SCIENTIFIC COMMITTEE
TENTH REGULAR SESSION

Majuro, Republic of the Marshall Islands
6-14 August 2014

Basis for regional structures used in the 2014 tropical tuna assessments, including regional weights

WCPFC-SC10-2014/SA-IP-02

McKechnie, S., Harley, S., Davies, N., Rice, J., Hampton, J., and Berger, A.

[1]Oceanic Fisheries Programme (OFP)

Secretariat of the Pacific Community, Noumea, New Caledonia

1. Executive Summary

Improvements to the spatial and fisheries structures were key recommendations from the independent review of the 2011 BET assessment (Ianelli *et al.* 2011). This paper outlines all changes made to the regional boundaries and fisheries definitions between the 2011 and 2014 assessments. Where possible, the fisheries definitions and region boundaries for all species are kept as similar as possible and for the 2014 assessment they are identical for BET and YFT. For each of the 33 (BET/YFT) and 23 (SKJ) fisheries in the 2014 assessments a graphical summary of catch and size frequency data is provided and their geographical extent is shown.

Significant improvements have been made to the MULTIFAN-CL (MFCL) stock assessment model regions for the 2014 assessments of bigeye (BET), yellowfin (YFT) and skipjack (SKJ) tuna. Regions 3 and 5 (for BET/YFT) and region 2 (SKJ) were divided in response to concerns that assumptions about the mixing of tagged and untagged fish were not being met in previous stock assessments and spatial heterogeneity in size composition data. The changes to region boundaries have resulted in more fisheries in MFCL and there have been several other modifications to fisheries as a result of the provision of new data and the re-examination of existing data.

Modified regional boundaries also require the recalculation of the so-called "regional weights" that are used to rescale the catch-per-unit-effort (CPUE) indices of the all-fleets longline (LL) fisheries and have an important role in influencing the relative populations of BET/YFT among regions. The generalized additive model (GAM) method of estimating regional weights for the 2014 assessments is outlined and the resulting weights are compared to those used in 2011.

2. Introduction

MULTIFAN-CL (MFCL) stock assessment models for the three tropical tunas being assessed in 2014 (skipjack – SKJ; Rice *et al.* 2014, bigeye - BET; Harley *et al.* 2014 and yellowfin - YFT; Davies *et al.* 2014) are spatially explicit and consist of several discrete geographical regions containing region-specific subpopulations and fisheries. The regions are linked via parameters such as fish movement and catchability coefficients of certain fisheries, which allows for variation in population processes and fisheries dynamics between different regions of the WCPO convention area.

Assessment model regions were selected to separate tropical areas where fisheries are present year-round and temperate areas where fisheries are more seasonally variable. For BET/YFT this is the 6 region assessment model that has been used since 2005 for both species, while a 3 region model has been used for SKJ since the 2010 assessment.

With increasing amounts of tagging data being included in successive assessments and the subsequent increase in their influence on assessment outcomes, additional focus has recently been placed upon the definitions of regional structures. This is because the assessment model assumes that tagged fish and untagged fish within model regions must be randomly mixed after a defined mixing period. However recent analyses of the tagging data in relation to the 2011 assessment model regions suggest that this assumption may frequently be violated (Hoyle *et al.* 2013, Kolody and Hoyle 2013). Fish appear not to be dispersing at a rate high enough to ensure the full tagged and untagged populations in a region are uniformly mixed, at least within a practical mixing period.

Changing regional boundaries to give more, smaller regions is one possible solution to improving the likelihood that the tag mixing assumption is met. This report will address the changes that have been made to regional boundaries for the 2014 assessments of the three tropical tunas and will document the consequences to fisheries definitions used in MFCL that result from these changes.

Within an assessment region there will generally be multiple "fisheries", as defined in MFCL. These are fishing units within the whole, or part of the region. Because model fisheries by definition are unique to regions, the division of regions in the 2014 assessments has resulted in more complex fisheries structures with previous fisheries having to be split into two or more new units.

In addition, there are other reasons for fisheries to change between assessments and this has been the case between many sequential assessments in the past. For example, new datasets (catch, CPUE, size frequency) may become available for a fleet that either indicate that they may be better modelled as part of another fishery or as a new standalone fishery. An example is the addition of a domestically-based Indonesia (ID) and Philippines (PH) purse-seine fishery in the 2011 BET and YFT assessments when new data suggested these vessels were fishing outside the national archipelagic waters.

The provision of new data and the re-examination of existing datasets for the 2014 assessments have led to multiple changes to the structure of fisheries for each species in addition to those created by dividing regions. This report will therefore outline the basis for the new regional boundaries and the consequences for fisheries definitions and data inputs for MFCL. Catch and size data for fleets within regions will also be examined and the resulting changes to fisheries definitions will be outlined. Finally, the data inputs used in the 2014 assessments in MFCL (catch-effort and size frequency datasets) will be explicitly linked to the fisheries definitions provided herein, to avoid confusion that has occurred in the past about which datasets are attributed to which fisheries and how fisheries within and between regions are linked (e.g. Ianelli *et al.* 2012).

3. New assessment region boundaries

Restricted mixing of tagged fish has been detected in the WCPO (Kolody and Hoyle 2013) and this can potentially have a profound effect on the results of stock assessments (Hoyle *et al.* 2013). Two areas where this has been a problem have been the Coral Sea area off the east coast of Australia (for the BET assessment) and the archipelagic waters around Papua New Guinea and the Solomon islands (for all three tropical tuna assessments). A proposed solution has been to redefine region boundaries such that areas of intense tagging efforts are enclosed in smaller regions so that the mixing assumption of MFCL is less likely to be violated. The bigeye review supported this option and suggested the splitting of BET regions 3 and 5 into two regions each (Ianelli *et al.* 2013).

The region boundaries used for the 2011 stock assessments and new boundaries used in the 2014 assessments are shown in Figure 1 for BET/YFT and Figure 2 for SKJ. To simplify the use of the assessment models in management analyses, identical changes have been made for BET and YFT regions, and as close as possible for the SKJ regions. Changes to the boundaries and their justifications are:

1. **Region 5 split into two**: BET tagged in the Coral Sea have shown a high degree of site fidelity (although a number of long distance returns have also occurred) and so region 9 was

established to represent the area where the majority of local recaptures occurred (within the box defined by 140-150E and 15-20S). This change was made for BET/YFT assessments only.

2. **Region established around Bismarck/Solomon Sea**: This has been a major area for tag releases, especially for SKJ and YFT, and there appears to be more restricted movement out of the archipelagic area and into the wider (former) region 3. The analyses conducted by Hoyle *et al.* (2013) prompted the formation of a new region for each species (R8 for BET/YFT, R5 for SKJ) that encompasses the archipelagic waters of the Bismark and Solomon Seas, with the only difference between species being the southern extent of the region (10S for BET/YFT, 20S for SKJ). It should be noted that the western boundary of R8 is at 140E while the boundary for the Bismark Sea LL fishery was at 130E for the 2011 BET/YFT assessments.

3. **Region established to encompass ID/PH fisheries**: The ID/PH fleets are high-volume fisheries for which data are poor, and their impacts on stock abundance is a source of high uncertainty in stock assessments for the tropical tunas. Region 7 (region 4 for SKJ) was established to contain these fisheries and allow more flexibility in how they are modelled and the potential impact on the overall assessment. For example, the western boundary was extended from 120 E to 110 E to ensure the inclusion of data that has recently become available for Vietnamese fishing vessels. The eastern boundary was established at 140E to include all ID/PH fleets, including the purse-seine fleet operating east of their national waters.

4. Changes to fisheries definitions

4.1. Bigeye and Yellowfin

Figures outlining the data available for each fishery described below and their geographical extent are shown in sections 9.1 and 9.2 for BET and YFT respectively.

4.1.1. Region 1

There are no changes to fisheries definitions in region 1. There are three fisheries present; All-fleets LL, Japanese (JP) purse-seine and JP pole-and-line. Note that the all-fleets LL fishery now includes data for the JP coastal vessels that was not available in the 2011 assessment.

4.1.2. Region 2

There are no changes to fisheries definitions in region 2. There are two fisheries; All-fleets LL and US LL.

4.1.3. Region 3

Changes made to fisheries definitions in region 3 are complicated by the reduction in size of this region which consequently excludes several of the 2011 fisheries from this region (e.g. Indonesian/Philippines fisheries) in addition to changes in fisheries still present in the 2014 region 3. There are five fisheries in the 2014 region 3; all-fleets LL which includes all fleets other than offshore[1] fleets (i.e. PICT fleets and distant-water fleets), offshore LL (offshore

[1] In the fisheries definitions, we recognise two categories of fleets for CN, JP and TW – offshore fleets, which conduct short-duration trips from a base port, where catches are unloaded; and distant-water

fleets of distant-water fishing nations and other fleets that catch similar sized fish, Harley *et al.* 2010; Guam, Federated States of Micronesia, Palau, Marshall Islands, PH and ID), all-fleets associated purse-seine, all-fleets unassociated purse-seine and all-fleets pole-and-line. In 2011 there was a Papua New Guinea LL fishery in region 3, however most of the effort was concentrated in the 2014 region 8 and so the small amount of catch by this fleet in the 2014 region 3 was accounted for by including it in the all-fleets LL fishery for that region.

4.1.4. Region 4

Three LL fisheries were used in region 4 for the 2011 assessments of both species; all-fleets LL, offshore fleets LL and US (Hawaii) LL. For the 2014 assessments the all-fleets and offshore fleets fisheries were merged as there is very little catch for the offshore compared to the distant-water vessels and we are not able to differentiate between CNOS and CNDW catch and effort data. Furthermore, the separation of these fisheries during the 2011 BET assessment was of limited value given that selectivity of the OS fishery was fixed to be the same as that of the all-fleets fishery and the CN size data was discarded as there were concerns that the size data was from CNOS vessels while most of the catch data was from CNDW vessels (Harley *et al.* 2010). The US (Hawaii) handline fishery for BET that was present in the 2011 assessment (there was no analogous fishery in the 2011 YFT assessment) was removed because catches are negligible, there are no recent size data so this fishery was expected to have very little influence on the assessment. The two purse-seine fisheries (all-fleets associated and all-fleets unassociated) used for both species in 2011 remain in 2014. These changes resulted in four fisheries (two each of LL and purse-seine) for the 2014 BET/YFT assessments.

4.1.5. Region 5

There are no changes to the fisheries definitions in region 5 and so there remain two fisheries; all-fleets LL and Australian (AU) LL. However, note that two extra fisheries have been established in region 9 which is within the bounds of the 2011 region 5 (see section 4.1.9).

4.1.6. Region 6

In 2011 there were two fisheries in R6, the all-fleets LL containing PICT fleets and offshore fleets of other nations, and the distant-water LL fishery. In 2014 these fisheries have been merged due to similar issues to those encountered in region 4. The distant-water vessels make up a small and decreasing proportion of the overall catch and it is difficult to identify clear groups of fleets with different operational characteristics, especially given the difficulty in distinguishing between OS and DW vessels for CN.

4.1.7. Region 7

Region 7 has the most complicated fisheries structure with 10 fisheries. To be consistent with region 3 in both the 2011 and 2014 assessments, there are two LL fisheries; all-fleets LL (excluding offshore fleets) and offshore fleets LL (includes the same fleets as the offshore LL fishery in R3). The later includes the Vietnamese LL fleet for which data have become available since the 2011 assessment. The provision of data from Vietnam also led to the establishment of a Vietnamese fishery for vessels fishing with purse-seines and gillnets.

---

fleets, which are comprised of large-scale freezer vessels that undertake extended fishing campaigns in the region, transhipping catches at sea or in port (e.g. see Table 1).

There are two all-fleets purse-seine fisheries – associated and unassociated and also an all-fleets pole-and-line fishery.

The other four fisheries are ID and/or PH fisheries, some of which do not cover the whole of region 7. There are two miscellaneous fisheries, one for each of ID and PH, covering vessels with the following gears; gillnet, hook-and-line, small purse-seine, ringnet and troll. These fisheries cover all of region 7 except for the box 0-20N and 130-140E. Within that box there is a purse-seine fishery that includes domestic vessels from ID and PH that fish to the east of their national waters. Lastly, there is a handline fishery that includes ID and PH fleets over the whole of region 7.

4.1.8. Region 8

Four fisheries were established within region 8; all-fleets LL, all-fleets associated purse-seine, all-fleets unassociated purse-seine and all-fleets pole-and-line. Previously there was a fishery for the Papua New Guinea (PG) LL fleet in region 3 due to the availability of large amounts of size data. For the 2014 assessment the differences in sizes between PG and other fleets does not appear to be large enough to warrant a stand-alone fishery given the truncated time-period of PG size data and the relatively small contribution of this fleet to the overall catch in R8.

4.1.9. Region 9

Two fisheries were established within region 9; all-fleets LL and AU LL. The AU LL fishery is responsible for nearly all the recaptures of tagged fish in this region and the all-fleets LL fishery was established to account for all other LL fishing (mainly historical) in the region.

4.2. Skipjack

4.2.1. Region 1

Figures outlining the data available for each fishery described above and their geographical extent are shown in section 9.3. The number of fisheries in region 1 was reduced from four to three by merging the JPOS and JPDW pole-and-line fisheries into a single fishery. The other fisheries – all-fleets purse-seine and JP LL remain the same.

4.2.2. Region 2

Region 2 of the 2011 SKJ assessment has been split into three regions (a new, smaller region 2 and regions 4 and 5). This has led to numerous changes to fisheries definitions in this area. Within the new region 2 there are four fisheries; Japanese pole-and-line, all-fleets associated purse-seine, all-fleets unassociated purse-seine and JP LL.

4.2.3. Region 3

The number of fisheries in region 3 was reduced from five to four by merging the Japanese pole-and-line and Fijian (FJ) pole-and-line fisheries into a single all-fleets pole-and-line fishery. The catch of those fisheries has decreased dramatically since about 1980 and is now an extremely minor component of the overall fishery in the region and given the relatively similar sizes caught by JP and FJ vessels it was deemed suitable to merge them. The other fisheries – all-fleets associated purse-seine, all-fleets unassociated purse-seine and JP LL remain the same for the 2014 assessment.

4.2.4. Region 4

Region 4 contains the complex fisheries associated with Indonesia/Philippines and there are 8 fisheries in this region in total. Five fisheries cover the whole region; all-fleets (except domestic ID and PH) associated purse-seine, all-fleets (except domestic ID and PH) unassociated purse-seine, all-fleets pole-and-line, JP LL and a Vietnamese gillnet and purse-seine fishery. The remaining fisheries are the ID/PH domestic purse-seine fishery operating outside national waters which is contained within the north-east sub-region, the ID miscellaneous (LL, handline, and domestic purse-seine) fishery and the PH miscellaneous (LL, hook-and-line, domestic purse-seine and ringnet) fishery. The two miscellaneous fisheries operate over all of region 4 except for the north-east sub-region.

4.2.5. Region 5

There are four fisheries within region 5; all-fleets pole-and-line, all-fleets associated purse-seine, all-fleets unassociated purse-seine and JP LL.

5. Regional weighting factors

5.1. Methods

Models constructed with spatial splines were used to estimate regional weighting factors for the 2014 assessments of BET and YFT. Aggregate catch and effort data at the 5×5° scale for the LL fleets from JP, Chinese Taipei and Korea were extracted for the entire Pacific Ocean. The data were separated into individual year-quarters for analyses and CPUE was calculated for both species. A GAM model was fitted to each year-quarter separately and was of the form

$$logy_i \sim \text{Normal}(\log \mu_i, \sigma^2)$$

$$log\mu_i = \beta_0 + f(long_i, lat_i) + \beta_{flag[i]}$$

where $logy_i$ is the log of CPUE (numbers of fish caught per 100 hooks, with a constant of 0.01 added to prevent taking the log of zero), $log\mu_i$ is the expected log CPUE and $long_i$, lat_i, and $flag_{[i]}$ are the longitude, latitude (both at the midpoint of the 5×5° cell they represent) and flag, all of the *i*th record. Function f is an isotropic smooth function of latitude and longitude and so predictions from the model can be made that give a two-dimensional surface of CPUE over the geographical model area for each year-quarter. Because the splines are continuous over the area, predictions can be made for both cells with observations (fitted values) and cells without observations (imputed values). The regional weights for a given assessment region were the sum of the predicted CPUE values for each 5×5° cell within that region in the given year-quarter. Regional weights were normalised such that for each year-quarter the weights over the nine assessment regions summed to one. This is referred to as the simple GAM approach.

An alternative GAM model (alternative GAM approach) was formulated by (L Tremblay-Boyer unpublished analysis) to assess spatial contraction of BET and YFT populations in the Pacific. These models were used to calculate another set of regional weights to compare to those estimated above to ensure that the choice of model structure did not have a large effect on the resulting weights. Predictions were again made for each 5×5° cell at each time-

step (in this case annually rather than for each year-quarter) and the weights were calculated by summing the CPUE over all cells in a region.

5.2. Results

The estimates of regional weights using the spatial GAMs were relatively similar to the regional weights used in the 2011 BET/YFT assessments (Table 2). There was some temporal variability (including seasonality) in weights but no major shifts for either species, with region 4 for BET, and regions 3, 4 and 7, having the highest weights throughout the time-series. Regional weights calculated using the alternative GAM models were generally very similar to the more simple GAMs except they lack the short-term variability. The exceptions were the alternative GAM regional weights for BET region 4 and YFT region 8 which were both consistently higher than the simple GAM estimates.

6. References

Davies, N., Harley, S., Hampton, J., McKechnie, S. 2014. Stock assessment of yellowfin tuna in the western and central Pacific Ocean. WCPFC SC10-SA-WP-04, Majuro, Republic of the Marshall Islands, 6 – 14 August 2014.

Harley, S., Davies, N., Hampton, J., McKechnie, S. 2014. Stock assessment of bigeye tuna in the western and central Pacific Ocean. WCPFC SC10- SA-WP-01, Majuro, Republic of the Marshall Islands, 6 – 14 August 2014.

Hoyle, S. D., Kolody, D. S., Nichol, S. J. (2013). Analyses of tagging data for tropical tunas, with implications for the structure of WCPO bigeye stock assessments. WCPFC-SC9-2013/SA-IP-06. Pohnpei, Federated States of Micronesia 6-14 August 2013.

Kolody, D., Hoyle, S. (2013). Evaluation of tag mixing assumptions for skipjack, yellowfin and bigeye tuna stock assessments in the Western Pacific and Indian Oceans. WCPFC-SC9-2013/SA-IP-11. Pohnpei, Federated States of Micronesia 6-14 August 2013.

Ianelli, J., Maunder, M., Punt, A. E. (2013). Independent (peer) review of 2011 WCPO bigeye tuna assessment. WCPFC-SC8-2012/SA-WP-01. Busan, Korea 7-15 August 2013.

Rice, J., Hampton, J., Davies, N., McKechnie, S. 2014. Stock assessment of skipjack tuna in the western and central Pacific Ocean. WCPFC SC10-SA-WP-05, Majuro, Republic of the Marshall Islands, 6 – 14 August 2014.

7. Tables

Table 1: Table of codes used to identify catch and size frequency data for different fleets and gear types in figures later in the paper.

Gear	Name	Fleet definition	Gear	Name	Fleet definition
D	PHPH	Philippines domestic - other gears	P	FJ	Fiji pole-and-line
G	JP	Japan drift gillnet	P	ID	Indonesia pole-and-line
G	JPDW	Japan distant water drift gillnet	P	JO	Japan pole-and-line (stdardised Eff)
G	KR	Korea drift gillnet	P	JODW	Japan DW pole-and-line (stdardised Eff)
G	PH	Philippines gillnet	P	JOOS	Japan offshore pole-and-line (stdardised Eff)
G	TW	Taiwan drift gillnet	P	JP	Japan pole-and-line (all fleets)
G	VN	Vietnam Gillnet	P	JPDW	Japan distant water pole-and-line
H	ID	Indonesia handline	P	JPOS	Japan offshore pole-and-line
H	PH	Philippines handline	P	KI	Kiribati pole-and-line
H	US	USA handline	P	KR	Korea pole-and-line
H	USHW	US Hawaii handline	P	MX	Mexico pole-and-line
J	AU	Australia handline (RTTP)	P	NC	New Caledonia pole-and-line
J	FM	Federated States of Micornesia	P	NZ	New Zealand pole-and-line
J	JP	Japan handline (RTTP)	P	PF	French Polynesia pole-and-line
J	PH	Philippines handline (RTTP)	P	PG	Papua New Guinea pole-and-line
J	TO	Tonga handline (RTTP)	P	SB	Solomon Islands pole-and-line
J	TV	Tuvalu handline (RTTP)	P	SP	Secretariat of the Pacific Community
J	US	USA handline (RTTP)	P	TV	Tuvalu pole-and-line
J	USHW	US Hawaii handline (RTTP)	P	USHW	Hawaii pole-and-line
K	IDID	Indonesia hook-and-line (small	P	VU	Vanuatu pole-and-line
K	PH	Philippines hook-and-line (small	R	PH	Philippines ringnet
L	AS	American Samoa longline	S	AU	Australia purse seine (all fleets)
L	AU	Australia domestic and chartered	S	CN	China purse seine
L	BZ	Belize longline	S	EC	Ecuador purse seine
L	CK	Cook Islands longline	S	EP	Eastern Pacific Us Purse Seine
L	CN	China longline	S	ES	Spain purse seine
L	CNOS	China offshore longline	S	FM	Federated States of Micronesia purse seine
L	ES	Spain longline	S	FR	France purse seine
L	FJ	Fiji longline	S	ID	Indonesia purse seine (all fleets)
L	FM	Federated States of Micronesia	S	IDDW	Indonesia distant-water purse seine
L	GE	Georgia longline	S	IDID	Indonesia domestic purse seine
L	GU	Guam longline	S	JO	Japan Fleets (standardised Effort)
L	ID	Indonesia longline	S	JOOS	Japan offshore purse seine (stdardised Eff)
L	IN	India longline	S	JP	Japan purse seine (all fleets)
L	JP	Japan longline (all fleets)	S	JPDW	Japan distant-water purse seine
L	JPDW	Japan distant water longline	S	KI	Kiribati purse seine
L	JPOS	Japan offshore longline	S	KR	Korea purse seine
L	KI	Kiribati longline	S	MH	Marshall Islands purse seine
L	KR	Korea longline	S	MX	Mexico purse seine
L	KRDW	Korea distant water longline	S	NZ	New Zealand purse seine
L	MH	Marshall Islands longline	S	PG	Papua New Guinea purse seine
L	NC	New Caledonia longline	S	PH	Philippines purse seine (all fleets)
L	NU	Niue longline	S	PHDW	Philippines distant water purse seine
L	NZ	New Zealand longline	S	PHPH	Philippines domestic purse seine
L	PF	French Polynesia longline	S	SB	Solomon Islands purse seine

L	PG	Papua New Guinea longline	S	SU	Russia purse seine
L	PH	Philippines domestic longline	S	SV	El Salvador purse seine
L	PW	Palau longline	S	TV	Tuvalu purse seine
L	SB	Solomon Islands longline	S	TW	Taiwan purse seine
L	SU	Soviet Union longline	S	TWOS	Taiwan offshore purse seine
L	TO	Tonga longline	S	US	Unites States of America purse seine
L	TV	Tuvalu longline	S	USHW	US Hawaii purse seine
L	TW	Taiwan longline (all fleets)	S	VN	Vietnam Purse seine
L	TWDW	Taiwan distant-water longline	S	VU	Vanuatu purse seine
L	TWOD	Taiwan offshore domestic longline	T	AU	Australia troll
L	TWOS	Taiwan offshore longline	T	CA	Canada troll
L	US	United States of America longline (all fleets)	T	FJ	Fiji troll
L	USAS	US American Samoa longline	T	FM	Federated States Of Micronesia troll
L	USHW	United States of America longline (Hawaii)	T	FR	France troll
L	USMC	US WCPO longline	T	ID	Indonesia troll
L	VN	Vietnam longline	T	NZ	New Zealand troll
L	VU	Vanuatu longline	T	PF	French Polynesia troll
L	WS	Samoa longline	T	PH	Philippines troll
N	PH	Philippines gillnet	T	TV	Tuvalu troll
O	ID	Indonesia unclassified	T	US	United States of America troll
O	PH	Philippines unclassified	T	USHW	US Hawaii troll
P	AU	Australia pole-and-line	Y	NZ	New Zealand recreational
P	EP	Eastern Pacific pole-and-line			

Table 2: Regional weights as calculated for the 2011 assessments (BET 2011, YFT 2011) and for the 2014 assessments for the old 6 region and new 9 region spatial structures using the simple GAM approach. All weights shown are calculated over the period 1960-1986 so the 2011 and 2014 weightings are directly comparable. Note that region 3 for the 6 region structures includes the areas represented by regions 3, 7 and 8 in the 9 region structures. Similarly, region 5 for the 6 region structures includes the areas represented by regions 5, and 9 in the 9 region structures.

