Appendix

Appendix Table 1. Descriptive Statistics of the Landing Data

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Fishery | Mean | Min | Max | Std. Dev. |
| Abalones nei single\_stock | 3,502 | 1,163 | 6,466 | 1,661 |
| Alaska pollock(=Walleye poll.) pacific\_stock | 984,691 | 179,778 | 2,842,713 | 828,418 |
| Alaska pollock(=Walleye poll.) sea\_of\_japan\_north\_stock | 43,881 | 188 | 233,043 | 56,219 |
| Albacore single\_stock | 70,377 | 42,570 | 127,338 | 19,673 |
| Amberstripe scad single\_stock | 53,694 | 14,814 | 109,255 | 25,742 |
| Antarctic krill nei single\_stock | 42,313 | 3,169 | 74,073 | 17,839 |
| Bastard halibut pacific\_central\_stock | 656 | 360 | 1,181 | 179 |
| Bastard halibut pacific\_north\_stock | 1,954 | 835 | 3,500 | 628 |
| Bastard halibut sea\_of\_japan\_north\_central\_stock | 2,155 | 1,021 | 4,014 | 579 |
| Bastard halibut sea\_of\_japan\_west\_east\_china\_sea\_stock | 1,485 | 796 | 2,980 | 465 |
| Bastard halibut seto\_inland\_sea\_stock | 940 | 277 | 1,353 | 317 |
| Bigeye tuna single\_stock | 102,501 | 47,670 | 159,083 | 28,946 |
| Blackhead seabream, Goldlined seabream single\_stock | 3,680 | 3,113 | 4,298 | 314 |
| Blue marlin single\_stock | 11,425 | 2,786 | 30,204 | 6,197 |
| Broadbanded thornyhead hokkaido\_east\_hokkaido\_south | 2,761 | 465 | 6,725 | 1,947 |
| Broadbanded thornyhead pacific\_north | 3,187 | 368 | 8,246 | 2,799 |
| Conger eels nei single\_stock | 7,423 | 3,797 | 12,980 | 2,666 |
| Crimson seabream, Yellowback seabream single\_stock | 3,967 | 928 | 7,872 | 2,488 |
| Cuttlefishes nei single\_stock | 12,576 | 6,767 | 21,704 | 4,559 |
| Daggertooth pike conger single\_stock | 12,041 | 1,988 | 32,712 | 9,131 |
| Dolphinfishes nei single\_stock | 11,919 | 6,887 | 23,700 | 3,728 |
| Dotted gizzard shad single\_stock | 11,630 | 3,920 | 23,707 | 5,607 |
| Flyingfish nei single\_stock | 9,521 | 5,954 | 18,548 | 2,530 |
| Frigate and bullet tunas single\_stock | 24,301 | 13,092 | 37,248 | 5,735 |
| Japanese amberjack single\_stock | 56,870 | 26,942 | 125,202 | 23,926 |
| Japanese anchovy pacific\_stock | 158,197 | 40,953 | 386,876 | 89,924 |
| Japanese anchovy seto\_inland\_sea\_stock | 58,475 | 22,036 | 107,230 | 25,471 |
| Japanese anchovy tsushima\_current\_stock | 78,736 | 31,292 | 158,399 | 29,343 |
| Japanese carpet shell single\_stock | 82,698 | 13,813 | 160,424 | 47,550 |
| Japanese flying squid winter\_stock | 277,277 | 90,997 | 668,660 | 110,391 |
| Japanese hard clam single\_stock | 3,780 | 868 | 15,705 | 3,298 |
| Japanese jack mackerel pacific\_stock | 57,588 | 18,683 | 147,168 | 27,127 |
| Japanese jack mackerel tsushima\_current\_stock | 153,123 | 34,886 | 466,343 | 88,868 |
| Japanese pilchard pacific\_stock | 779,680 | 6,849 | 2,982,683 | 1,023,688 |
| Japanese pilchard tsushima\_current\_stock | 380,259 | 840 | 1,554,935 | 517,577 |
| Japanese sandfish hokkaido | 2,536 | 308 | 7,647 | 1,871 |
| Japanese sandfish sea\_of\_japan\_north\_stock | 6,541 | 118 | 24,089 | 7,926 |
| Japanese sandfish sea\_of\_japan\_west\_stock | 5,542 | 2,673 | 9,475 | 1,829 |
| Japanese seabass single\_stock | 8,198 | 4,505 | 11,574 | 1,824 |
| Japanese seabream pacific\_central\_stock | 1,431 | 518 | 4,379 | 818 |
| Japanese seabream pacific\_south\_stock | 505 | 300 | 782 | 103 |
| Japanese seabream sea\_of\_japan\_north\_central\_stock | 1,913 | 1,120 | 2,709 | 383 |
| Japanese seabream sea\_of\_japan\_west\_east\_china\_sea\_stock | 8,636 | 5,610 | 15,665 | 3,129 |
