0.6              | -0.4  | 0.7  | -1.1  | 0.7  | -0.4                      | -0.3 | 0.3   | -0.7  | 0.4   |
| Soybean               | -1.9              | -1.4  | 2.0  | -3.2  | 2.1  | -1.5                      | -0.9 | 1.4   | -2.6  | 1.6   |
| <b>Other</b>          |                   |       |      |       |      |                           |      |       |       |       |
| Total Protein Meal    | -3.8              | -2.8  | 4.2  | -6.7  | 4.5  | -1.3                      | -0.9 | 1.3   | -2.1  | 1.4   |
| Vegetable oils        | 0.2               | 0.2   | -0.2 | 0.4   | -0.2 | -0.3                      | -0.2 | 0.3   | -0.5  | 0.3   |
| Fish meal             | -20.3             | -12.9 | 43.9 | -34.7 | 47.8 | 0.3                       | 0.1  | -0.7  | 0.7   | -0.7  |

Note: 'MSYf1' denotes the catches resulting from the applying the MSY fishing pressure to overfished stocks. 'MSYf0' denotes the catches resulting from closing the fisheries where stocks are below 80 percent of their MSY levels and where the MSYf1 rule is applied to the stocks that subsequently recover. 'BaU' denotes the catches resulting from applying the most recent estimated fishing pressure to all overfished stocks. 'MSY\*' and 'BaU\*' denote the long term MSY and BaU fishing pressure impacts.