	Region								
	1	2	3	4	5	6	7	8	9
BET 2011	0.06	0.15	0.29	0.42	0.04	0.05			
BET 2014 6 region	0.05	0.16	0.26	0.39	0.04	0.10			
BET 2014 9 region	0.05	0.16	0.13	0.39	0.04	0.10	0.10	0.02	<.01
YFT 2011	0.03	0.02	0.53	0.27	0.11	0.04			
YFT 2014 6 region	0.03	0.02	0.56	0.21	0.10	0.08			
YFT 2014 9 region	0.03	0.02	0.20	0.21	0.10	0.08	0.27	0.09	<.01

8. Figures

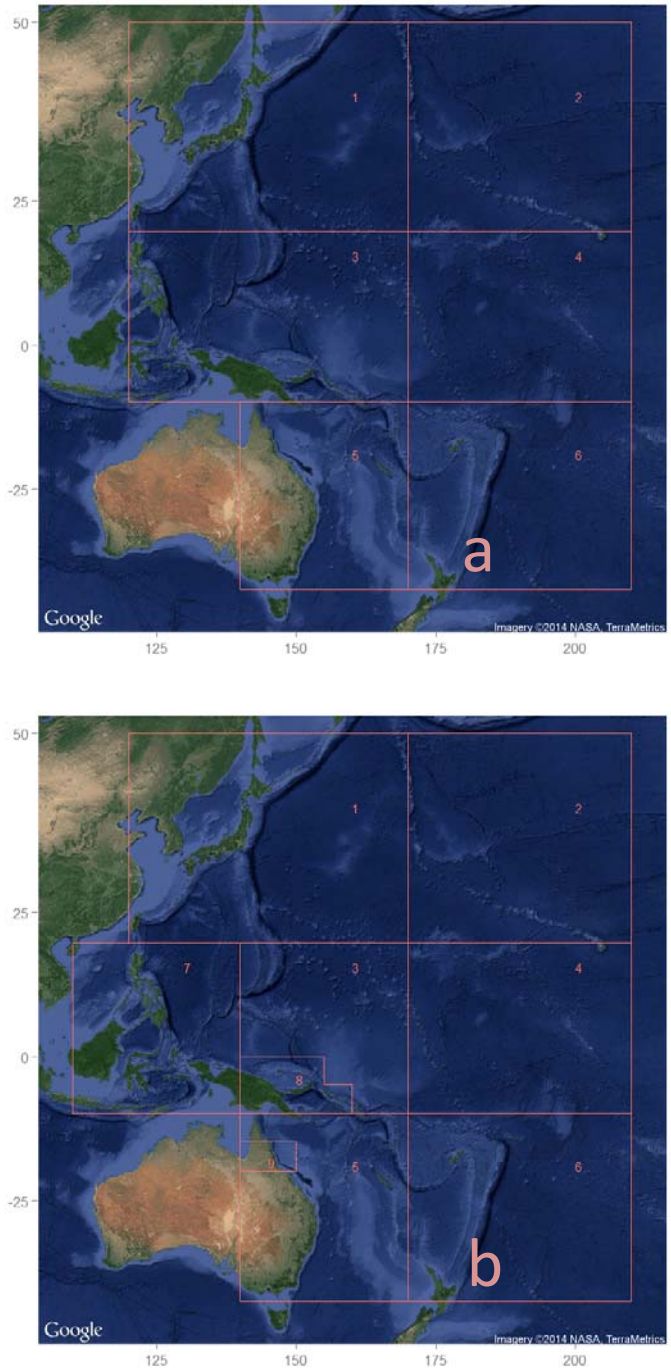


Figure 1: Maps of the boundaries of the 2011 (a) and 2014 (b) stock assessment regions for BET/YFT.

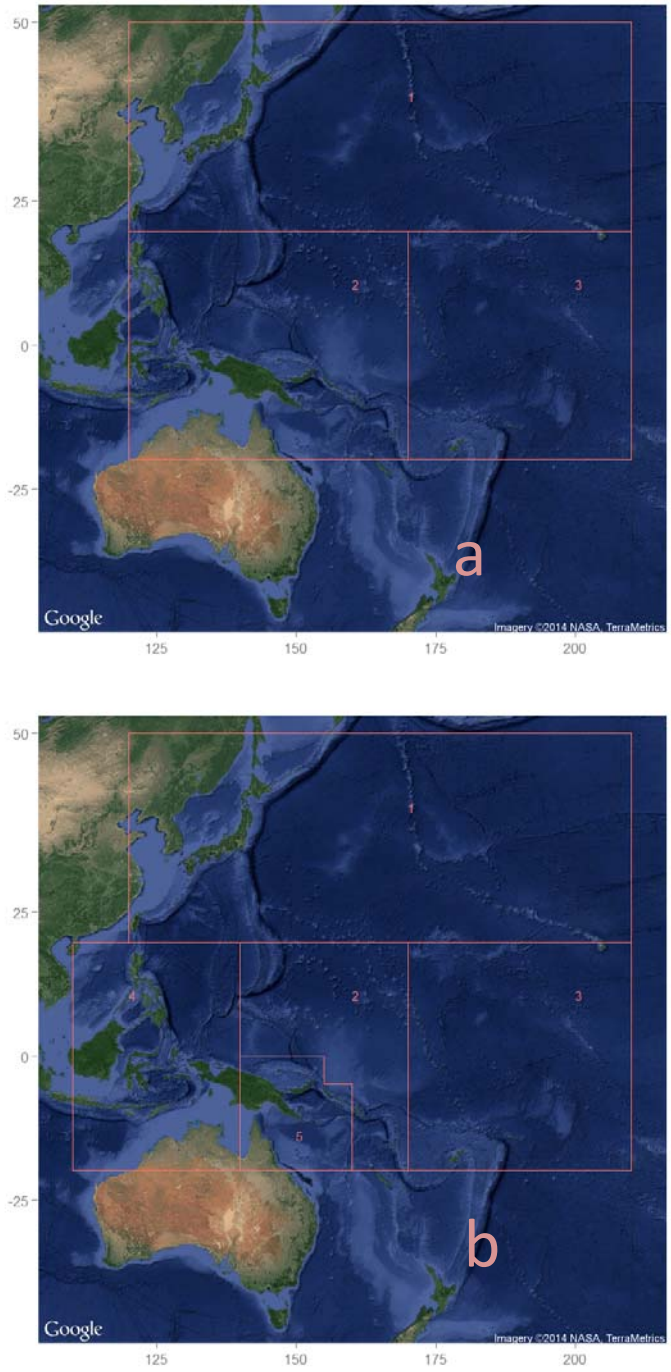


Figure 2: Maps of the boundaries of the 2011 (a) and 2014 (b) stock assessment regions for BET/YFT.

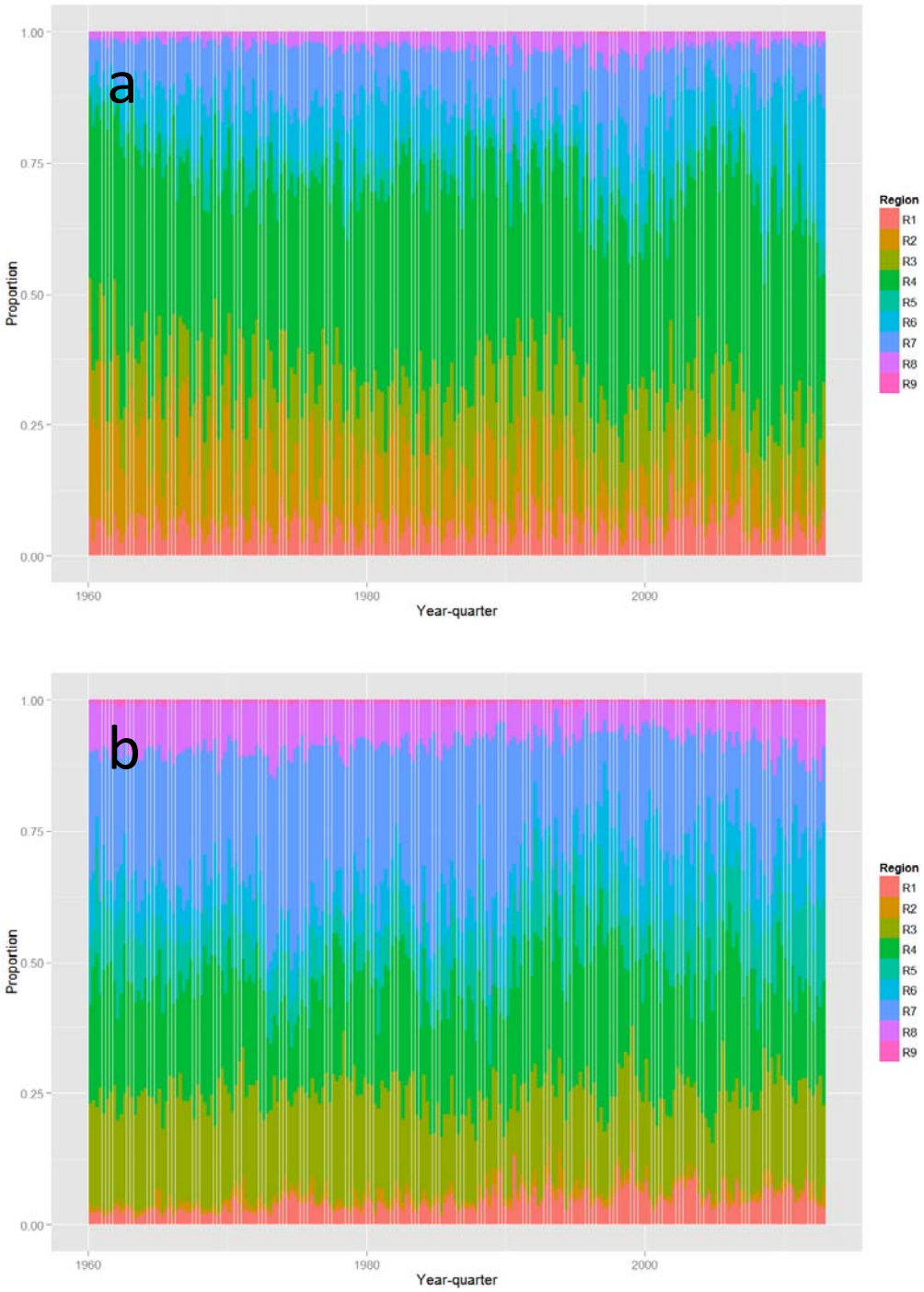


Figure 3: Stacked bar plot of the regional weights for BET (a) and YFT (b) from 1960-2012. The height of the different coloured bars indicate the normalised weight for the region of that colour.

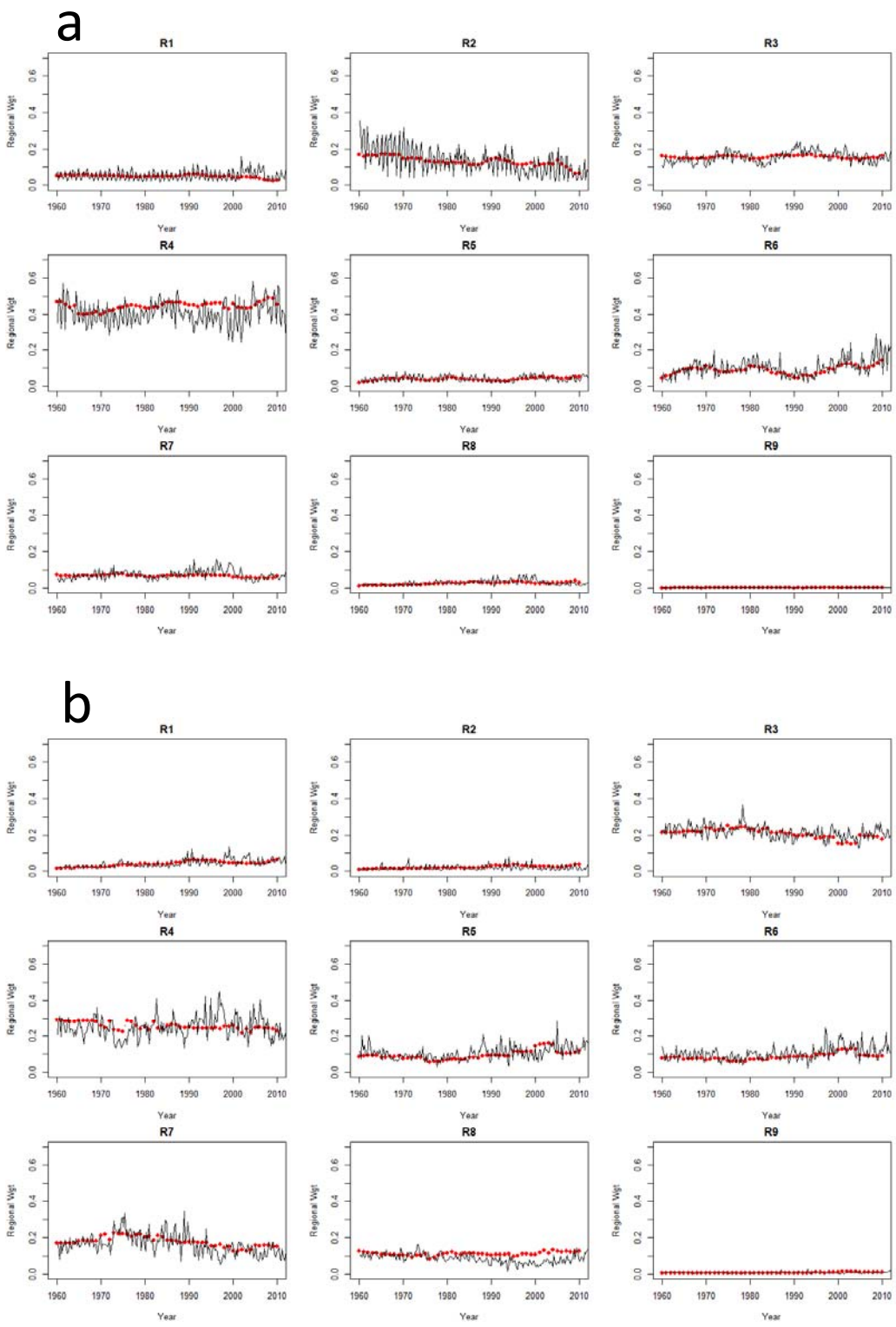
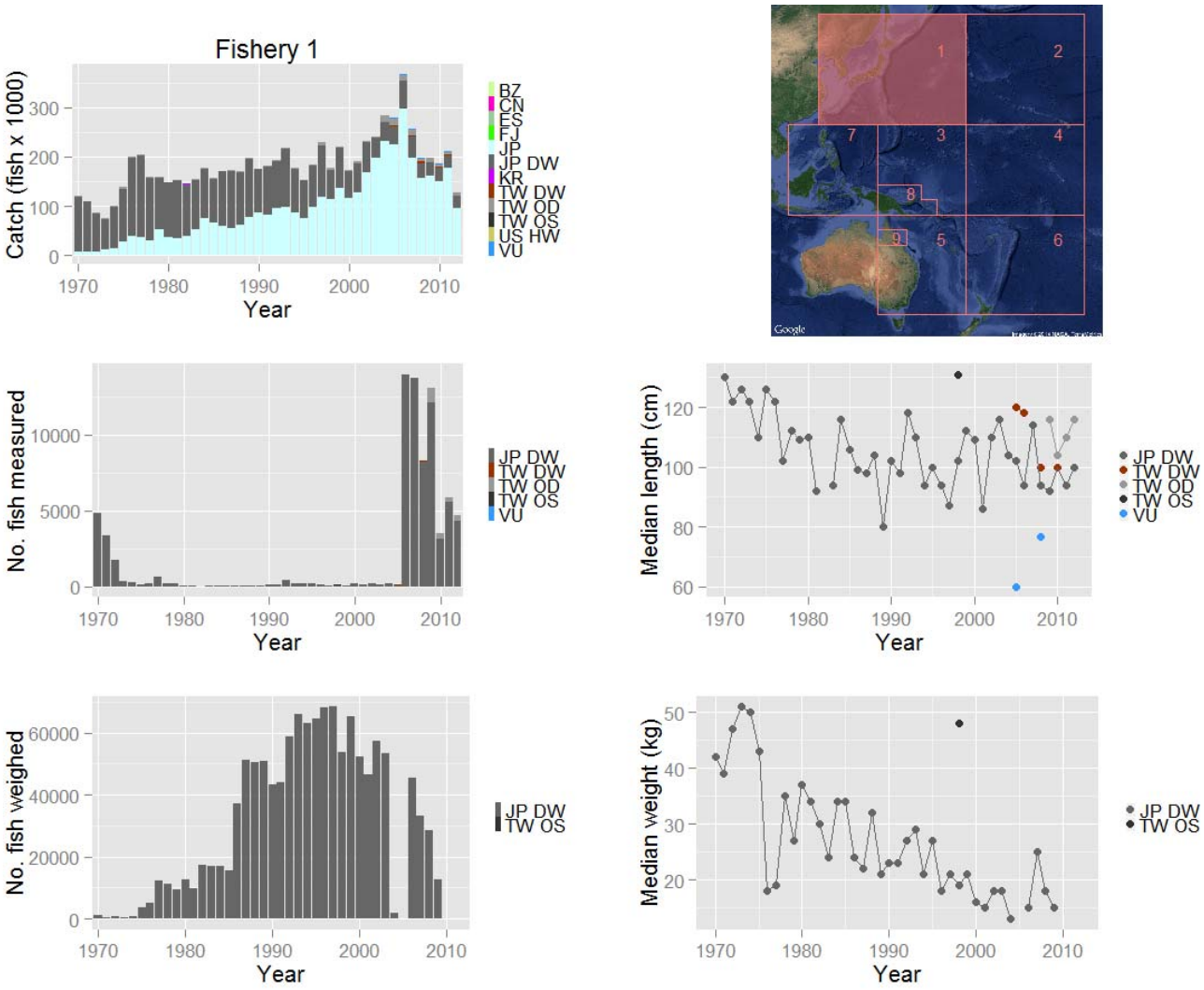


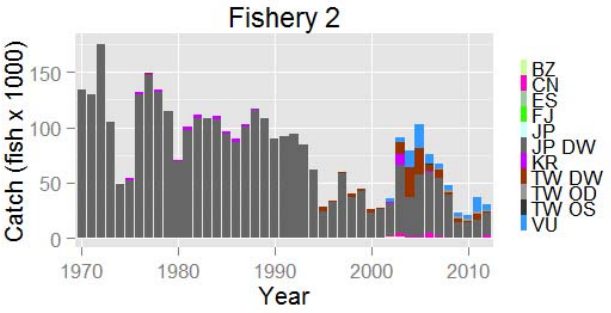
Figure 4: Comparison of the normalised regional weights estimated using the simple GAM method (black lines) and the alternative GAM method (red points) for BET (a) and YFT (b) for the 9 regions in the 2014 stock assessments.

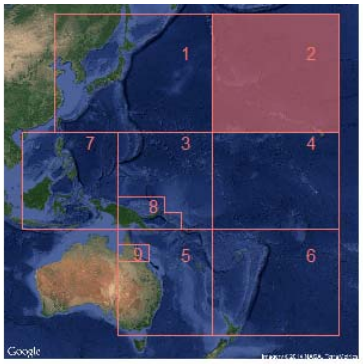
9. Appendices

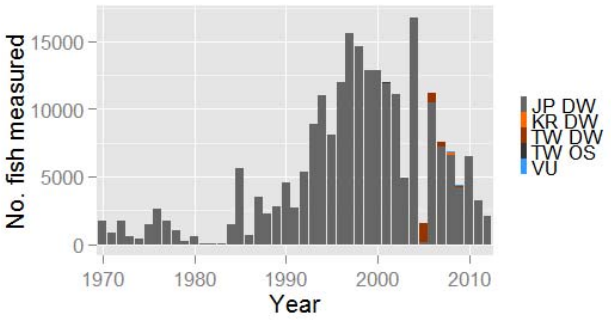
9.1. BET fishery definitions plots

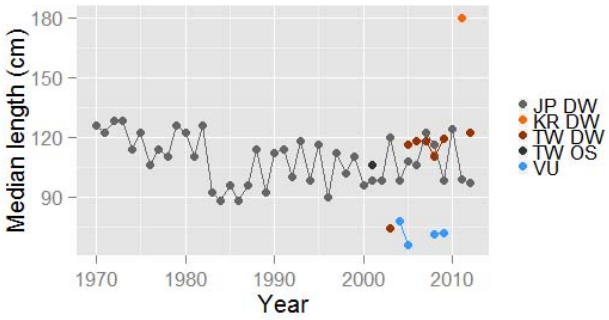
Fisheries definition plots: The plots in sections 9.1, 9.2 and 9.3 summarise the catch and size frequency data available for all fleets within each fishery defined in the stock assessment model at the year scale. Panels are – upper left; catch in either number of individual fish or weight (metric tonnes), upper right; the geographical extent of the fishery, middle left; number of fish measure for length, middle right; median fork length (cm) of fish measure, lower left; number of fish weighed, lower right; median weight of fish measured (kg). Note that there are some differences in the naming conventions between catch and size data and so Table 1 should be referred to when identifying the fleet in the figures.