| Japanese seabream seto\_inland\_sea\_central\_west\_stock | 3,034 | 1,915 | 4,055 | 645 |
| Japanese seabream seto\_inland\_sea\_east\_stock | 903 | 180 | 2,079 | 562 |
| Japanese Spanish mackerel east\_china\_sea\_stock | 8,089 | 804 | 20,212 | 5,567 |
| Japanese Spanish mackerel seto\_inland\_sea\_stock | 3,392 | 541 | 20,387 | 2,796 |
| Japanese spiny lobster single\_stock | 1,235 | 947 | 1,738 | 181 |
| Largehead hairtail single\_stock | 29,648 | 6,935 | 68,309 | 14,588 |
| Lizardfishes nei single\_stock | 14,692 | 4,247 | 25,437 | 6,745 |
| Mackerels nei pacific\_stock | 421,742 | 67,351 | 987,471 | 204,772 |
| Mackerels nei tsushima\_current\_stock | 303,502 | 96,256 | 693,850 | 178,154 |
| Neon flying squid single\_stock | 52,688 | 2,923 | 154,942 | 39,177 |
| Octopuses nei single\_stock | 56,556 | 32,438 | 103,765 | 16,874 |
| Okhotsk atka mackerel hokkaido\_north | 127,715 | 17,114 | 240,973 | 50,141 |
| Pacific bluefin tuna single\_stock\_exc\_sbf\_inc\_sml | 13,024 | 7,548 | 20,818 | 3,730 |
| Pacific cod hokkaido | 38,644 | 19,066 | 72,673 | 14,441 |
| Pacific cod pacific\_north\_stock | 31,870 | 6,101 | 85,831 | 18,709 |
| Pacific cod sea\_of\_japan\_stock | 3,503 | 751 | 11,001 | 1,960 |
| Pacific herring single\_stock | 23,633 | 1,365 | 100,483 | 30,557 |
| Pacific ocean perch single\_stock | 36,685 | 588 | 121,820 | 41,873 |
| Pacific salmons nei single\_stock | 151,172 | 66,957 | 287,458 | 60,114 |
| Pacific saury single\_stock | 225,821 | 63,288 | 406,445 | 67,615 |
| Pufferfishes nei ise\_mikawa\_bay\_stock | 485 | 265 | 946 | 193 |
| Pufferfishes nei sea\_of\_japan\_east\_china\_sea\_seto\_inland\_sea\_stock | 5,645 | 0 | 10,043 | 2,427 |
| Queen crab okhotsk\_stock | 4,394 | 139 | 20,283 | 4,541 |
| Queen crab sea\_of\_japan\_stock | 5,586 | 1,947 | 16,702 | 3,664 |
| Rays and skates nei single\_stock | 6,926 | 3,962 | 11,882 | 2,372 |
| Red snow crab single\_stock | 21,428 | 16,075 | 29,626 | 4,305 |
| Red-eye round herring pacific\_stock | 21,828 | 7,857 | 63,154 | 13,106 |
| Red-eye round herring tsushima\_current\_stock | 24,153 | 7,908 | 44,308 | 9,972 |
| Righteye flounders nei hokkaido\_north\_stock | 45,587 | 19,004 | 88,799 | 23,961 |
| Righteye flounders nei pacific\_north | 69,903 | 7,015 | 222,813 | 71,494 |
| Righteye flounders nei sea\_of\_japan\_stock | 46,080 | 14,421 | 163,550 | 35,862 |
| Rudderfish single\_stock | 6,026 | 824 | 25,128 | 5,635 |
| Sandlances nei ise\_mikawa\_bay\_stock | 12,381 | 699 | 28,777 | 7,794 |
| Sandlances nei sea\_of\_japan\_stock | 3,317 | 3 | 15,907 | 4,055 |
| Sandlances nei sendai\_bay\_stock | 22,235 | 69 | 88,078 | 17,893 |
| Sandlances nei seto\_inland\_sea\_east\_stock | 31,379 | 4,380 | 74,443 | 15,133 |
| Sandlances nei soya\_strait | 43,370 | 608 | 194,804 | 44,420 |
| Sea cucumbers nei single\_stock | 8,602 | 5,996 | 13,019 | 1,970 |
| Sea urchins nei single\_stock | 18,042 | 7,855 | 29,728 | 6,587 |
| Skipjack tuna single\_stock | 297,109 | 136,071 | 437,900 | 59,979 |
| Smelts nei pacific\_stock | 1,504 | 563 | 3,399 | 651 |
| Smelts nei sea\_of\_japan\_stock | 6,984 | 2,366 | 19,046 | 3,650 |
| Southern bluefin tuna single\_stock | 4,533 | 0 | 7,210 | 1,896 |
| Striped marlin single\_stock | 10,765 | 1,923 | 28,054 | 7,193 |
| Swimming crabs, etc. nei single\_stock | 3,069 | 607 | 5,668 | 1,132 |
| Swordfish single\_stock | 13,894 | 7,581 | 21,680 | 4,013 |
| Tilefish nei single\_stock | 1,798 | 1,092 | 4,193 | 838 |
| Trout nei single\_stock | 27,352 | 4,097 | 74,352 | 16,336 |
| Turbans nei single\_stock | 8,646 | 4,820 | 12,560 | 1,801 |
| Whitebait smelt single\_stock | 59,606 | 32,378 | 100,435 | 16,850 |
| Yellowfin tuna single\_stock | 93,654 | 52,387 | 133,694 | 21,236 |
| Yesso scallop single\_stock | 173,765 | 4,989 | 358,981 | 122,276 |

Appendix Table 2. Landing Dataset

|  |  |  |
| --- | --- | --- |
| Fish Species Category in the Survey of Fisheries Production and Value | Stocks | Estimated Habitat Range |
| Bluefin Tuna |  | All |
| Southern Bluefin Tuna |  | All |
| Albacore Tuna |  | All |
| Bigeye Tuna |  | All |
| Yellowfin Tuna |  | All |
| Other Tuna |  | All |
| Marlin |  | All |
| Swordfish |  | All |
| Blue Marlin |  | All |
| Other Kajiki |  | All |
| Skipjack |  | All |
| Auxis |  |  |
| Shark |  | All |
| Salmon |  | All |
| Trout |  | All |
| Shad |  |  |
| Herring |  | All |
| Japanese Sardine | Pacific Stock | Prefectures facing the Pacific Ocean, Oita, Miyazaki, Kagoshima |
| Japanese Sardine | Tsushima Warm Current Stock | Prefectures facing the Sea of Japan, Fukuoka, Saga, Nagasaki, Kumamoto |
| Round Herring | Pacific Stock | Kagoshima–Chiba Pacific Coast |
| Round Herring | Tsushima Warm Current Stock | Kumamoto–Ishikawa Sea off Japan’s coast |
| Japanese Anchovy | Pacific Stock | Kagoshima–Hokkaido Pacific Coast |
| Japanese Anchovy | Seto Inland Sea Stock | Seto Inland Sea (Osaka, Hyogo, Okayama, Hiroshima, Tokushima, Kagawa, Ehime) |
| Japanese Anchovy | Tsushima Warm Current Stock | Kumamoto–Yamagata Sea off Japan’s coast |
| Whitebait |  | Prefectures facing the Pacific Ocean, Oita, Miyazaki, Kagoshima |
| Japanese Jack Mackerel | Tsushima Warm Current Stock | Okinawa–Iwate Pacific Coast |
| Japanese Jack Mackerel | Pacific Stock | Kagoshima–Akita Pacific Coast |
| Amberstripe Scad | East China Sea Stock | Kagoshima–Fukui Sea off Japan’s coast |
| Mackerel | Pacific Stock | Kagoshima–Hokkaido Pacific Coast |
| Mackerel | Tsushima Warm Current Stock | Kagoshima–Akita Sea off Japan’s coast |
| Mackerel | East China Sea Stock | Kagoshima–Toyama Sea off Japan’s coast |
| Saury | North Pacific Stock | All |
| Yellowtail |  | All |
| Bastard Halibut | Pacific North Stock | Ibaraki–Aomori Pacific Coast |
| Bastard Halibut | Seto Inland Sea Stock | Osaka, Hyogo, Okayama, Hiroshima, Yamaguchi, Tokushima, Kagawa, Ehime, Fukuoka, Oita |
| Bastard Halibut | Sea of Japan North and Middle Stock | Hyogo–Aomori Sea off Japan’s coast |
| Bastard Halibut | Sea of Japan West and・East China Sea Stock | Kagoshima–Tottori Sea off Japan’s coast |
| Righteye Flounder | Pacific North Stock | Ibaraki–Iwate Pacific Coast |
| Righteye Flounder | Sea of Japan Stock | Nagasaki–Tottori Sea off Japan’s coast (Round-nose flounder), Shimane–Aomori Sea off Japan’s coast (Flathead flounder), Niigata–Aomori Sea off Japan’s coast (Brown sole) |
| Righteye Flounder | Hokkaido North Stock | Hokkaido |
| Cod | Hokkaido | Hokkaido |
| Cod | Pacific North Stock | Ibaraki–Aomori Pacific Coast |
| Cod | Sea of Japan Stock | Ishikawa–Aomori Sea of Japan Coast |
| Pollock | Sea of Japan North Stock | Niigata–Hokkaido Sea of Japan Coast |
| Pollock | Nemuro Strait | Hokkaido |
| Pollock | Okhotsuk Sea South Stock | Hokkaido |
| Pollock | Pacific Stock | Ibaraki–Hokkaido Pacific Coast |
| Atka Mackerel | Nemuro Strait, Hokkaido East, Hidaka and IburiStock | Hokkaido |