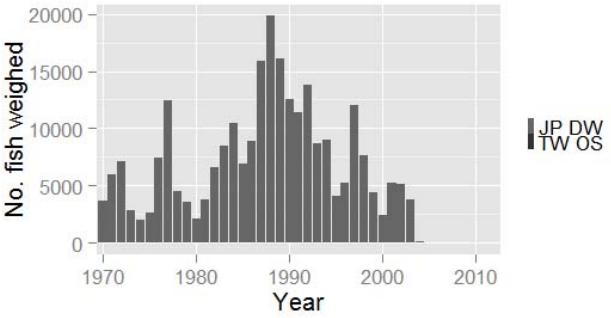


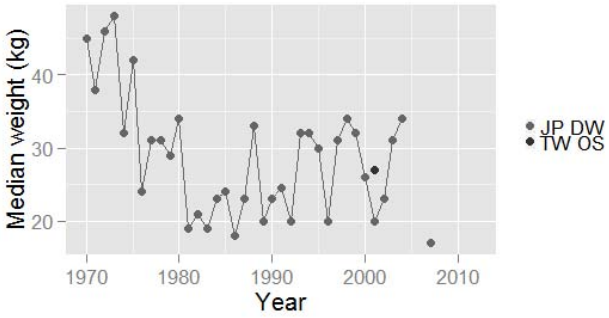

Fishery 2
Catch (fish x 1000)
150
100
50
0
1970
1980
1990
2000
2010
Year
BZ
CN
ES
FJ
JP
JP DW
KR
TW DW
TW OD
TW OS
VU

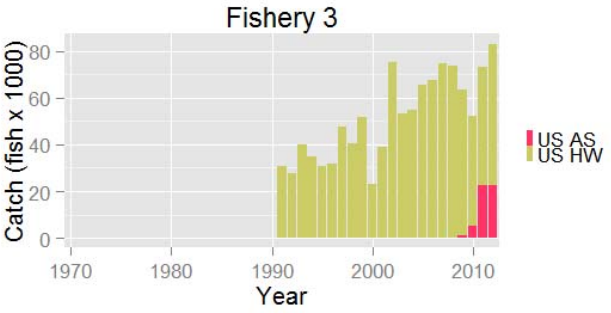

1
2
7
3
4
8
9
5
6
Google

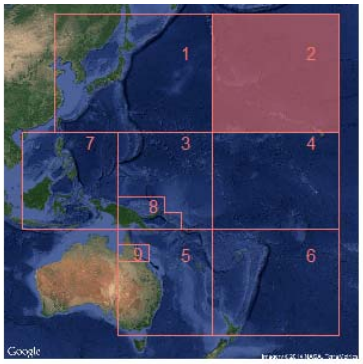

No. fish measured
15000
10000
5000
0
1970
1980
1990
2000
2010
Year
JP DW
KR DW
TW DW
TW OS
VU

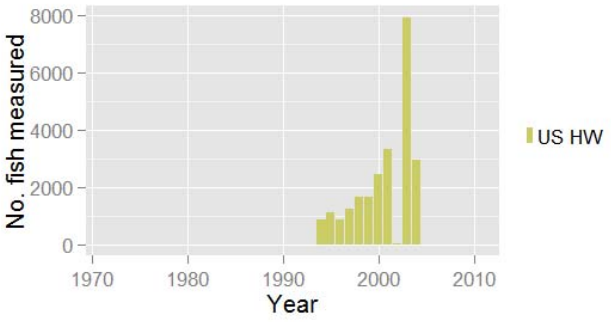

Median length (cm)
180
150
120
90
1970
1980
1990
2000
2010
Year
JP DW
KR DW
TW DW
TW OS
VU

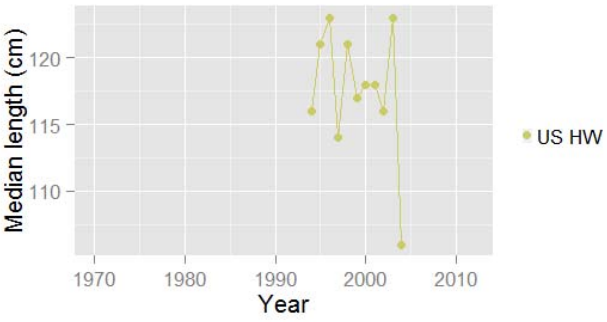

No. fish weighed
20000
15000
10000
5000
0
1970
1980
1990
2000
2010
Year
JP DW
TW OS

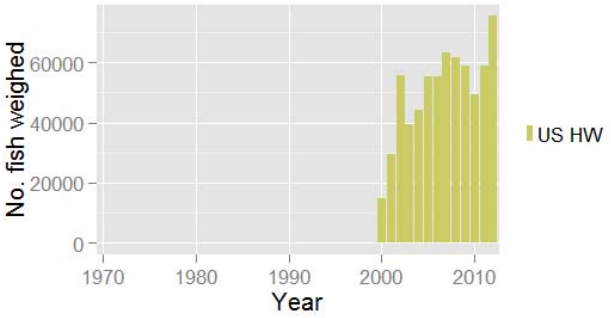

Median weight (kg)
40
30
20
1970
1980
1990
2000
2010
Year
JP DW
TW OS

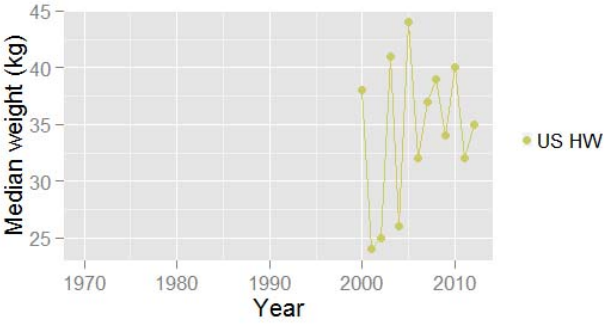

Fishery 3
Catch (fish x 1000)
0
20
40
60
80
1970
1980
1990
2000
2010
Year
US AS
US HW

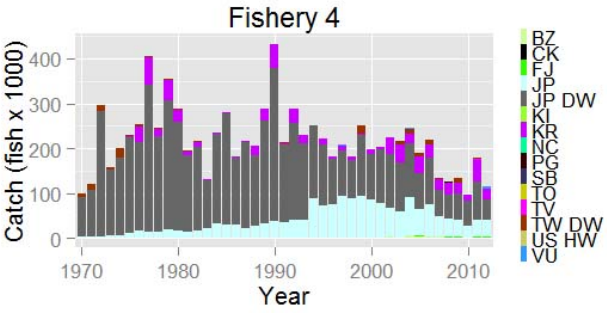

1
2
7
3
4
8
9
5
6
Google

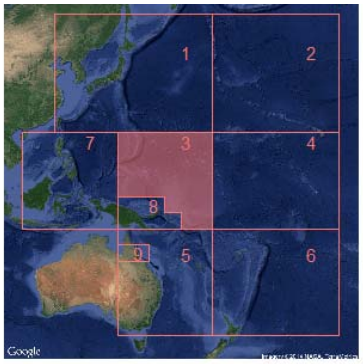

No. fish measured
0
2000
4000
6000
8000
1970
1980
1990
2000
2010
Year
US HW

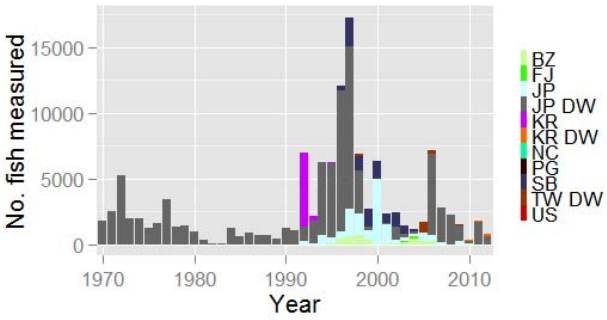

Median length (cm)
110
115
120
1970
1980
1990
2000
2010
Year
US HW

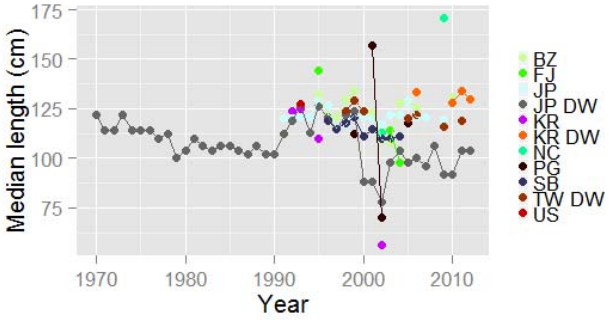

No. fish weighed
0
20000
40000
60000
1970
1980
1990
2000
2010
Year
US HW

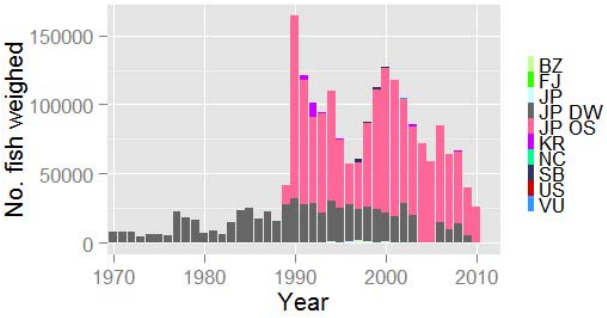

Median weight (kg)
25
30
35
40
45
1970
1980
1990
2000
2010
Year
US HW

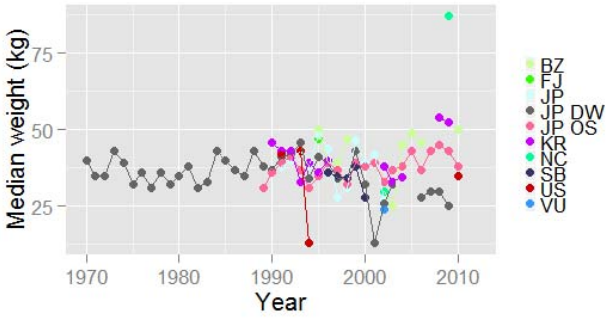

Fishery 4
Catch (fish x 1000)
0
100
200
300
400
1970
1980
1990
2000
2010
Year
BZ
CK
FJ
JP
JP DW
KI
KR
NC
PG
SB
TO
TV
TW DW
US HW
VU

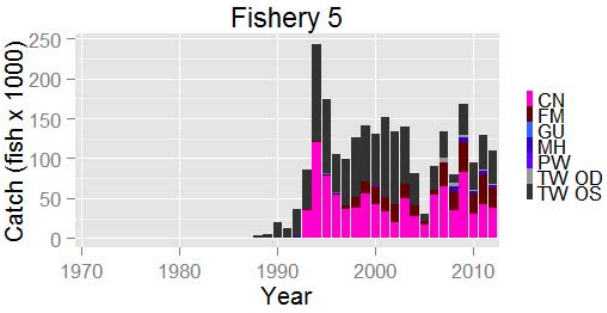

1
2
3
4
5
6
7
8
9
Google

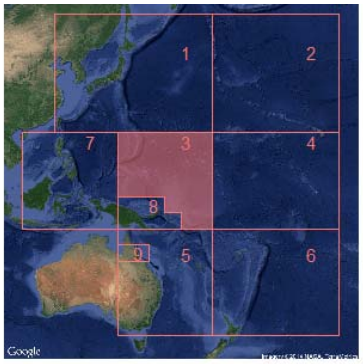

No. fish measured
0
5000
10000
15000
1970
1980
1990
2000
2010
Year
BZ
FJ
JP
JP DW
KR
KR DW
NC
PG
SB
TW DW
US

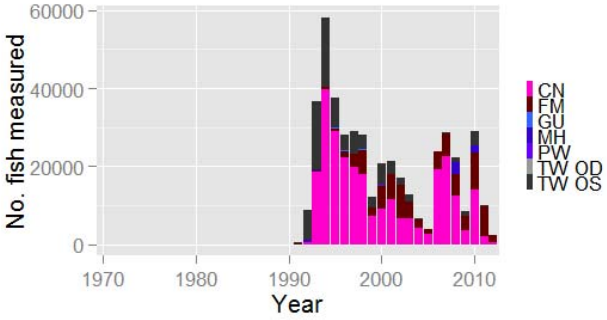

Median length (cm)
75
100
125
150
175
1970
1980
1990
2000
2010
Year
BZ
FJ
JP
JP DW
KR
KR DW
NC
PG
SB
TW DW
US

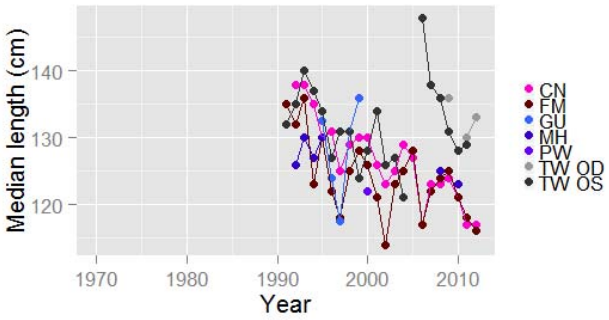

No. fish weighed
0
50000
100000
150000
1970
1980
1990
2000
2010
Year
BZ
FJ
JP
JP DW
JP OS
KR
NC
SB
US
VU

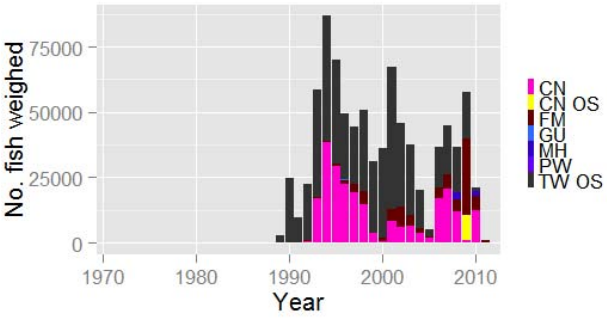

Median weight (kg)
25
50
75
1970
1980
1990
2000
2010
Year
BZ
FJ
JP
JP DW
JP OS
KR
NC
SB
US
VU

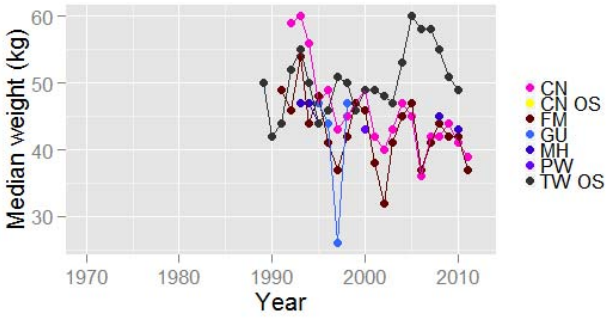

Fishery 5
Catch (fish x 1000)
250
200
150
100
50
0
1970
1980
1990
2000
2010
Year
CN
FM
GU
MH
PW
TW OD
TW OS

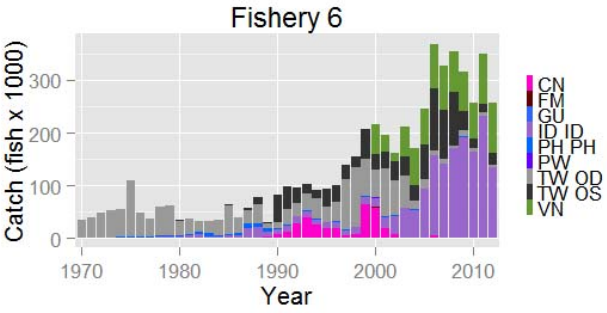

1
2
7
3
4
8
9
5
6
Google

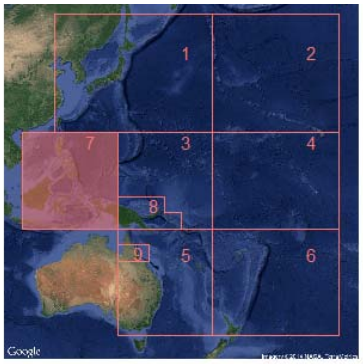

No. fish measured
60000
40000
20000
0
1970
1980
1990
2000
2010
Year
CN
FM
GU
MH
PW
TW OD
TW OS

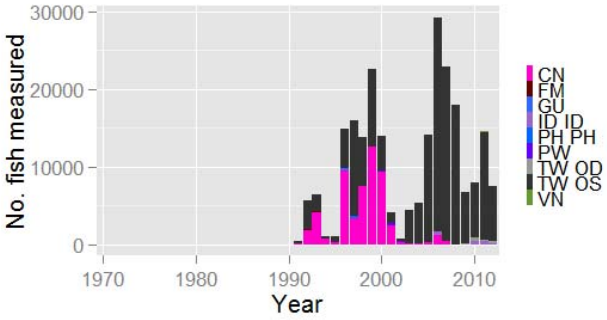

Median length (cm)
140
130
120
1970
1980
1990
2000
2010
Year
CN
FM
GU
MH
PW
TW OD
TW OS

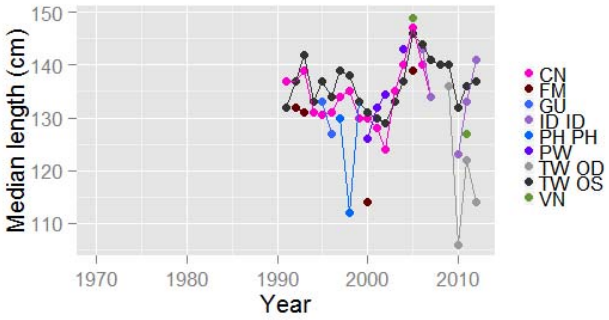

No. fish weighed
75000
50000
25000
0
1970
1980
1990
2000
2010
Year
CN
CN OS
FM
GU
MH
PW
TW OS

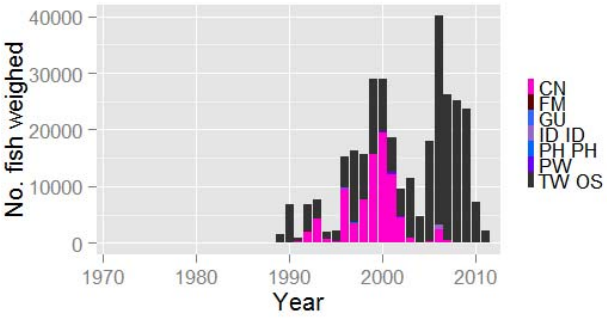

Median weight (kg)
60
50
40
30
1970
1980
1990
2000
2010
Year
CN
CN OS
FM
GU
MH
PW
TW OS

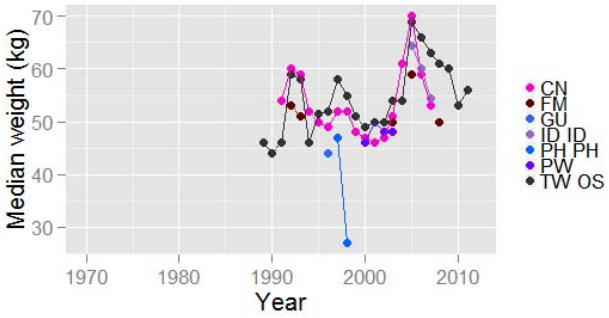

Fishery 6
Catch (fish x 1000)
0
100
200
300
1970
1980
1990
2000
2010
Year
CN
FM
GU
ID ID
PH PH
PW
TW OD
TW OS
VN

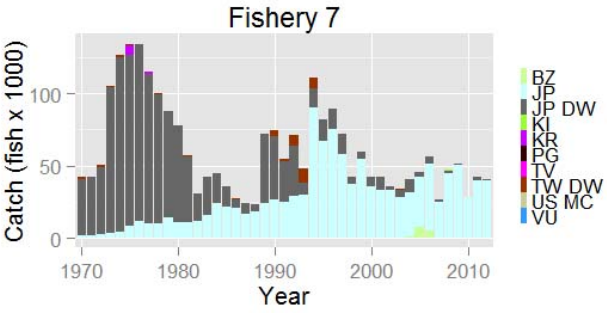

1
2
3
4
5
6
7
8
9
Google

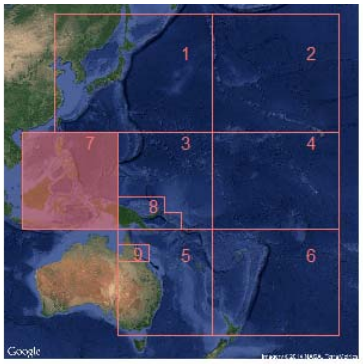

No. fish measured
0
10000
20000
30000
1970
1980
1990
2000
2010
Year
CN
FM
GU
ID ID
PH PH
PW
TW OD
TW OS
VN

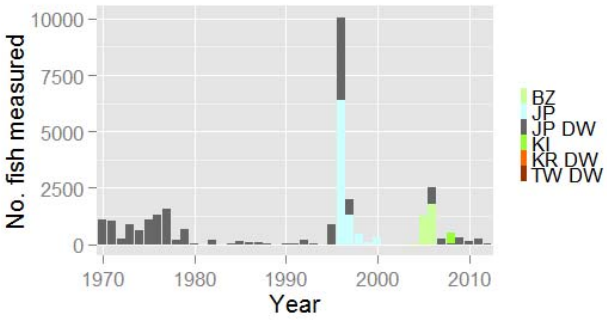

Median length (cm)
110
120
130
140
150
1970
1980
1990
2000
2010
Year
CN
FM
GU
ID ID
PH PH
PW
TW OD
TW OS
VN

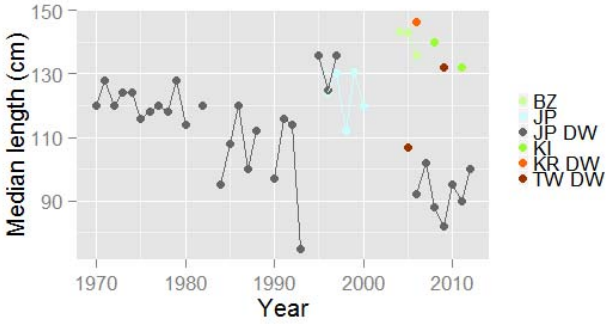

No. fish weighed
0
10000
20000
30000
40000
1970
1980
1990
2000
2010
Year
CN
FM
GU
ID ID
PH PH
PW
TW OS

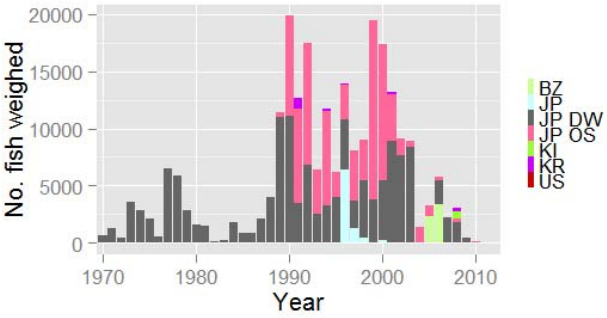

Median weight (kg)
30
40
50
60
70
1970
1980
1990
2000
2010
Year
CN
FM
GU
ID ID
PH PH
PW
TW OS

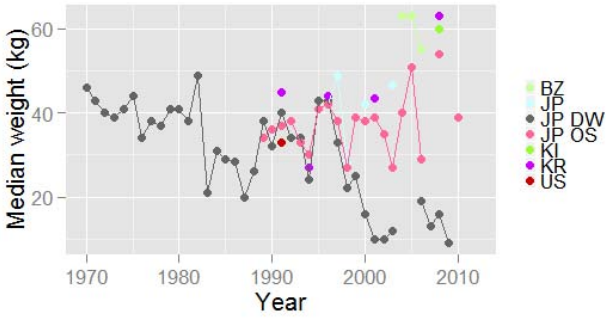

Fishery 7
Catch (fish x 1000)
0
50
100
1970
1980
1990
2000
2010
Year
BZ
JP
JP DW
KI
KR
PG
TV
TW DW
US MC
VU

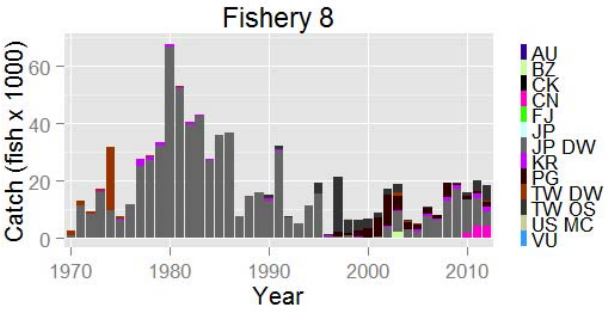

1
2
3
4
5
6
7
8
9
Google

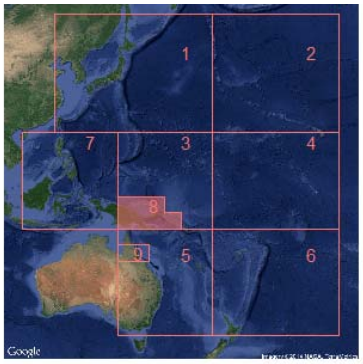

No. fish measured
0
2500
5000
7500
10000
1970
1980
1990
2000
2010
Year
BZ
JP
JP DW
KI
KR DW
TW DW