| Atka Mackerel | Hokkaido North | Hokkaido |
| Atka Mackerel | Hokkaido South | Hokkaido |
| Red Rock Fish |  |  |
| Broadbanded Thornyhead | Okhotsuk Sea Stock | Hokkaido |
| Broadbanded Thornyhead | Hokkaido East and Hokkaido South | Hokkaido |
| Broadbanded Thornyhead | Pacific North Stock | Ibaraki–Aomori Pacific Coast |
| Sandfish | Sea of Japan West Stock | Yamaguchi–Ishikawa Sea of Japan Coast |
| Sandfish | Sea of Japan North Stock | Toyama–Aomori Sea of Japan Coast |
| Smelt | Sea of Japan Stock | Shimane–Aomori Sea of Japan Coast |
| Smelt | Pacific Stock | Miyazaki–Miyagi Pacific Coast |
| Yellow Croaker |  |  |
| Other Croaker |  |  |
| Lizardfish |  |  |
| Rudderfish |  |  |
| Conger Eel | Ise and Mikawa Bay Stock | Aichi, Mie |
| Daggertooth Pike Conger |  |  |
| Largehead Hairtail | Sea of Japan and East China Sea Stock | Kagoshima–Akita Sea of Japan Coast |
| Spiny Red Gurnard |  |  |
| Redwing Searobin |  |  |
| Rays |  |  |
| Japanese Seabream | Seto Inland Sea East Stock | Osaka, Hyogo, Tokushima, Kagawa |
| Japanese Seabream | Seto Inland Sea Middle and West Stock | Okayama, Hiroshima, Kagawa, Ehime, Yamaguchi, Fukuoka, Oita |
| Japanese Seabream | Sea of Japan West and East China Sea Stock | Kagoshima–Tottori Sea of Japan Coast |
| Crimson Seabream and Yellowback Seabream |  | Okinawa, Nagasaki–Fukui Sea of Japan Coast |
| Crimson Seabream |  |  |
| Yellowback Seabream | Sea of Japan・East China Sea Stock | Okinawa, Nagasaki–Fukui Sea of Japan Coast |
| Blackhead Seabream and Goldlined Seabream |  |  |
| Threeline Grunt |  |  |
| Japanese Spanish Mackerel | East China Sea Stock | Kagoshima–Aomori Sea of Japan Coast |
| Japanese Spanish Mackerel | Seto Inland Sea Stock | Osaka, Hyogo, Wakayama, Okayama, Hiroshima, Yamaguchi, Tokushima, Kagawa, Ehime, Kochi, Fukuoka, Oita, Miyazaki |
| Dolphinfish |  |  |
| Flyingfish |  |  |
| Flathead Mullet |  |  |
| Japanese Seabass |  |  |
| Sand Lance | Soya Strait | Hokkaido |
| Sand Lance | Ise and Mikawa Bay Stock | Aichi, Mie |
| Sand Lance | Seto Inland Sea East Stock | Osaka, Hyogo, Wakayama, Tokushima, Kagawa, Okayama |
| Tilefish | East China Sea Stock | Okinawa–Shimane Sea of Japan Coast |
| Pufferfish | Sea of Japan, East China Sea and Seto Inland Sea Stock | Okinawa–Wakayama Pacific Coast, Kagoshima–Aomori Sea of Japan Coast |
| Pufferfish | Ise and Mikawa Bay Stock | Shizuoka, Aichi, Mie |
| Other Fish |  |  |
| Spiny Lobster |  |  |
| Japanese Shrimp |  |  |
| Other Shrimp |  |  |
| King Crab |  |  |
| Snow Crab |  |  |
| Snow Crab | Okhotsuk Sea Stock | Hokkaido |
| Snow Crab | Pacific North Stock | Ibaraki–Aomori Pacific Coast |
| Snow Crab | Sea of Japan Stock | Shimane–Akita Sea of Japan Coast |
| Snow Crab | Hokkaido West Stock | Hokkaido |
| Red Snow Crab | Sea of Japan Stock | Shimane–Akita Sea of Japan Coast |
| Swimming Crab |  |  |
| Other Crab |  |  |
| Krill |  |  |
| Abalone |  |  |
| Spiny Top Shell |  |  |
| Japanese Hard Clam |  |  |
| Manila Clam |  |  |
| Scallop |  |  |
| Surf Clam |  |  |
| Half-Crenate Ark Shell |  |  |
| Other Shellfish |  |  |
| Golden Cuttlefish |  |  |
| Japanese Common Squid | Winter Stock | All Japan |
| Japanese Common Squid | Fall Stock | Nagasaki–Akita Sea of Japan Coast, Hokkaido, Aomori |
| Neon Flying Squid | North Pacific Stock |  |
| Other Squid |  |  |
| Octopus |  |  |
| Sea Urchin |  |  |
| Sea Cucumber |  |  |
| Marine Mammals |  |  |
| Other Fish |  |  |
| Kelp |  |  |