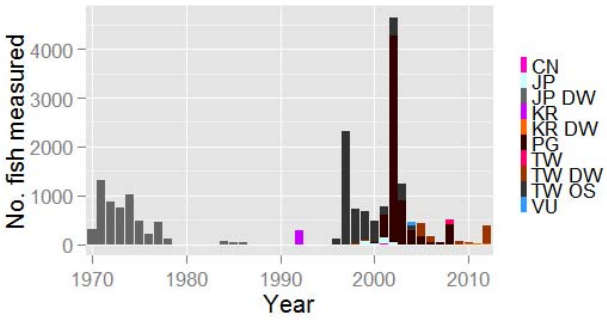

Median length (cm)
90
110
130
150
1970
1980
1990
2000
2010
Year
BZ
JP
JP DW
KI
KR DW
TW DW

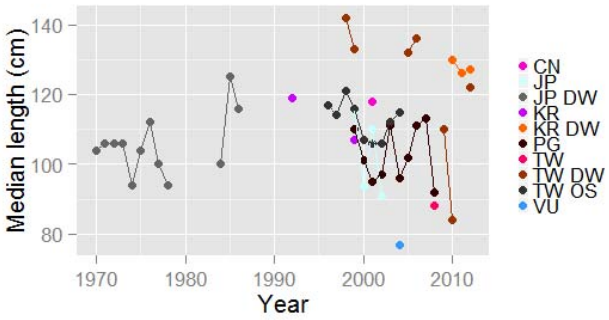

No. fish weighed
0
5000
10000
15000
20000
1970
1980
1990
2000
2010
Year
BZ
JP
JP DW
JP OS
KI
KR
US

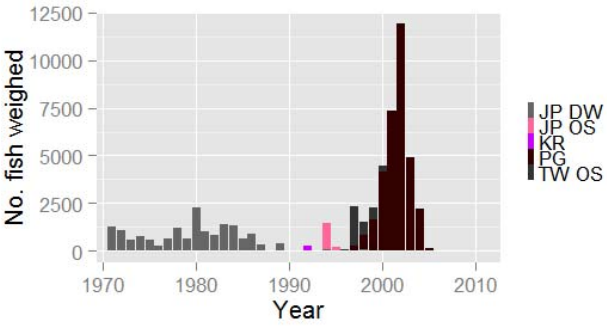

Median weight (kg)
20
40
60
1970
1980
1990
2000
2010
Year
BZ
JP
JP DW
JP OS
KI
KR
US

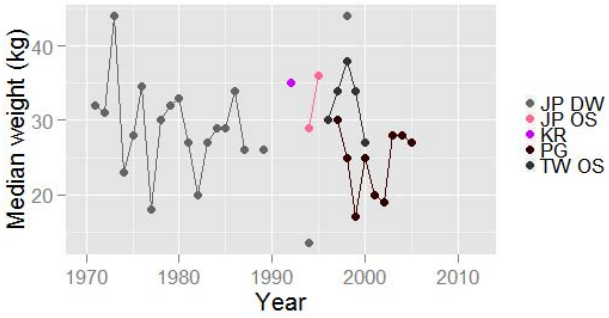

Fishery 8
Catch (fish x 1000)
0
20
40
60
1970
1980
1990
2000
2010
Year
AU
BZ
CK
CN
FJ
JP
JP DW
KR
PG
TW DW
TW OS
US MC
VU

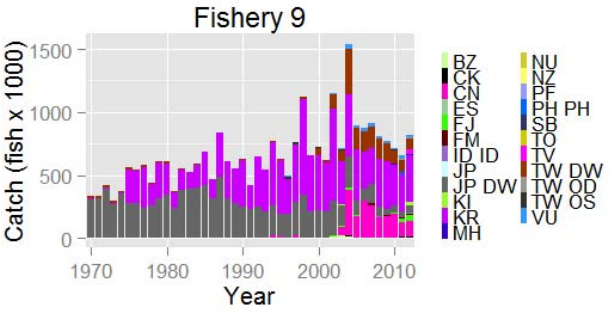

1
2
7
3
4
8
9
5
6
Google

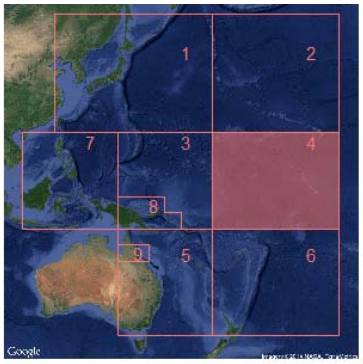

No. fish measured
0
1000
2000
3000
4000
1970
1980
1990
2000
2010
Year
CN
JP
JP DW
KR
KR DW
PG
TW
TW DW
TW OS
VU

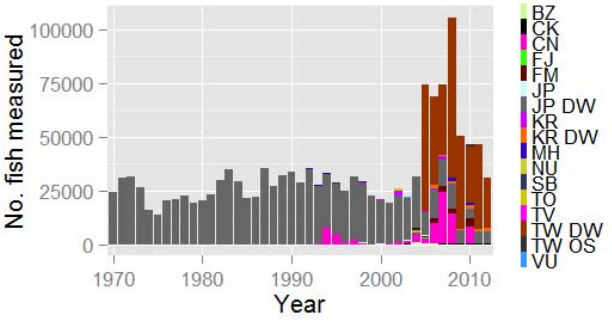

Median length (cm)
80
100
120
140
1970
1980
1990
2000
2010
Year
CN
JP
JP DW
KR
KR DW
PG
TW
TW DW
TW OS
VU

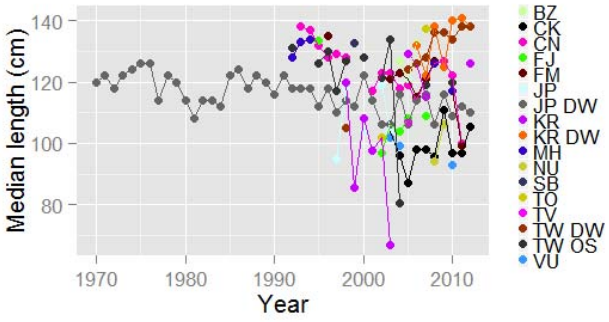

No. fish weighed
0
2500
5000
7500
10000
12500
1970
1980
1990
2000
2010
Year
JP DW
JP OS
KR
PG
TW OS

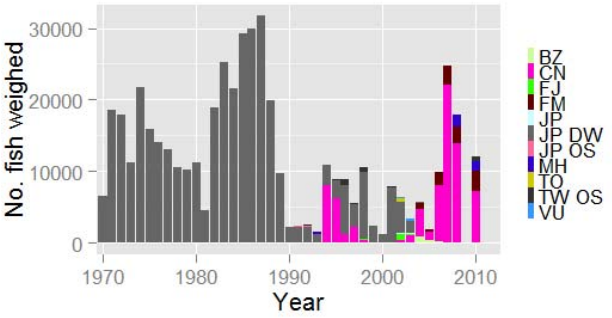

Median weight (kg)
20
30
40
1970
1980
1990
2000
2010
Year
JP DW
JP OS
KR
PG
TW OS

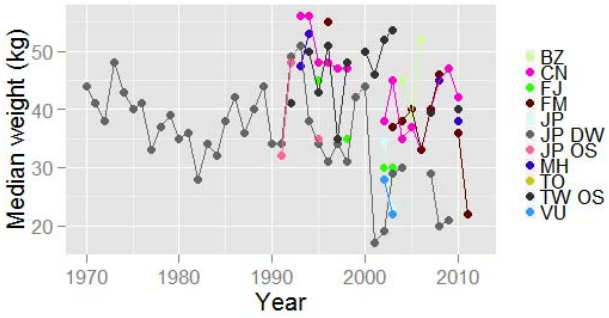

Fishery 9
Catch (fish x 1000)
1500
1000
500
0
1970
1980
1990
2000
2010
Year
BZ
CK
CN
ES
FJ
FM
ID ID
JP
JP DW
KI
KR
MH
NU
NZ
PF
PH PH
SB
TO
TV
TW DW
TW OD
TW OS
VU

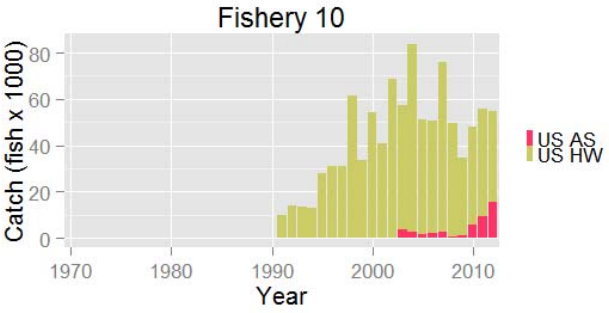

1
2
3
4
5
6
7
8
9
Google

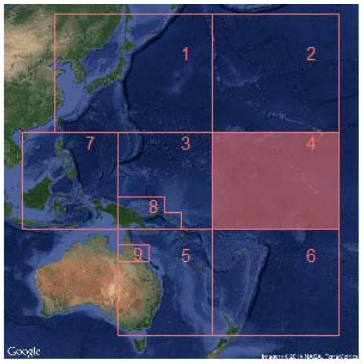

No. fish measured
100000
75000
50000
25000
0
1970
1980
1990
2000
2010
Year
BZ
CK
CN
FJ
FM
JP
JP DW
KR
KR DW
MH
NU
SB
TO
TV
TW DW
TW OS
VU

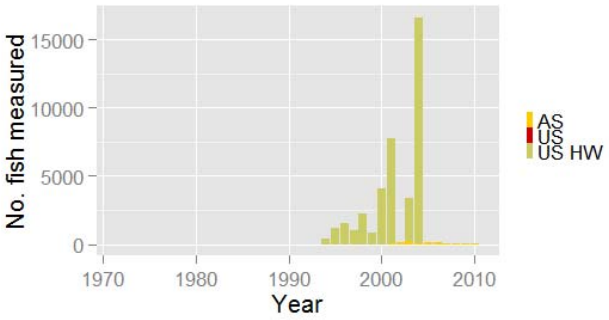

Median length (cm)
140
120
100
80
1970
1980
1990
2000
2010
Year
BZ
CK
CN
FJ
FM
JP
JP DW
KR
KR DW
MH
NU
SB
TO
TV
TW DW
TW OS
VU

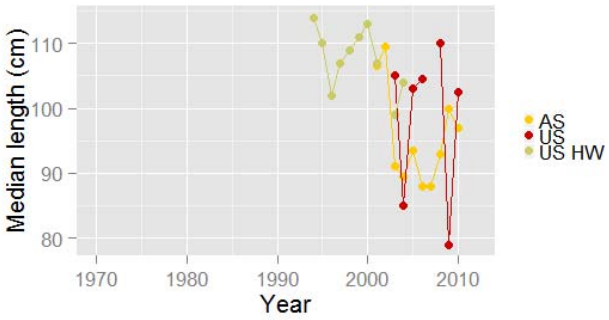

No. fish weighed
30000
20000
10000
0
1970
1980
1990
2000
2010
Year
BZ
CN
FJ
FM
JP
JP DW
JP OS
MH
TO
TW OS
VU

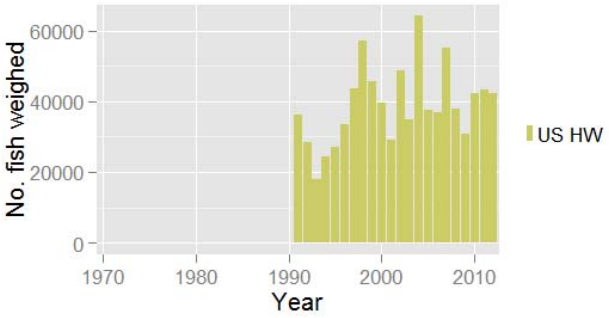

Median weight (kg)
50
40
30
20
1970
1980
1990
2000
2010
Year
BZ
CN
FJ
FM
JP
JP DW
JP OS
MH
TO
TW OS
VU

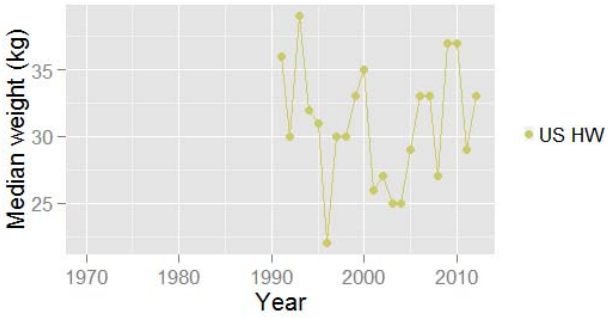

Fishery 10
Catch (fish x 1000)
0
20
40
60
80
1970
1980
1990
2000
2010
Year
US AS
US HW

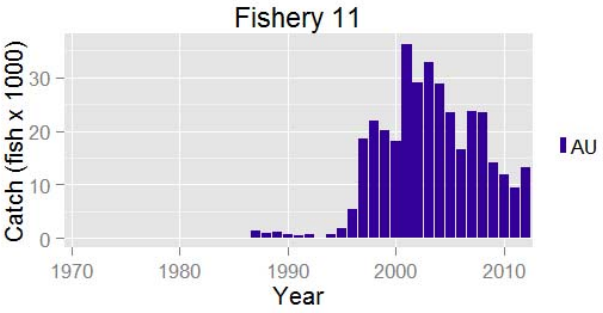

1
2
3
4
5
6
7
8
9
Google

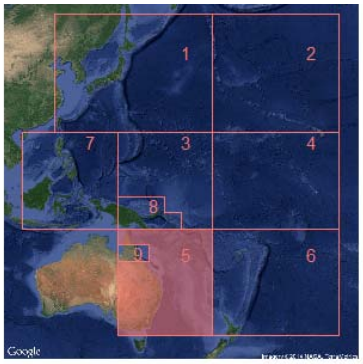

No. fish measured
0
5000
10000
15000
1970
1980
1990
2000
2010
Year
AS
US
US HW

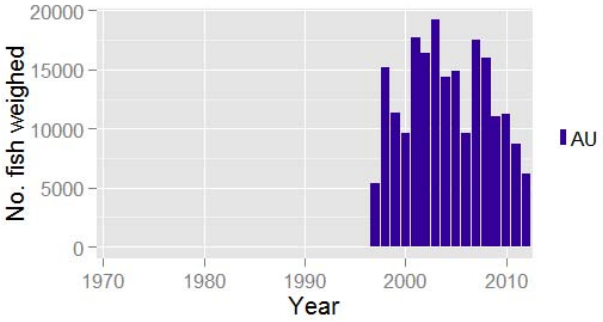

Median length (cm)
80
90
100
110
1970
1980
1990
2000
2010
Year
AS
US
US HW

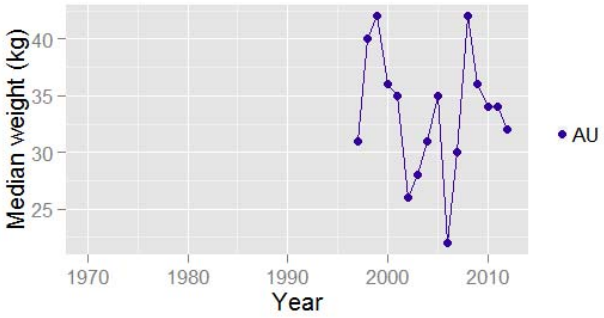

No. fish weighed
0
20000
40000
60000
1970
1980
1990
2000
2010
Year
US HW

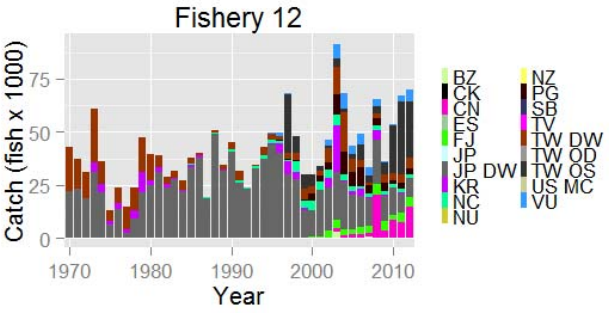

Median weight (kg)
25
30
35
1970
1980
1990
2000
2010
Year
US HW

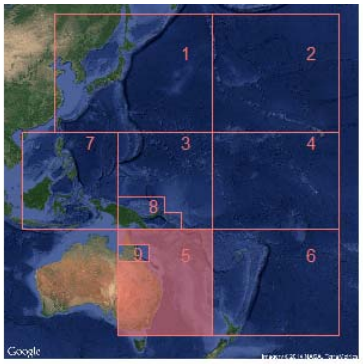

Fishery 11
Catch (fish x 1000)
30
20
10
0
1970
1980
1990
2000
2010
Year
AU

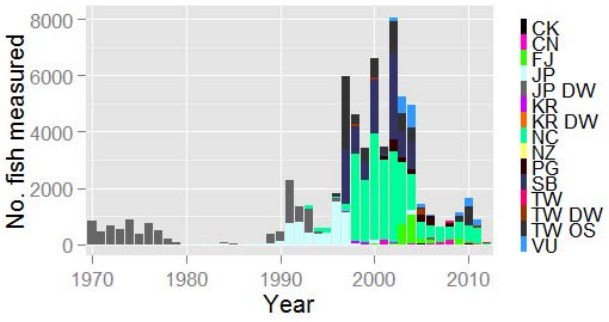

1
2
7
3
4
8
9
5
6
Google

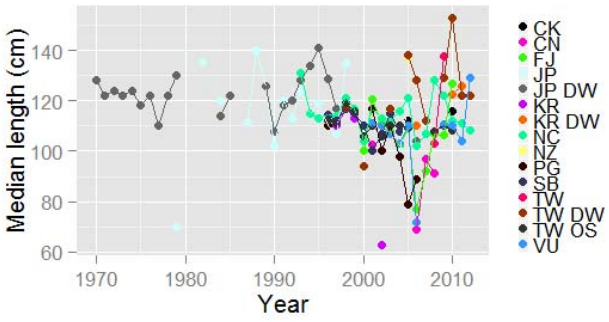

No. fish weighed
20000
15000
10000
5000
0
1970
1980
1990
2000
2010
Year
AU

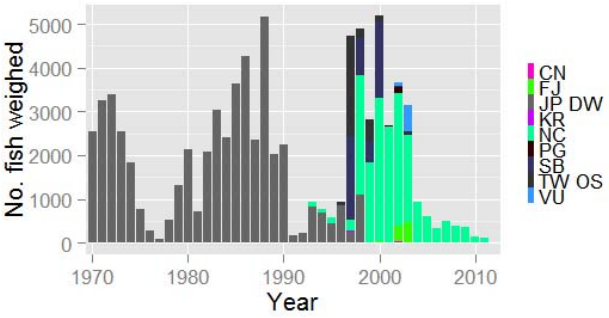

Median weight (kg)
40
35
30
25
1970
1980
1990
2000
2010
Year
AU

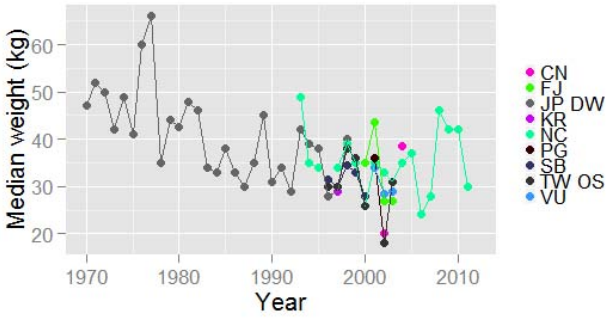

Fishery 12
Catch (fish x 1000)
0
25
50
75
1970
1980
1990
2000
2010
Year
BZ
CK
CN
ES
FJ
JP
JP DW
KR
NC
NU
NZ
PG
SB
TV
TW DW
TW OD
TW OS
US MC
VU

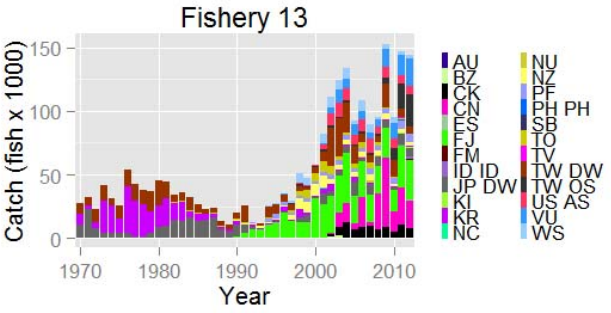

1
2
3
4
5
6
7
8
9
Google

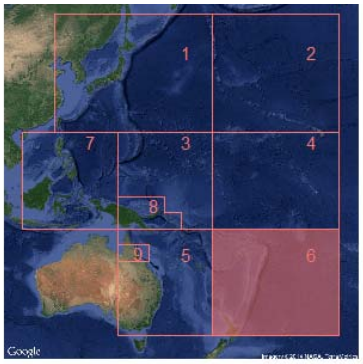

No. fish measured
0
2000
4000
6000
8000
1970
1980
1990
2000
2010
Year
CK
CN
FJ
JP
JP DW
KR
KR DW
NC
NZ
PG
SB
TW
TW DW
TW OS
VU

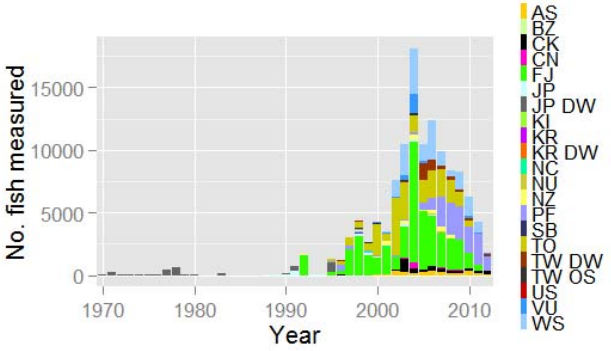

Median length (cm)
60
80
100
120
140
1970
1980
1990
2000
2010
Year
CK
CN
FJ
JP
JP DW
KR
KR DW
NC
NZ
PG
SB
TW
TW DW
TW OS
VU

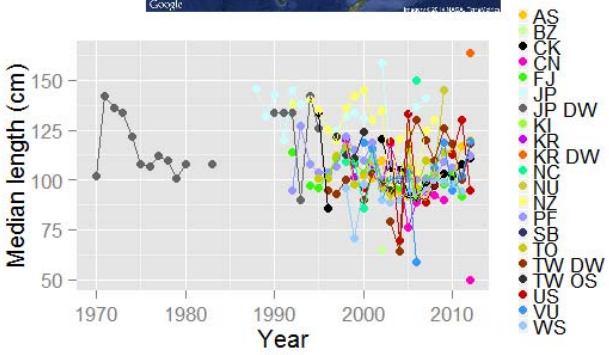

No. fish weighed
0
1000
2000
3000
4000
5000
1970
1980
1990
2000
2010
Year
CN
FJ
JP DW
KR
NC
PG
SB
TW OS
VU

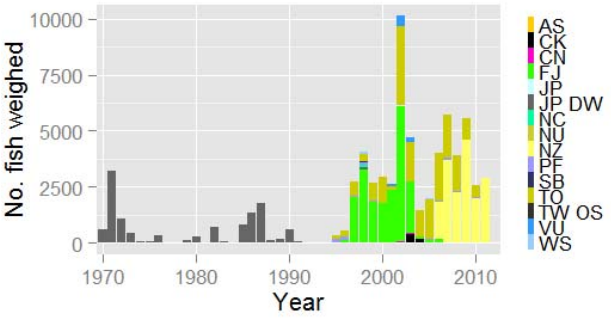

Median weight (kg)
20
30
40
50
60
1970
1980
1990
2000
2010
Year
CN
FJ
JP DW
KR
NC
PG
SB
TW OS
VU

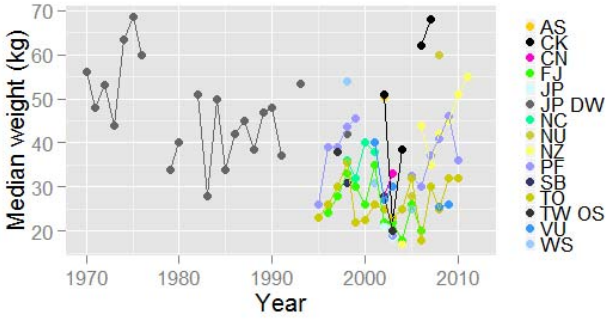

Fishery 13
Catch (fish x 1000)
150
100
50
0
1970
1980
1990
2000
2010
Year
AU
BZ
CK
CN
ES
FJ
FM
ID ID
JP DW
KI
KR
NC
NU
NZ
PF
PH PH
SB
TO
TV
TW DW
TW OS
US AS
VU
WS

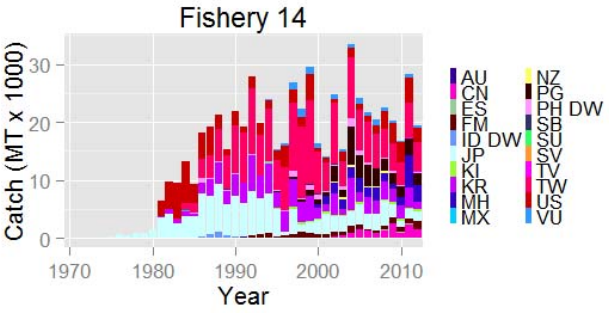

1
2
7
3
4
8
9
5
6
Google

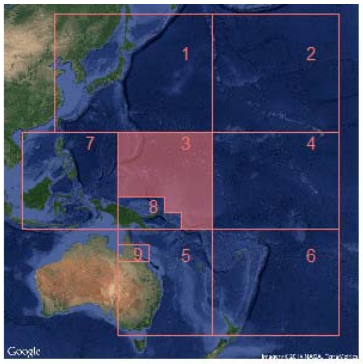

No. fish measured
15000
10000
5000
0
1970
1980
1990
2000
2010
Year
AS
BZ
CK
CN
FJ
JP
JP DW
KI
KR
KR DW
NC
NU
NZ
PF
SB
TO
TW DW
TW OS
US
VU
WS

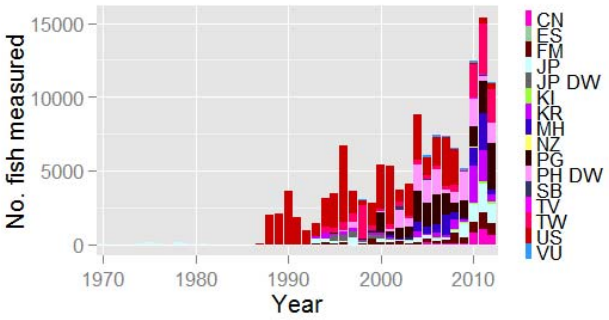

Median length (cm)
150
125
100
75
50
1970
1980
1990
2000
2010
Year
AS
BZ
CK
CN
FJ
JP
JP DW
KI
KR
KR DW
NC
NU
NZ
PF
SB
TO
TW DW
TW OS
US
VU
WS

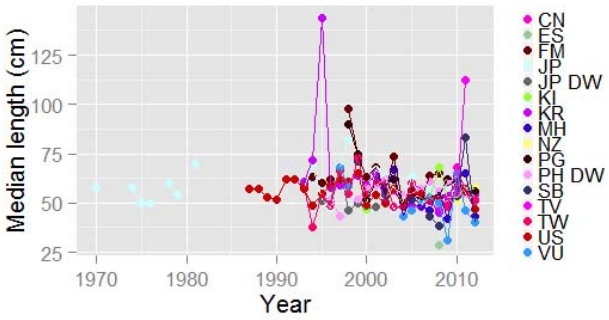

No. fish weighed
10000
7500
5000
2500
0
1970
1980
1990
2000
2010
Year
AS
CK
CN
FJ
JP
JP DW
NC
NU
NZ
PF
SB
TO
TW OS
VU
WS

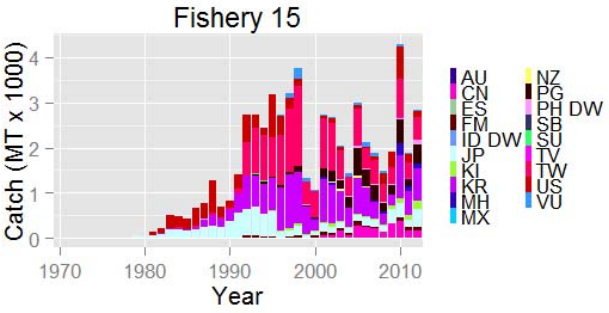

Median weight (kg)
70
60
50
40
30
20
1970
1980
1990
2000
2010
Year
AS
CK
CN
FJ
JP
JP DW
NC
NU
NZ
PF
SB
TO
TW OS
VU
WS

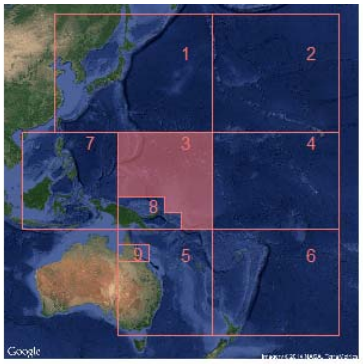

Fishery 14
Catch (MT x 1000)
0
10
20
30
1970
1980
1990
2000
2010
Year
AU
CN
ES
FM
ID DW
JP
KI
KR
MH
MX
NZ
PG
PH DW
SB
SU
SV
TV
TW
US
VU

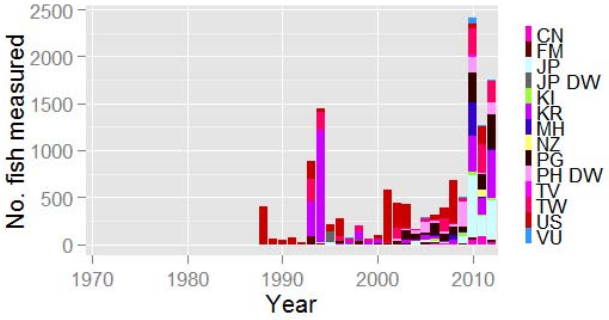

1
2
3
4
5
6
7
8
9
Google

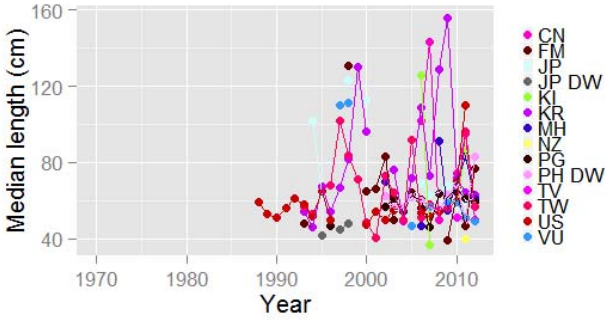

No. fish measured
0
5000
10000
15000
1970
1980
1990
2000
2010
Year
CN
ES
FM
JP
JP DW
KI
KR
MH
NZ
PG
PH DW
SB
TV
TW
US
VU

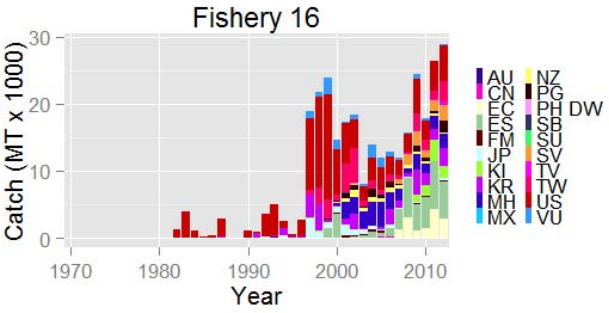

Median length (cm)
25
50
75
100
125
1970
1980
1990
2000
2010
Year
CN
ES
FM
JP
JP DW
KI
KR
MH
NZ
PG
PH DW
SB
TV
TW
US
VU

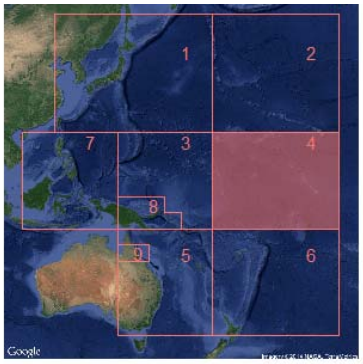

Fishery 15
Catch (MT x 1000)
0
1
2
3
4
1970
1980
1990
2000
2010
Year
AU
CN
ES
FM
ID DW
JP
KI
KR
MH
MX
NZ
PG
PH DW
SB
SU
TV
TW
US
VU

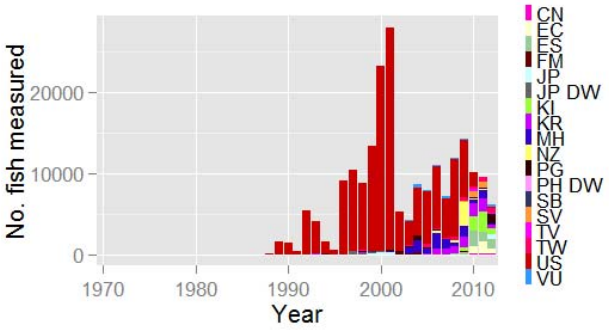

1
2
3
4
5
6
7
8
9

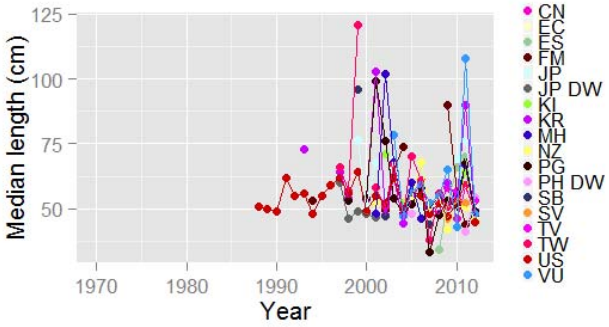

No. fish measured
0
500
1000
1500
2000
2500
1970
1980
1990
2000
2010
Year
CN
FM
JP
JP DW
KI
KR
MH
NZ
PG
PH DW
TV
TW
US
VU

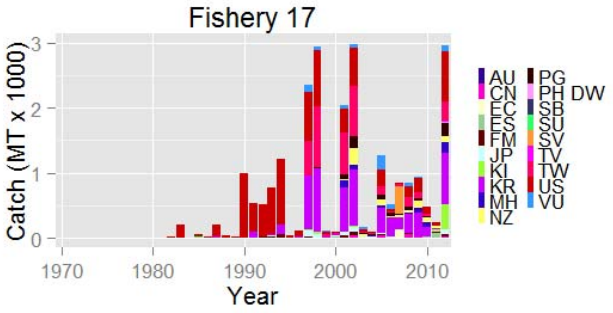

Median length (cm)
40
80
120
160
1970
1980
1990
2000
2010
Year
CN
FM
JP
JP DW
KI
KR
MH
NZ
PG
PH DW
TV
TW
US
VU

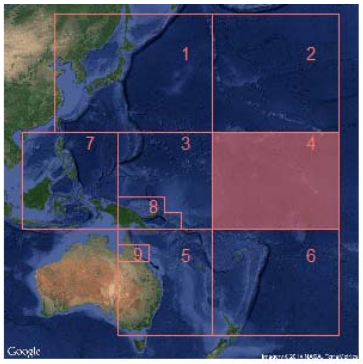

Fishery 16
Catch (MT x 1000)
30
20
10
0
1970
1980
1990
2000
2010
Year
AU
CN
EC
ES
FM
JP
KI
KR
MH
MX
NZ
PG
PH DW
SB
SU
SV
TV
TW
US
VU

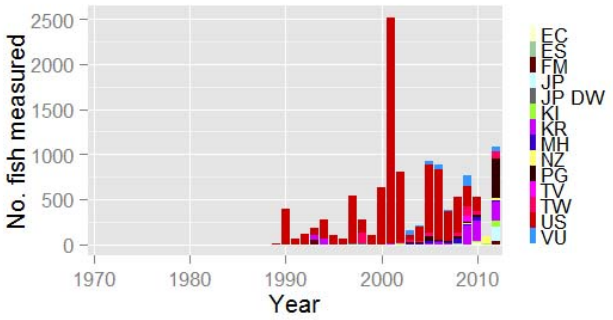

1
2
3
4
5
6
7
8
9
Google

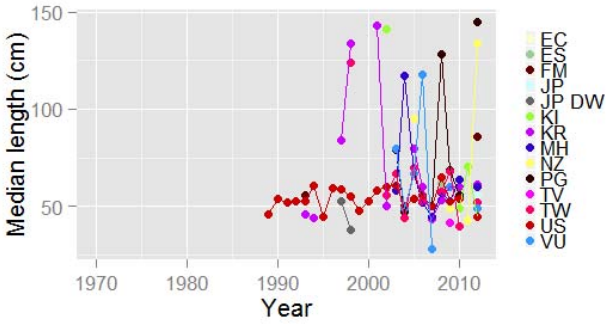

No. fish measured
20000
10000
0
1970
1980
1990
2000
2010
Year
CN
EC
ES
FM
JP
JP DW
KI
KR
MH
NZ
PG
PH DW
SB
SV
TV
TW
US
VU

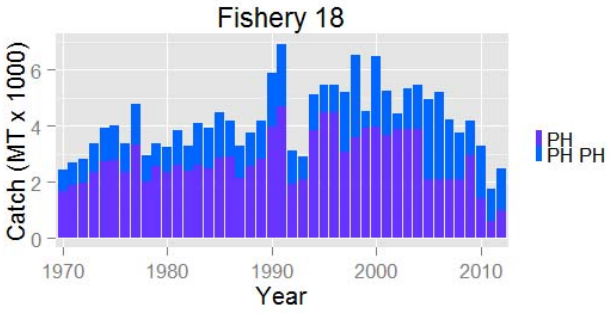

Median length (cm)
125
100
75
50
1970
1980
1990
2000
2010
Year
CN
EC
ES
FM
JP
JP DW
KI
KR
MH
NZ
PG
PH DW
SB
SV
TV
TW
US
VU

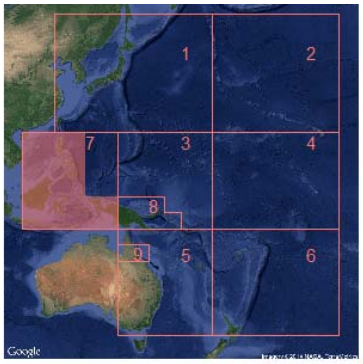

Fishery 17
Catch (MT x 1000)
0
1
2
3
1970
1980
1990
2000
2010
Year
AU
CN
EC
ES
FM
JP
KI
KR
MH
NZ
PG
PH DW
SB
SU
SV
TV
TW
US
VU

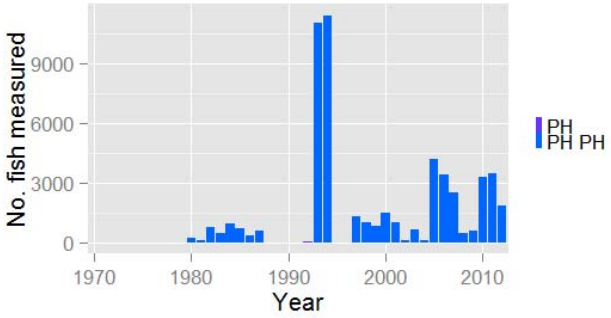

1
2
3
4
5
6
7
8
9
Google

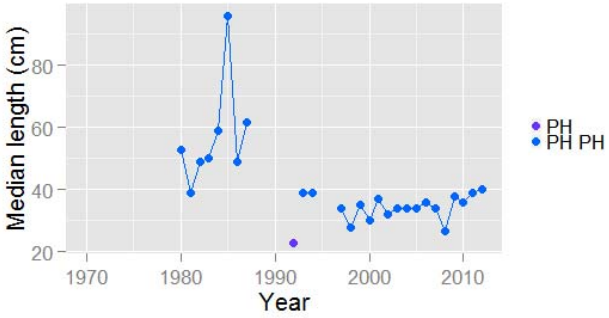

No. fish measured
0
500
1000
1500
2000
2500
1970
1980
1990
2000
2010
Year
EC
ES
FM
JP
JP DW
KI
KR
MH
NZ
PG
TV
TW
US
VU

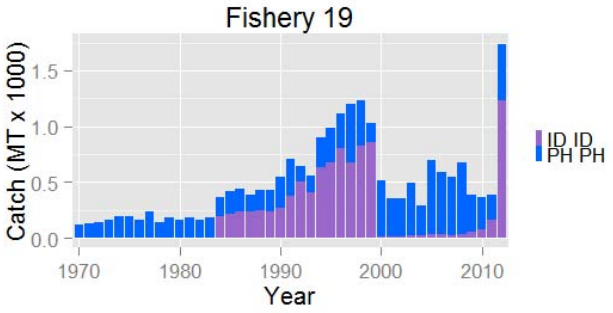

Median length (cm)
50
100
150
1970
1980
1990
2000
2010
Year
EC
ES
FM
JP
JP DW
KI
KR
MH
NZ
PG
TV
TW
US
VU

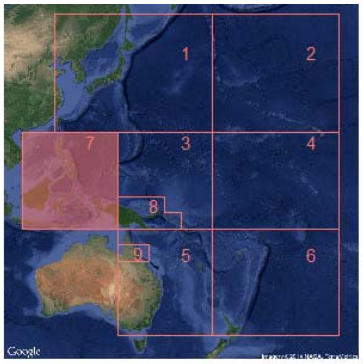

Fishery 18
Catch (MT x 1000)
0
2
4
6
1970
1980
1990
2000
2010
Year
PH
PH PH

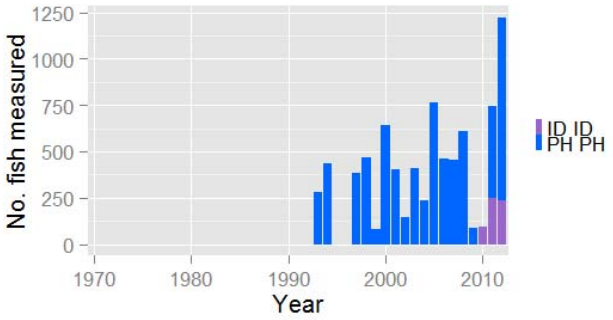

1
2
3
4
5
6
7
8
9
Google

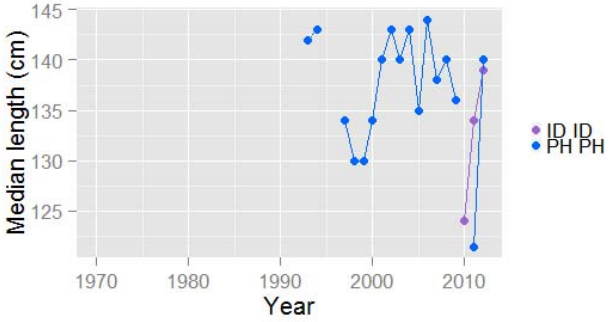

No. fish measured
0
3000
6000
9000
1970
1980
1990
2000
2010
Year
PH
PH PH

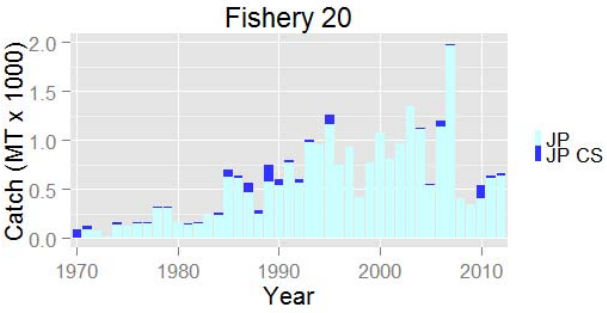

Median length (cm)
20
40
60
80
1970
1980
1990
2000
2010
Year
PH
PH PH

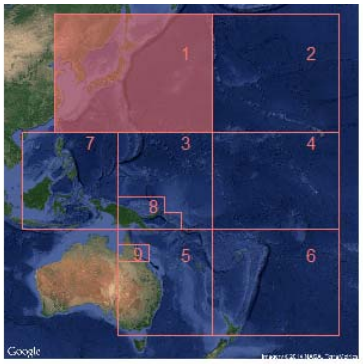

Fishery 19
Catch (MT x 1000)
1.5
1.0
0.5
0.0
1970
1980
1990
2000
2010
Year
ID ID
PH PH

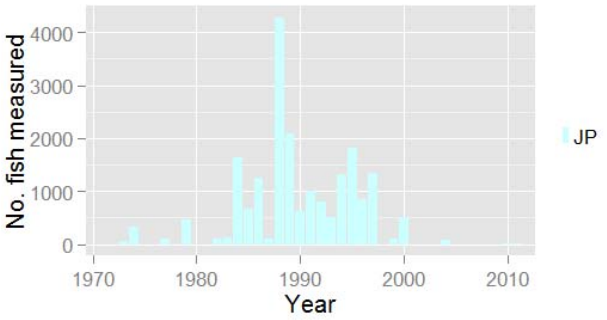

1
2
7
3
4
8
9
5
6
Google

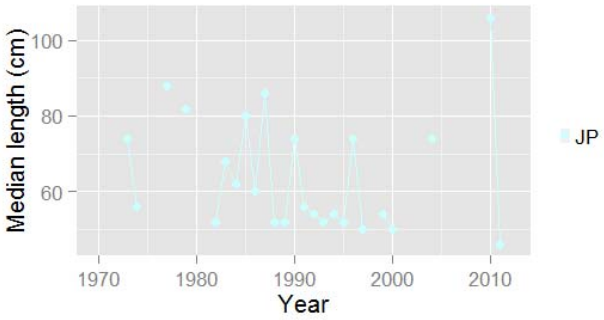

No. fish measured
1250
1000
750
500
250
0
1970
1980
1990
2000
2010
Year
ID ID
PH PH

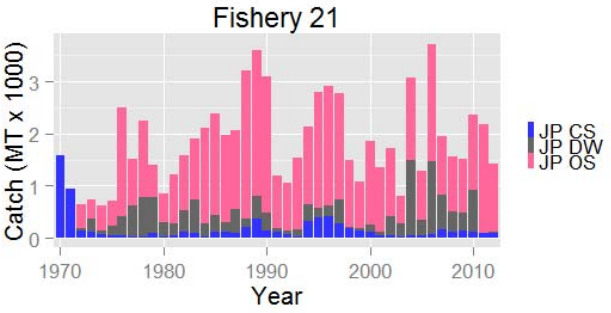

Median length (cm)
145
140
135
130
125
1970
1980
1990
2000
2010
Year
ID ID
PH PH

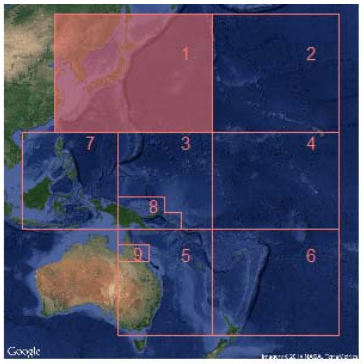

Fishery 20
Catch (MT x 1000)
2.0
1.5
1.0
0.5
0.0
1970
1980
1990
2000
2010
Year
JP
JP CS