| Wakame Seaweed |  |  |
| Hijiki Seaweed |  |  |
| Tengusa Seaweed |  |  |
| Funori Seaweed |  |  |
| Other Seaweed |  |  |

Additional Notes:

* Atka mackerel is assessed by the Japan Fisheries Research and Education Agency. However, the habitat ranges of all three stocks are in Hokkaido, and hence this study cannot distinguish these three stocks separately from the dataset.
* Broadbanded thornyhead is assessed by the Japan Fisheries Research and Education Agency. However, the habitat ranges of the two stocks are in Hokkaido, and this study hence cannot distinguish these two stocks separately from the dataset.
* Cod production from Aomori prefecture comes from two separate stocks. We assume that all the cod production from Aomori prefecture comes from All Pacific North stock, per expert opinion.
* Japanese anchovy production from Hyogo prefecture is assumed to be from Tsushima Warm Current stock, per expert opinion.
* Japanese anchovy production from Yamaguchi prefecture is assumed to be from Tsushima Warm Current stock, per expert opinion.
* Japanese common squid production is assessed by the Japan Fisheries Research and Education Agency. However, stocks cannot be determined, and hence they are considered to be a single stock.
* Japanese jack mackerel production from Hyogo prefecture is assumed to be from Tsushima Warm Current stock, per expert opinion.
* Japanese jack mackerel production from Yamaguchi prefecture is assumed to be from Tsushima Warm Current stock, per expert opinion.
* Japanese jack mackerel production from Aomori prefecture is assumed to be from Pacific stock, per expert opinion.
* Japanese sardine production from Hyogo prefecture is assumed to be from Tsushima Warm Current stock, per expert opinion.
* Japanese sardine production from Yamaguchi prefecture is assumed to be from Tsushima Warm Current stock, per expert opinion.
* Japanese sardine stock from Aomori prefecture and Hokkaido prefecture are assumed to be from Pacific stock, per expert opinion.
* Japanese seabream production from Yamaguchi prefecture is assumed to be from Sea of Japan West and East China Sea stock, per expert opinion.
* Japanese Spanish mackerel production from Yamaguchi prefecture is assumed to be from East China Sea stock, per expert opinion.
* Mackerel production from the Kagoshima–Akita Sea off Japan’s coast is assumed to be from Tsushima Warm Current stock, per expert opinion.
* Mackerel production from Aomori prefecture is from Pacific Stock, per expert opinion.
* Mackerel production from Kagoshima and Yamaguchi prefectures is assumed to be from Tsushima Warm Current stock, per expert opinion.
* Walleye pollock production from Hokkaido and Aomori prefectures is assumed to be from Pacific stock, per expert opinion.
* Righteyed flounder production from Yamaguchi prefecture is assumed to be from the Sea of Japan stock, per expert opinion.
* Round herring production from Hyogo and Yamaguchi prefectures is assumed to be from Tsushima Warm Current stock, per expert opinion.
* Smelt production from Hyogo prefecture is assumed to be from the Sea of Japan stock, per expert opinion.
* Snow crab production from Hokkaido is assumed to be from Okhotsuk Sea stock, per expert opinion.



Appendix Figure 1. Histogram of the estimated Pella-Tomlinson population growth rates



Appendix Figure 2. F/FMSY trajectories under the three policy scenarios, the lines are fitted by taking natural spline for all stocks.