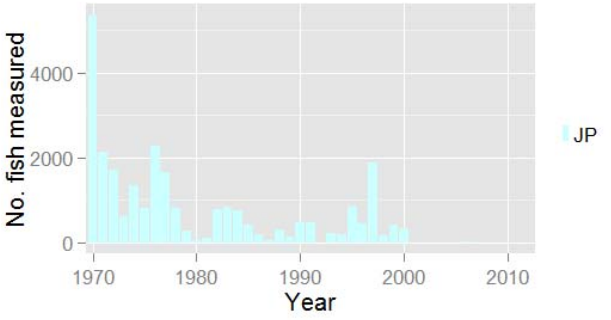

1
2
7
3
4
8
9
5
6
Google

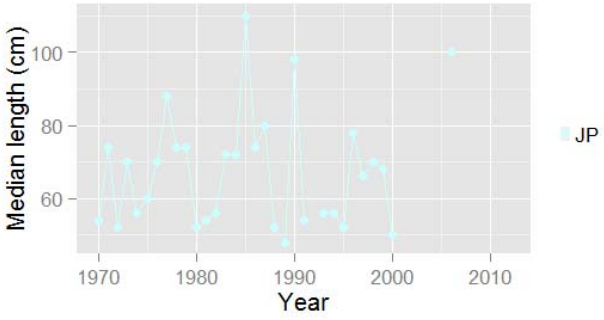

No. fish measured
4000
3000
2000
1000
0
1970
1980
1990
2000
2010
Year
JP

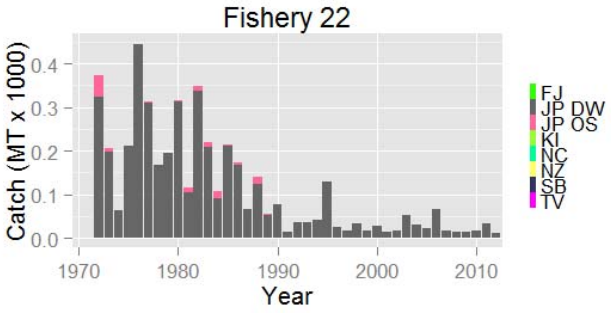

Median length (cm)
100
80
60
1970
1980
1990
2000
2010
Year
JP

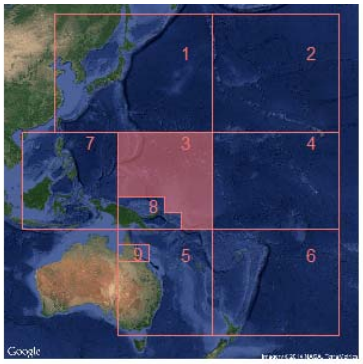

Fishery 21
Catch (MT x 1000)
0
1
2
3
1970
1980
1990
2000
2010
Year
JP CS
JP DW
JP OS

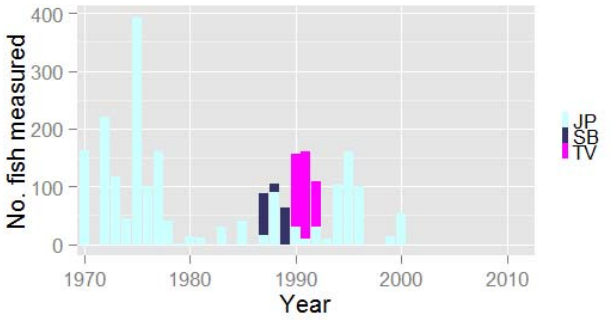

1
2
7
3
4
8
9
5
6
Google

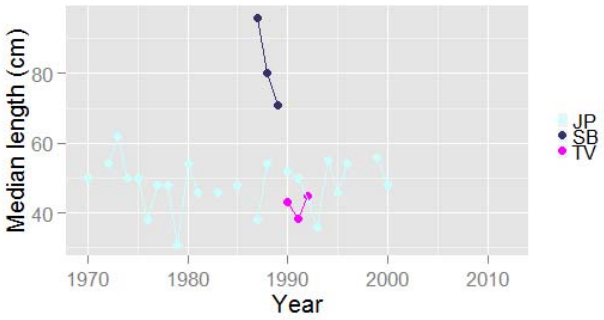

No. fish measured
0
2000
4000
1970
1980
1990
2000
2010
Year
JP

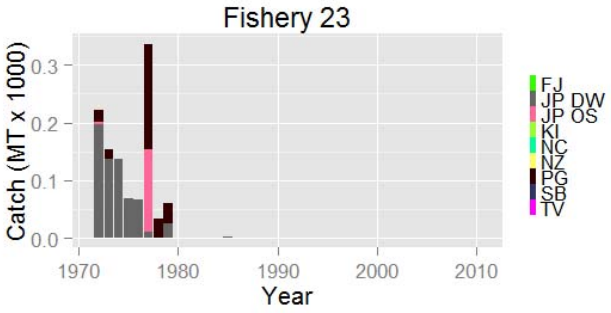

Median length (cm)
60
80
100
1970
1980
1990
2000
2010
Year
JP

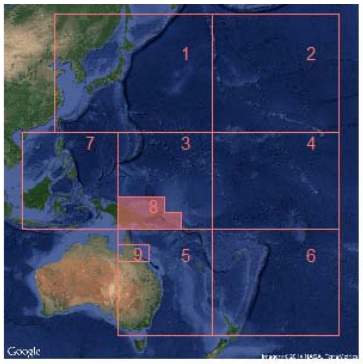

Fishery 22
Catch (MT x 1000)
0.0
0.1
0.2
0.3
0.4
1970
1980
1990
2000
2010
Year
FJ
JP DW
JP OS
KI
NC
NZ
SB
TV

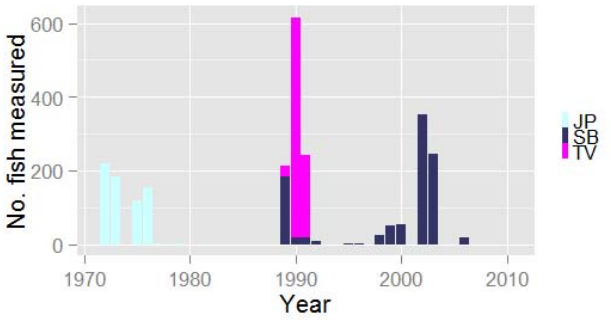

1
2
7
3
4
8
9
5
6
Google

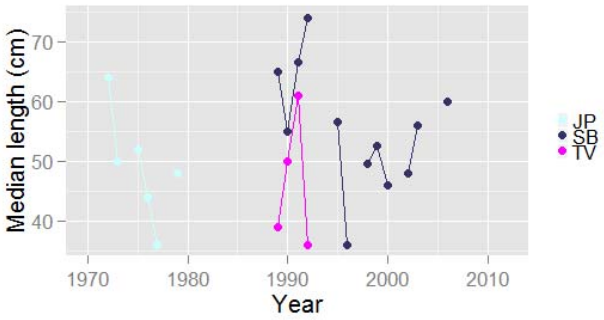

No. fish measured
0
100
200
300
400
1970
1980
1990
2000
2010
Year
JP
SB
TV

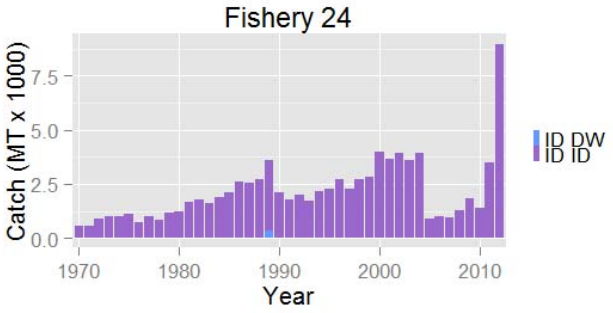

Median length (cm)
40
60
80
1970
1980
1990
2000
2010
Year
JP
SB
TV

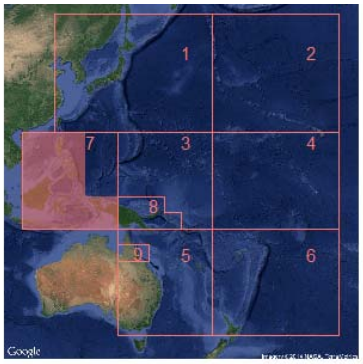

Fishery 23
Catch (MT x 1000)
0.0
0.1
0.2
0.3
1970
1980
1990
2000
2010
Year
FJ
JP DW
JP OS
KI
NC
NZ
PG
SB
TV

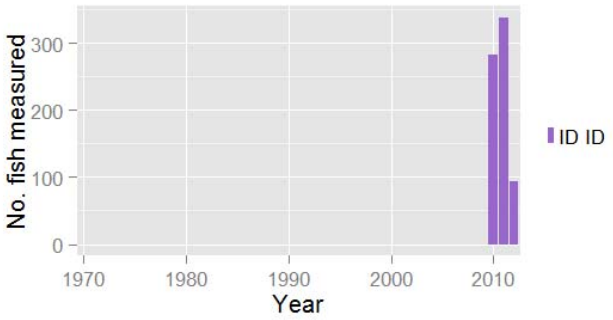

1
2
7
3
4
8
9
5
6
Google

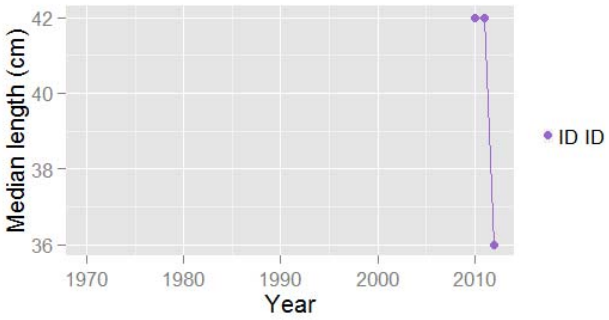

No. fish measured
0
200
400
600
1970
1980
1990
2000
2010
Year
JP
SB
TV

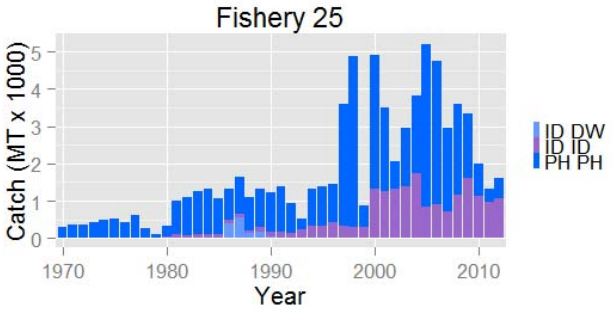

Median length (cm)
40
50
60
70
1970
1980
1990
2000
2010
Year
JP
SB
TV

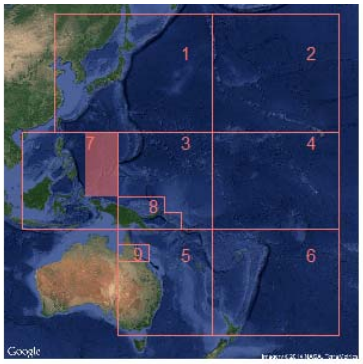

Fishery 24
Catch (MT x 1000)
7.5
5.0
2.5
0.0
1970
1980
1990
2000
2010
Year
ID DW
ID ID

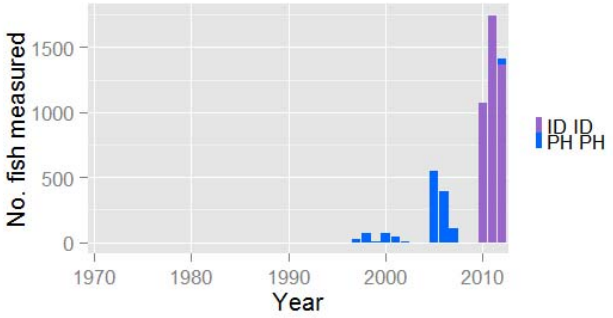

1
2
7
3
4
8
9
5
6
Google

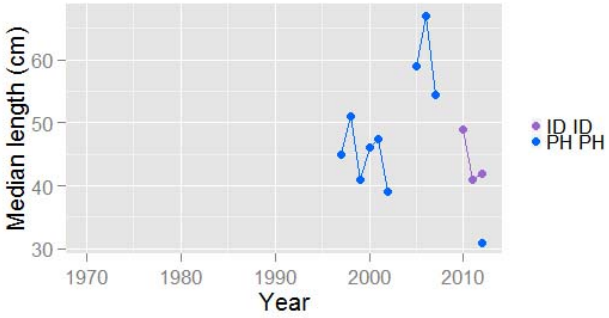

No. fish measured
300
200
100
0
1970
1980
1990
2000
2010
Year
ID ID

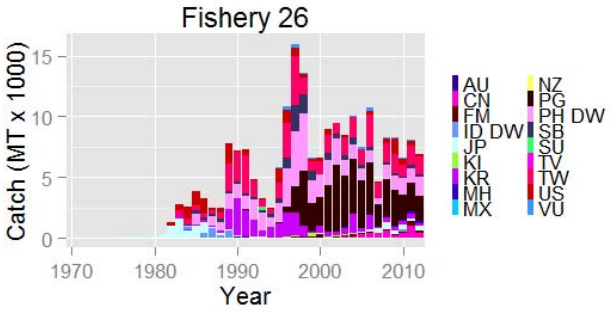

Median length (cm)
42
40
38
36
1970
1980
1990
2000
2010
Year
ID ID

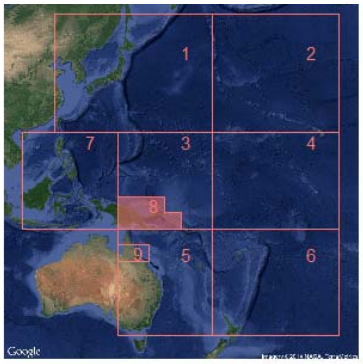

Fishery 25
Catch (MT x 1000)
0
1
2
3
4
5
1970
1980
1990
2000
2010
Year
ID DW
ID ID
PH PH

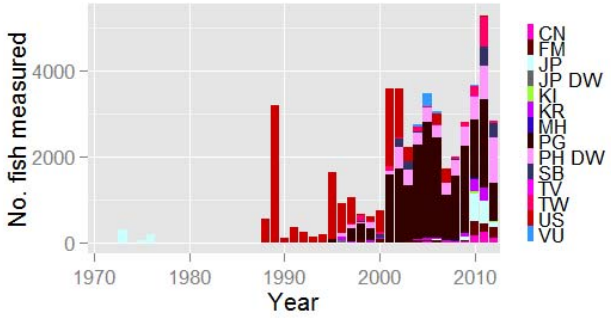

1
2
3
4
5
6
7
8
9
Google

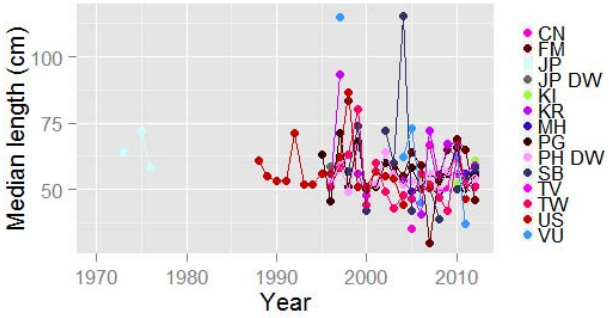

No. fish measured
0
500
1000
1500
1970
1980
1990
2000
2010
Year
ID ID
PH PH

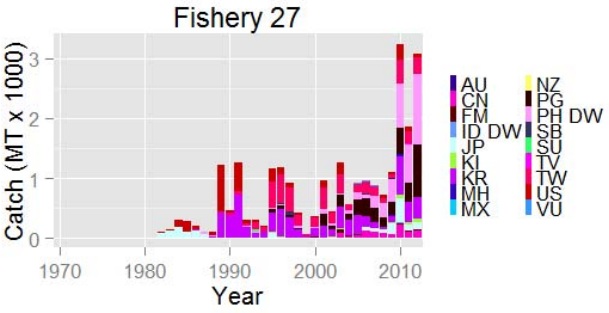

Median length (cm)
30
40
50
60
1970
1980
1990
2000
2010
Year
ID ID
PH PH

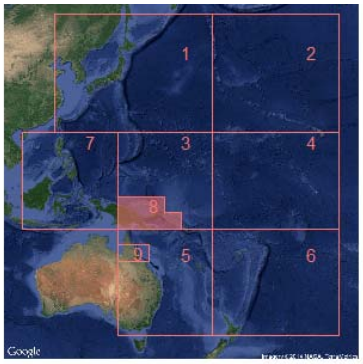

Fishery 26
Catch (MT x 1000)
15
10
5
0
1970
1980
1990
2000
2010
Year
AU
CN
FM
ID DW
JP
KI
KR
MH
MX
NZ
PG
PH DW
SB
SU
TV
TW
US
VU

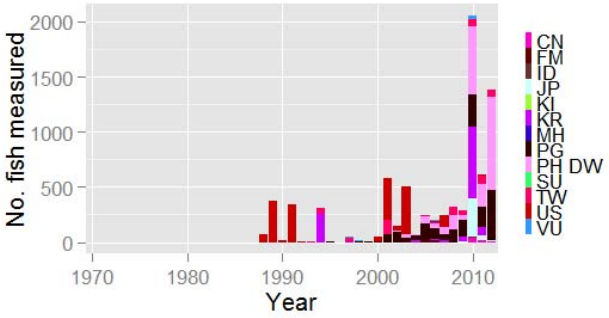

1
2
7
3
4
8
9
5
6
Google

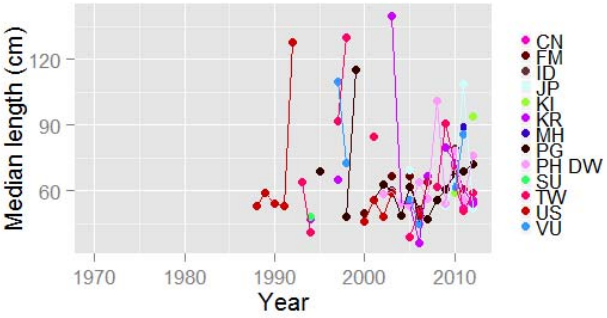

No. fish measured
4000
2000
0
1970
1980
1990
2000
2010
Year
CN
FM
JP
JP DW
KI
KR
MH
PG
PH DW
SB
TV
TW
US
VU

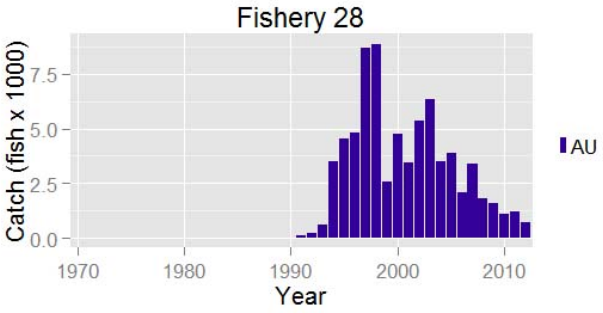

Median length (cm)
100
75
50
1970
1980
1990
2000
2010
Year
CN
FM
JP
JP DW
KI
KR
MH
PG
PH DW
SB
TV
TW
US
VU

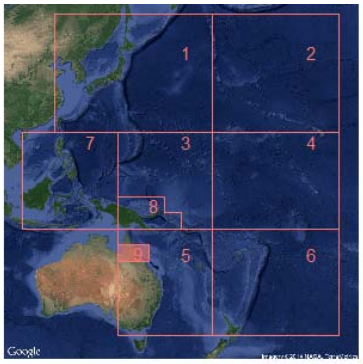

Fishery 27
Catch (MT x 1000)
0
1
2
3
1970
1980
1990
2000
2010
Year
AU
CN
FM
ID DW
JP
KI
KR
MH
MX
NZ
PG
PH DW
SB
SU
TV
TW
US
VU

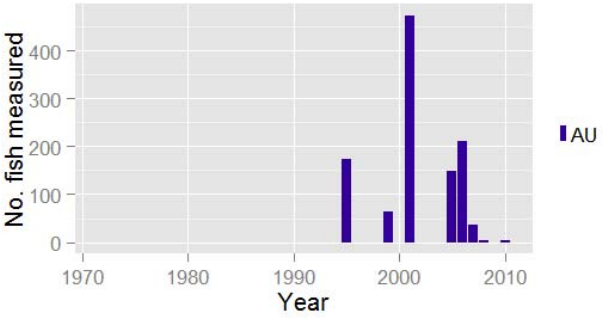

1
2
3
4
5
6
7
8
9
Google

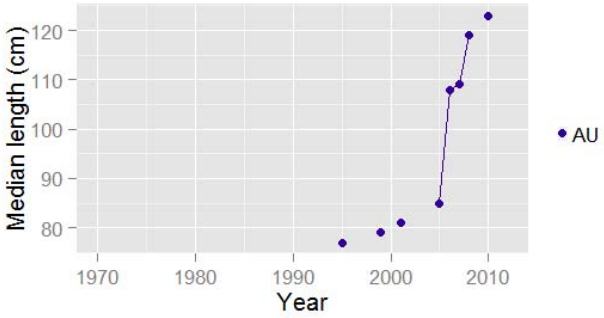

No. fish measured
0
500
1000
1500
2000
1970
1980
1990
2000
2010
Year
CN
FM
ID
JP
KI
KR
MH
PG
PH DW
SU
TW
US
VU

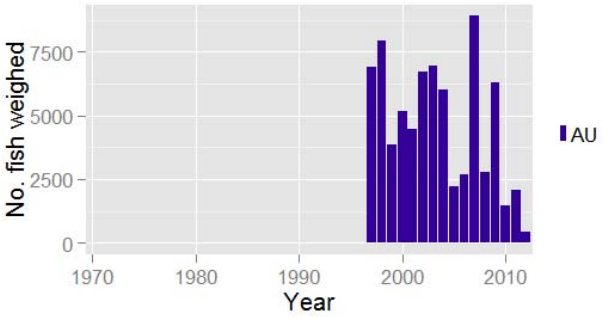

Median length (cm)
60
90
120
1970
1980
1990
2000
2010
Year
CN
FM
ID
JP
KI
KR
MH
PG
PH DW
SU
TW
US
VU

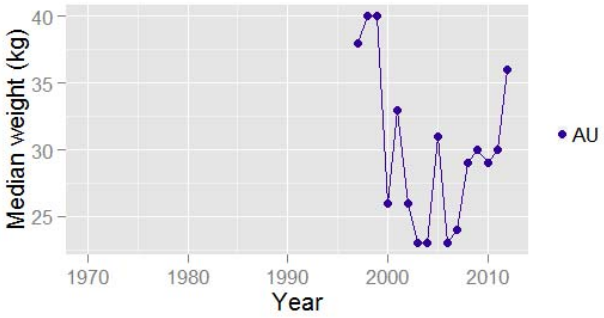

Fishery 28
Catch (fish x 1000)
7.5
5.0
2.5
0.0
1970
1980
1990
2000
2010
Year
AU

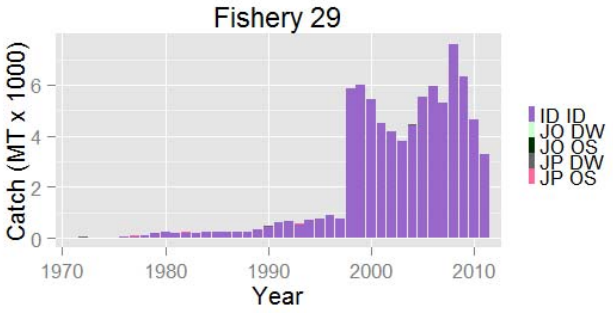

1
2
7
3
4
8
9
5
6
Google

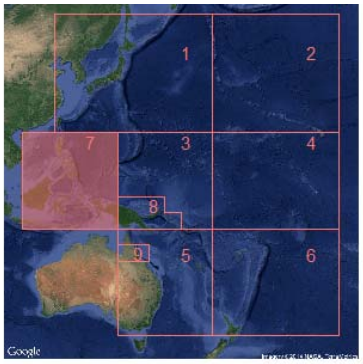

No. fish measured
400
300
200
100
0
1970
1980
1990
2000
2010
Year
AU

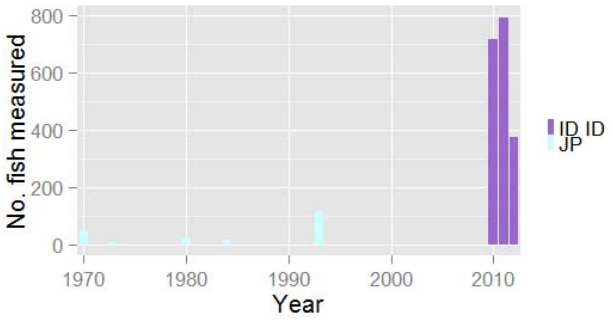

Median length (cm)
120
110
100
90
80
1970
1980
1990
2000
2010
Year
AU

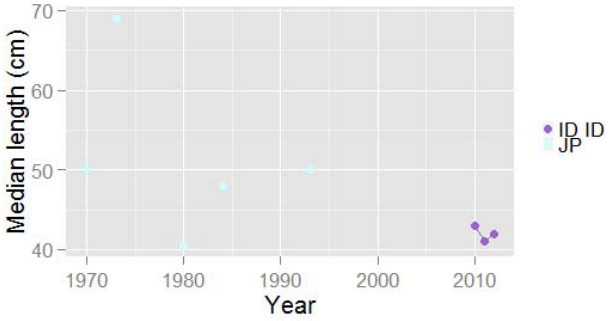

No. fish weighed
7500
5000
2500
0
1970
1980
1990
2000
2010
Year
AU

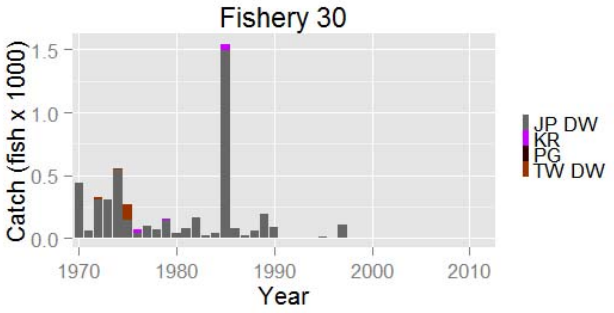

Median weight (kg)
40
35
30
25
1970
1980
1990
2000
2010
Year
AU

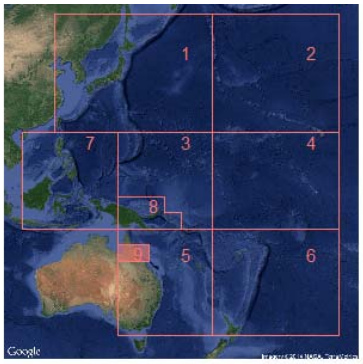

Fishery 29
Catch (MT x 1000)
0
2
4
6
1970
1980
1990
2000
2010
Year
ID ID
JO DW
JO OS
JP DW
JP OS

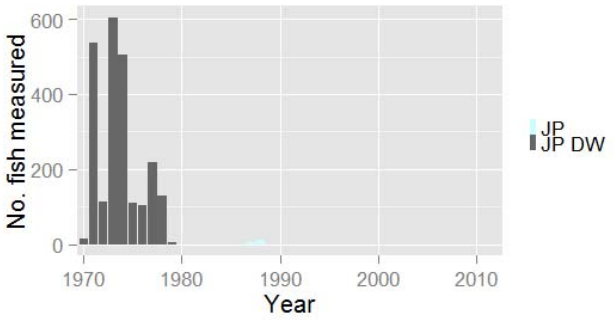

1
2
7
3
4
8
9
5
6
Google

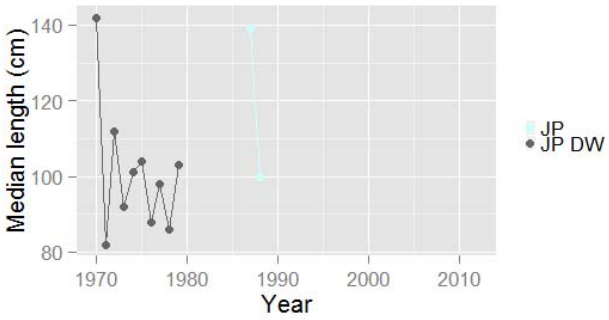

No. fish measured
0
200
400
600
800
1970
1980
1990
2000
2010
Year
ID ID
JP

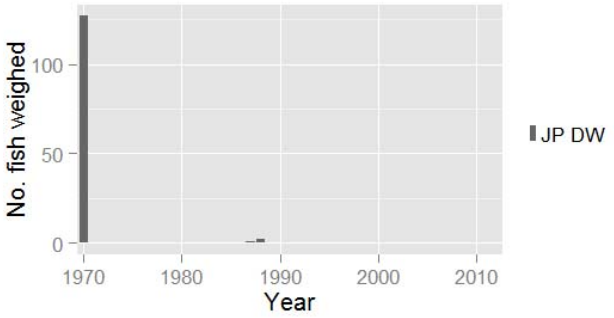

Median length (cm)
40
50
60
70
1970
1980
1990
2000
2010
Year
ID ID
JP

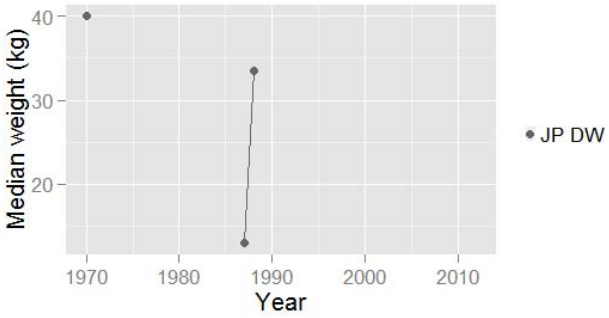

Fishery 30
Catch (fish x 1000)
1.5
1.0
0.5
0.0
1970
1980
1990
2000
2010
Year
JP DW
KR
PG
TW DW

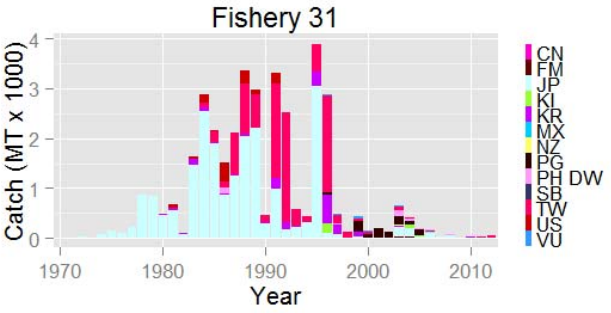

1
2
7
3
4
8
9
5
6
Google

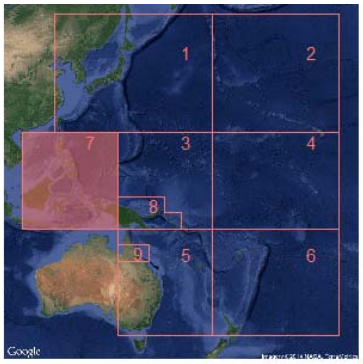

No. fish measured
600
400
200
0
1970
1980
1990
2000
2010
Year
JP
JP DW

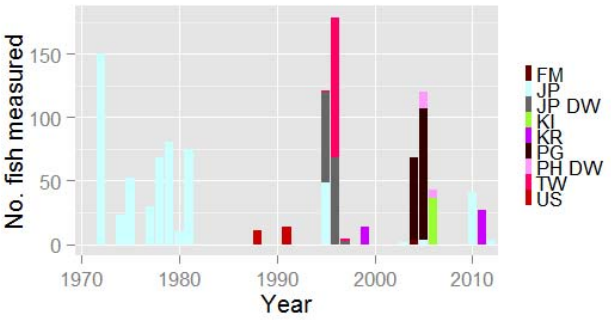

Median length (cm)
140
120
100
80
1970
1980
1990
2000
2010
Year
JP
JP DW

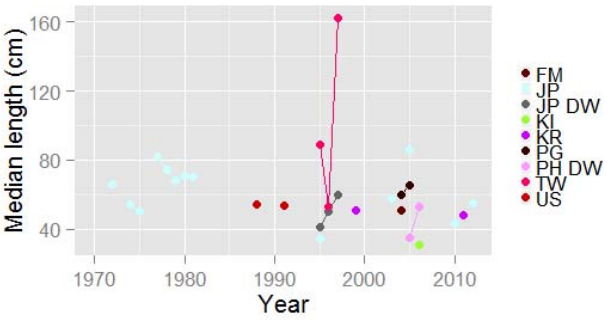

No. fish weighed
100
50
0
1970
1980
1990
2000
2010
Year
JP DW

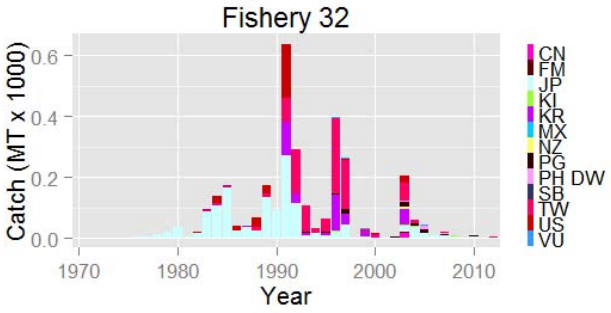

Median weight (kg)
40
30
20
1970
1980
1990
2000
2010
Year
JP DW

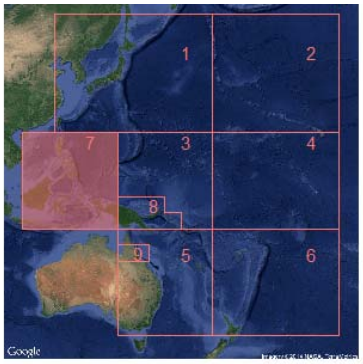

Fishery 31
Catch (MT x 1000)
Year
CN
FM
JP
KI
KR
MX
NZ
PG
PH DW
SB
TW
US
VU

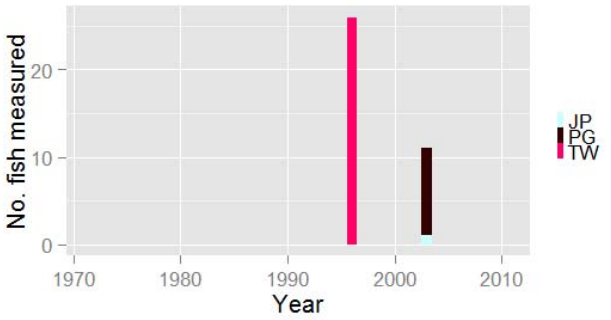

1
2
3
4
5
6
7
8
9

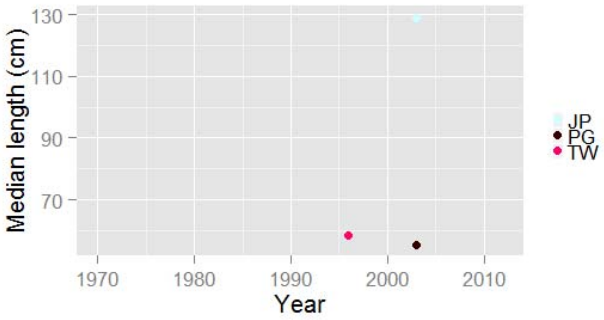

No. fish measured
Year
FM
JP
JP DW
KI
KR
PG
PH DW
TW
US

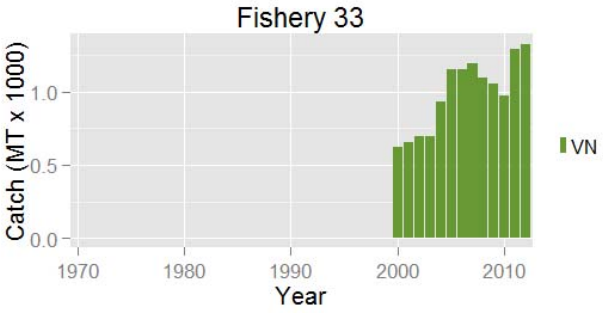

Median length (cm)
Year
FM
JP
JP DW
KI
KR
PG
PH DW
TW
US

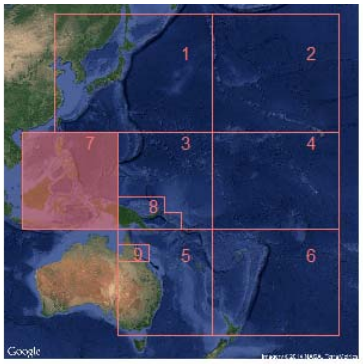

Fishery 32
Catch (MT x 1000)
0.0
0.2
0.4
0.6
1970
1980
1990
2000
2010
Year
CN
FM
JP
KI
KR
MX
NZ
PG
PH DW
SB
TW
US
VU


1
2
3
4
5
6
7
8
9
Google

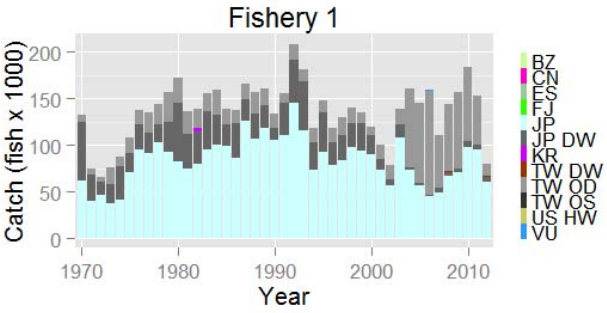

No. fish measured
0
10
20
1970
1980
1990
2000
2010
Year
JP
PG
TW

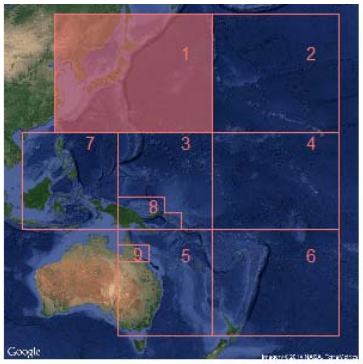

Median length (cm)
70
90
110
130
1970
1980
1990
2000
2010
Year
JP
PG
TW

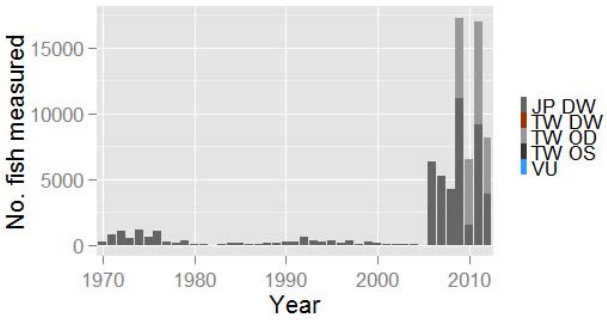

Fishery 33
Catch (MT x 1000)
1.0
0.5
0.0
1970
1980
1990
2000
2010
Year
VN

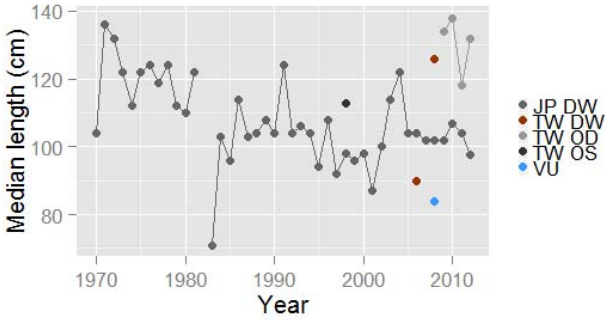

1
2
7
3
4
8
9
5
6
Google

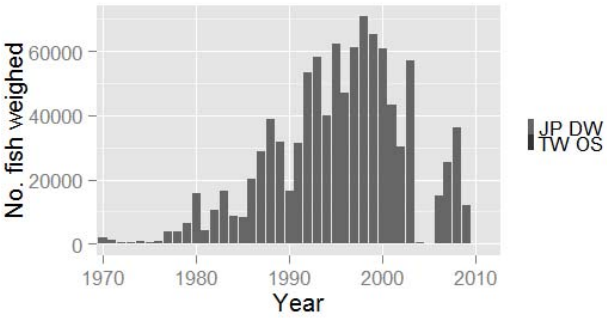
9.2. YFT fishery definitions plots

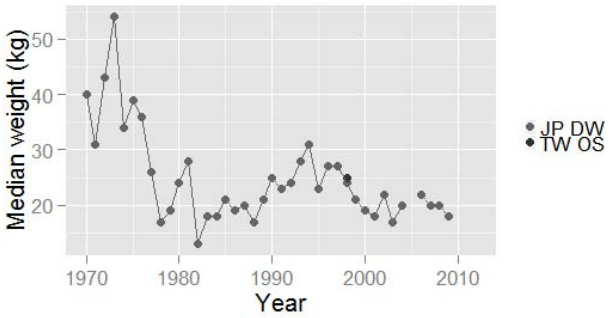


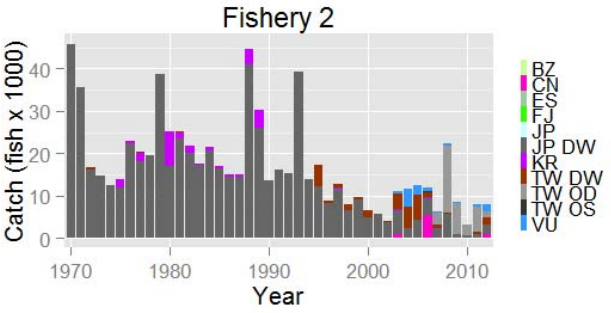


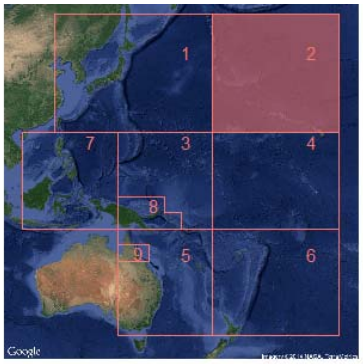


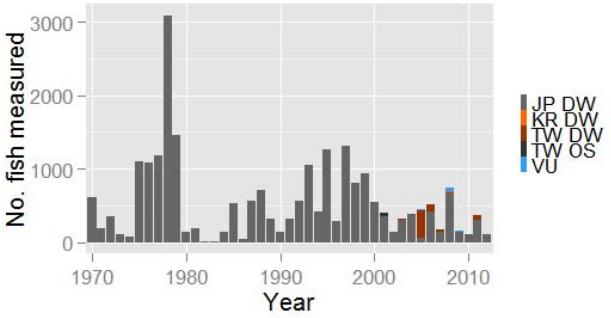


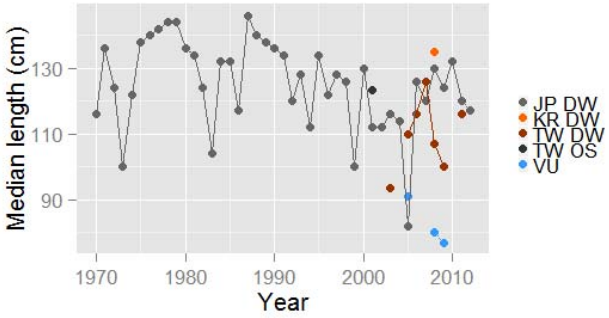


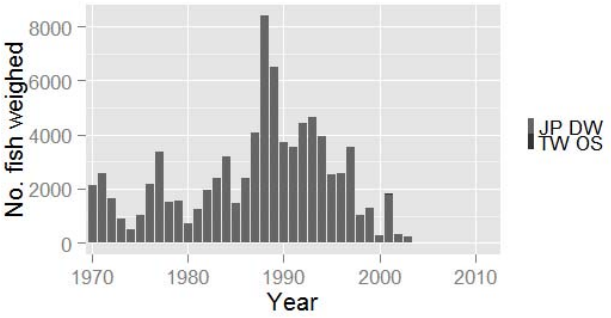


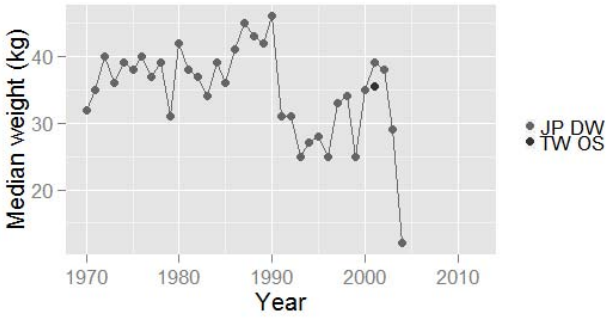

Fishery 2
Catch (fish x 1000)
0
10
20
30
40
1970
1980
1990
2000
2010
Year
BZ
CN
ES
FJ
JP
JP DW
KR
TW DW
TW OD
TW OS
VU

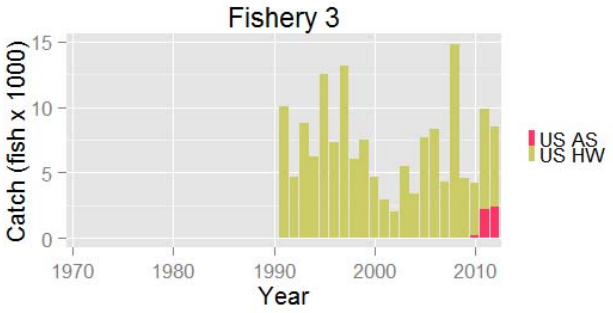

1
2
3
4
5
6
7
8
9
Google

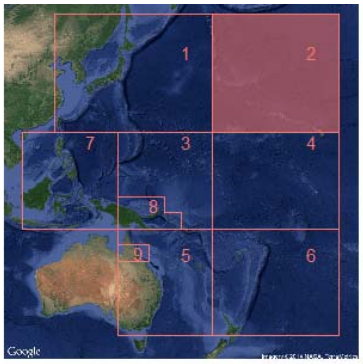

No. fish measured
0
1000
2000
3000
1970
1980
1990
2000
2010
Year
JP DW
KR DW
TW DW
TW OS
VU

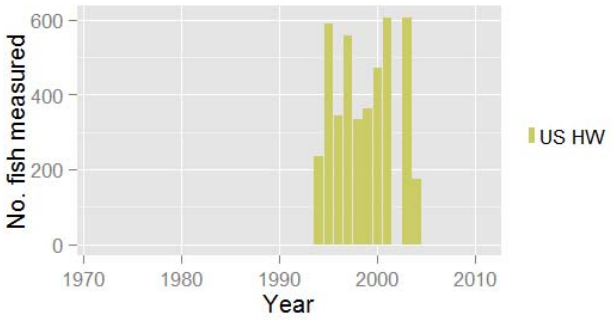

Median length (cm)
90
110
130
1970
1980
1990
2000
2010
Year
JP DW
KR DW
TW DW
TW OS
VU

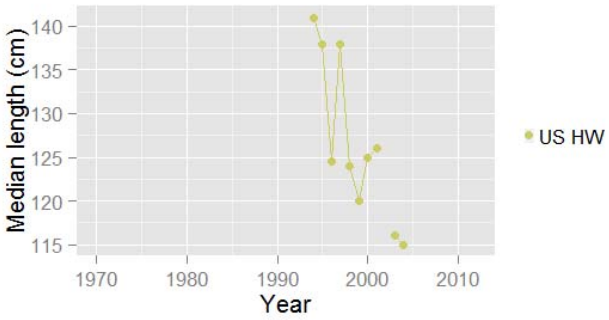

No. fish weighed
0
2000
4000
6000
8000
1970
1980
1990
2000
2010
Year
JP DW
TW OS

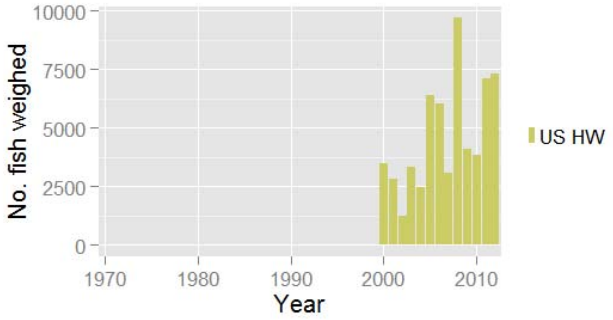

Median weight (kg)
20
30
40
1970
1980
1990
2000
2010
Year
JP DW
TW OS

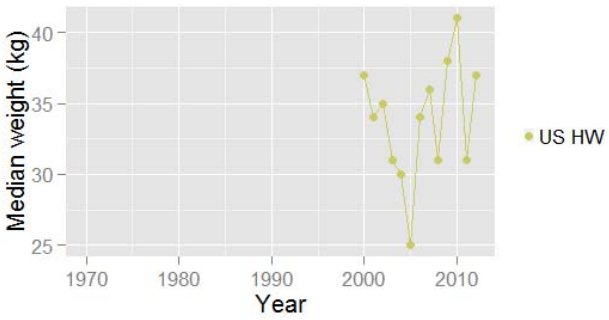

Fishery 3
Catch (fish x 1000)
15
10
5
0
1970
1980
1990
2000
2010
Year
US AS
US HW

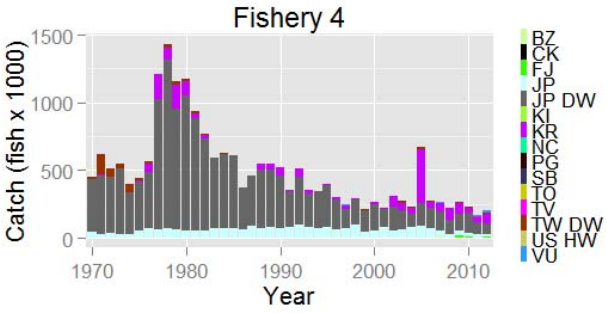

1
2
7
3
4
8
9
5
6
Google

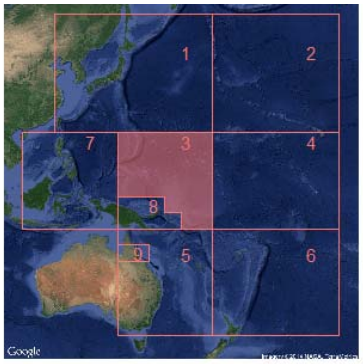

No. fish measured
600
400
200
0
1970
1980
1990
2000
2010
Year
US HW

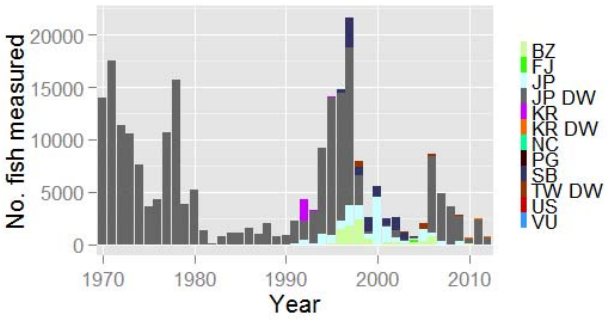

Median length (cm)
140
135
130
125
120
115
1970
1980
1990
2000
2010
Year
US HW

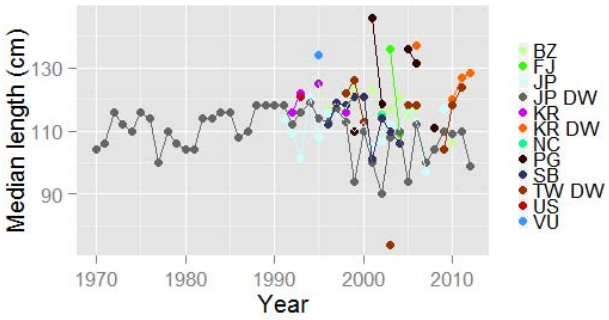

No. fish weighed
10000
7500
5000
2500
0
1970
1980
1990
2000
2010
Year
US HW

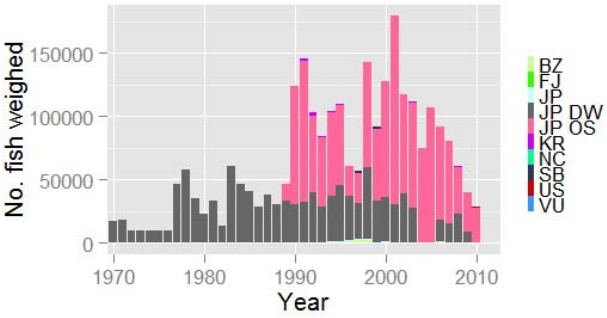

Median weight (kg)
40
35
30
25
1970
1980
1990
2000
2010
Year
US HW

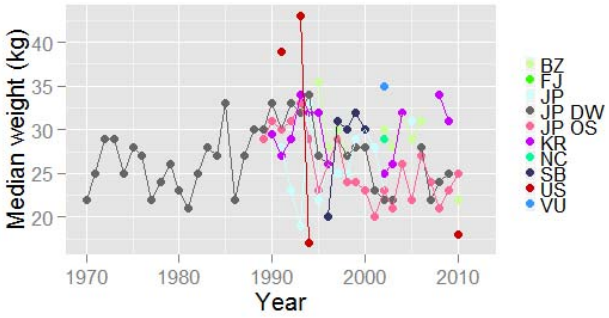

Fishery 4
Catch (fish x 1000)
1500
1000
500
0
1970
1980
1990
2000
2010
Year
BZ
CK
FJ
JP
JP DW
KI
KR
NC
PG
SB
TO
TV
TW DW
US HW
VU

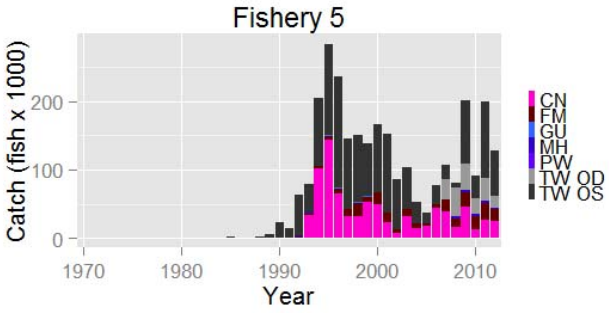

1
2
7
3
4
8
9
5
6
Google

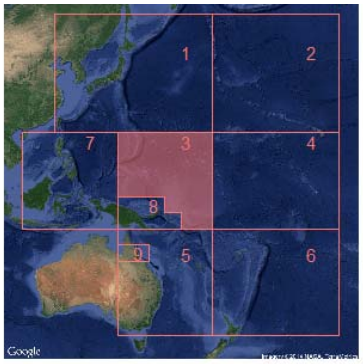

No. fish measured
20000
15000
10000
5000
0
1970
1980
1990
2000
2010
Year
BZ
FJ
JP
JP DW
KR
KR DW
NC
PG
SB
TW DW
US
VU

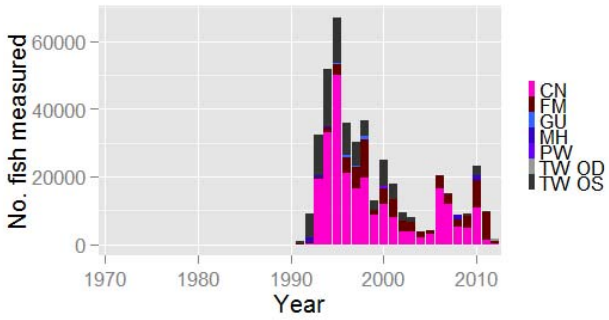

Median length (cm)
130
110
90
1970
1980
1990
2000
2010
Year
BZ
FJ
JP
JP DW
KR
KR DW
NC
PG
SB
TW DW
US
VU

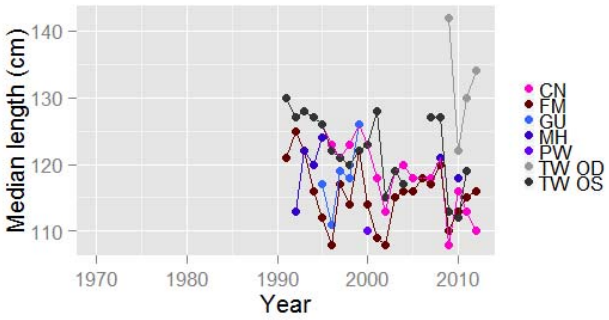

No. fish weighed
150000
100000
50000
0
1970
1980
1990
2000
2010
Year
BZ
FJ
JP
JP DW
JP OS
KR
NC
SB
US
VU

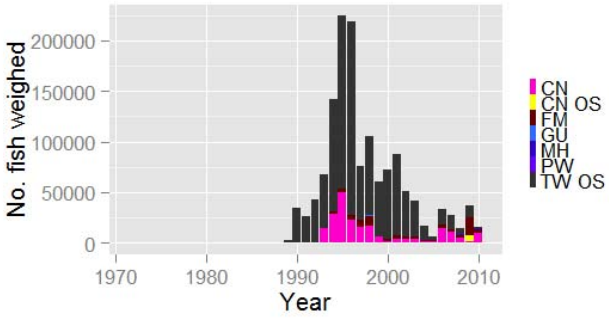

Median weight (kg)
40
35
30
25
20
1970
1980
1990
2000
2010
Year
BZ
FJ
JP
JP DW
JP OS
KR
NC
SB
US
VU

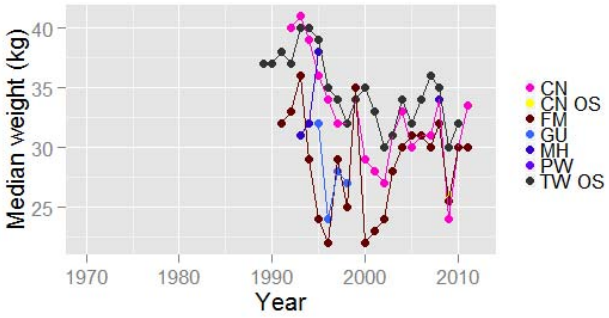

Fishery 5
Catch (fish x 1000)
0
100
200
1970
1980
1990
2000
2010
Year
CN
FM
GU
MH
PW
TW OD
TW OS

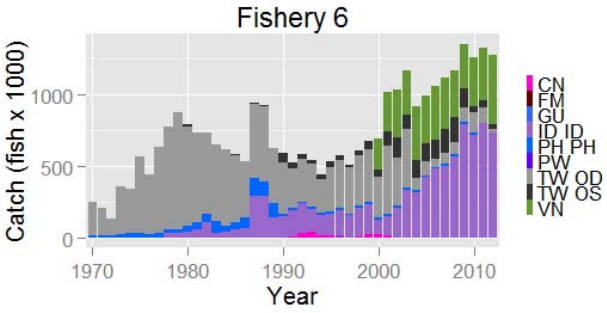

1
2
3
4
5
6
7
8
9
Google

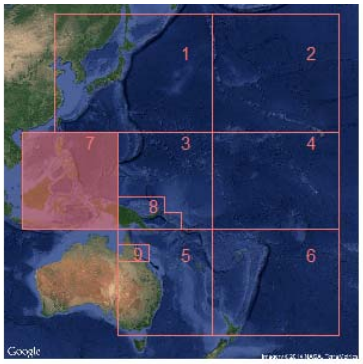

No. fish measured
0
20000
40000
60000
1970
1980
1990
2000
2010
Year
CN
FM
GU
MH
PW
TW OD
TW OS

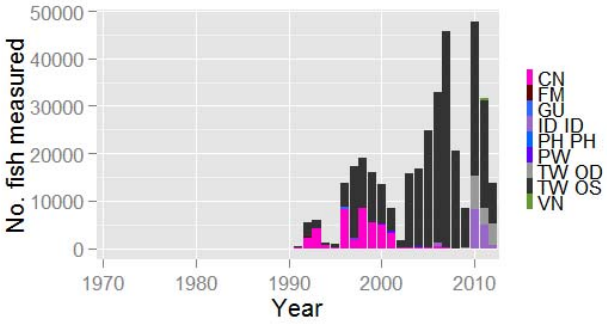

Median length (cm)
110
120
130
140
1970
1980
1990
2000
2010
Year
CN
FM
GU
MH
PW
TW OD
TW OS

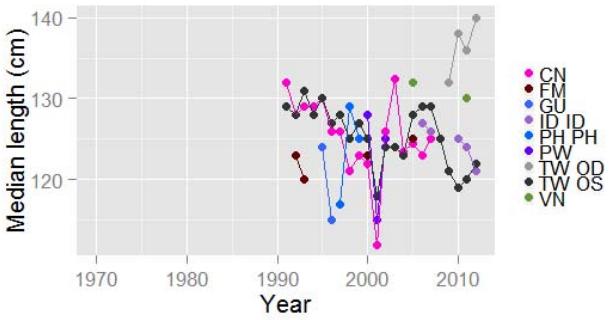

No. fish weighed
0
50000
100000
150000
200000
1970
1980
1990
2000
2010
Year
CN
CN OS
FM
GU
MH
PW
TW OS

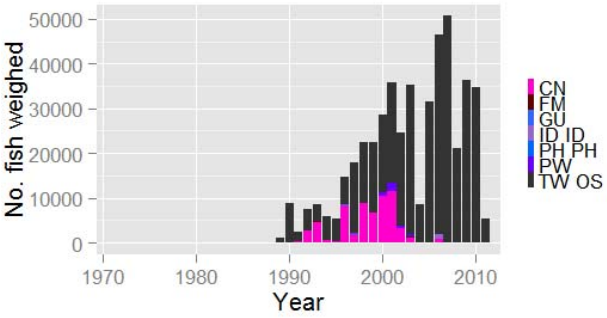

Median weight (kg)
25
30
35
40
1970
1980
1990
2000
2010
Year
CN
CN OS
FM
GU
MH
PW
TW OS

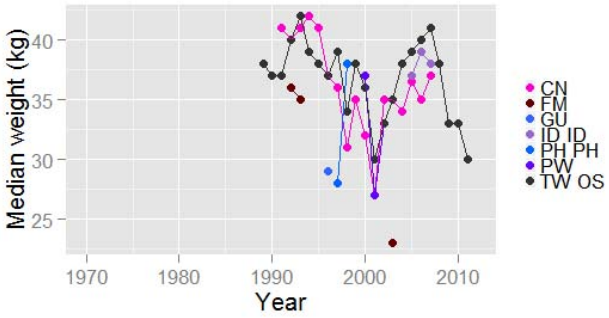

Fishery 6
Catch (fish x 1000)
0
500
1000
1970
1980
1990
2000
2010
Year
CN
FM
GU
ID ID
PH PH
PW
TW OD
TW OS
VN

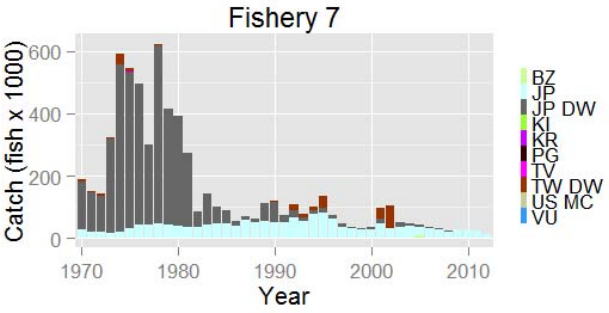

1
2
3
4
5
6
7
8
9
Google

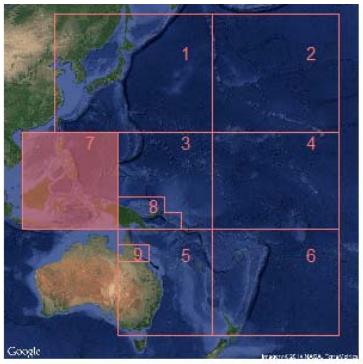

No. fish measured
0
10000
20000
30000
40000
50000
1970
1980
1990
2000
2010
Year
CN
FM
GU
ID ID
PH PH
PW
TW OD
TW OS
VN

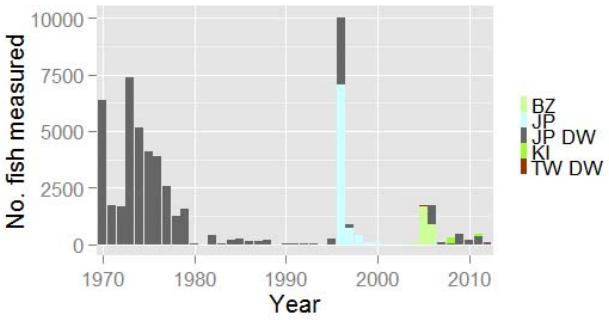

Median length (cm)
120
130
140
1970
1980
1990
2000
2010
Year
CN
FM
GU
ID ID
PH PH
PW
TW OD
TW OS
VN

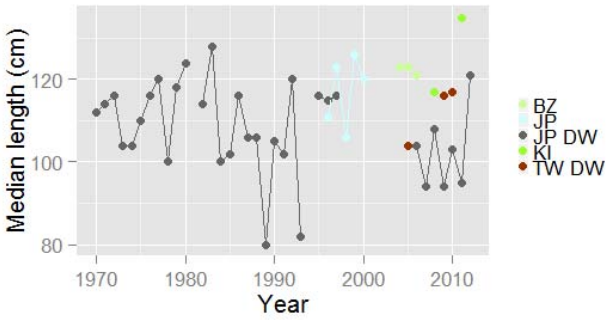

No. fish weighed
0
10000
20000
30000
40000
50000
1970
1980
1990
2000
2010
Year
CN
FM
GU
ID ID
PH PH
PW
TW OS

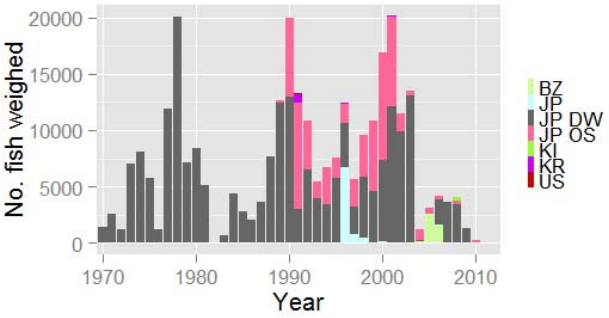

Median weight (kg)
25
30
35
40
1970
1980
1990
2000
2010
Year
CN
FM
GU
ID ID
PH PH
PW
TW OS

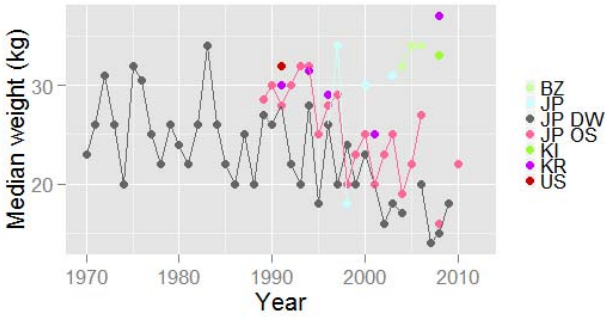

Fishery 7
Catch (fish x 1000)
600
400
200
0
1970
1980
1990
2000
2010
Year
BZ
JP
JP DW
KI
KR
PG
TV
TW DW
US MC
VU

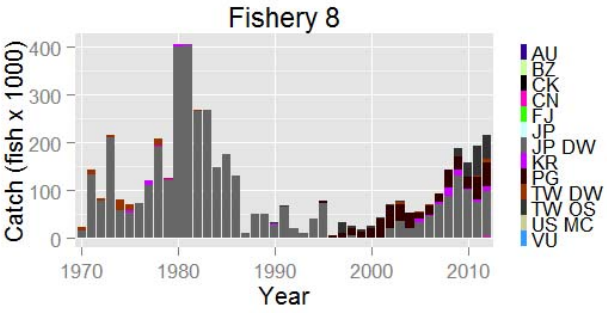

1
2
7
3
4
8
9
5
6
Google

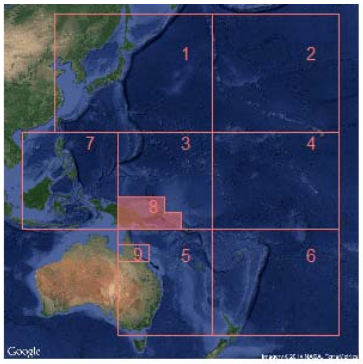

No. fish measured
10000
7500
5000
2500
0
1970
1980
1990
2000
2010
Year
BZ
JP
JP DW
KI
TW DW

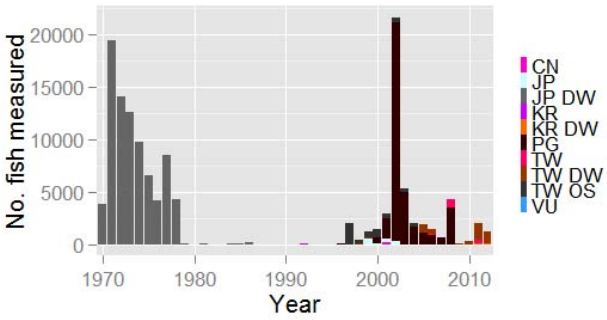

Median length (cm)
120
100
80
1970
1980
1990
2000
2010
Year
BZ
JP
JP DW
KI
TW DW

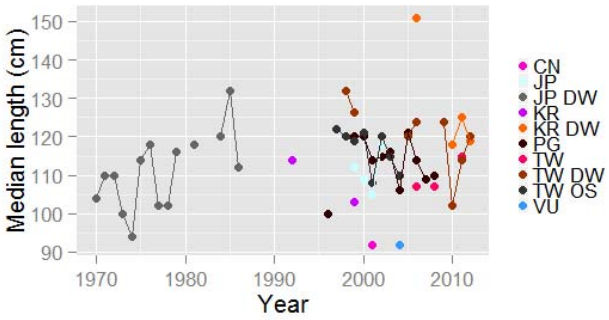

No. fish weighed
20000
15000
10000
5000
0
1970
1980
1990
2000
2010
Year
BZ
JP
JP DW
JP OS
KI
KR
US

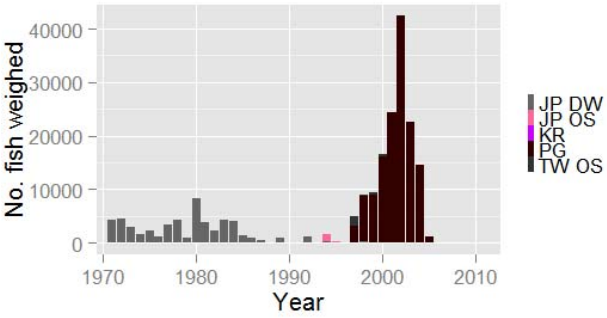

Median weight (kg)
30
20
1970
1980
1990
2000
2010
Year
BZ
JP
JP DW
JP OS
KI
KR
US

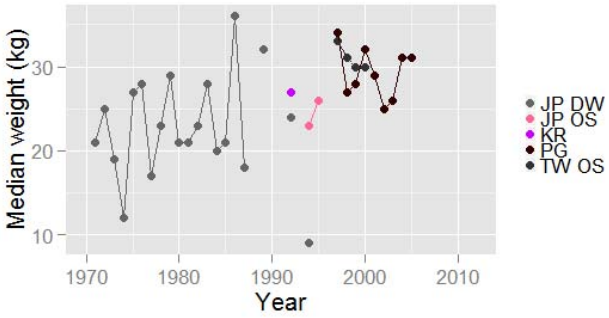

Fishery 8
Catch (fish x 1000)
400
300
200
100
0
1970
1980
1990
2000
2010
Year
AU
BZ
CK
CN
FJ
JP
JP DW
KR
PG
TW DW
TW OS
US MC
VU

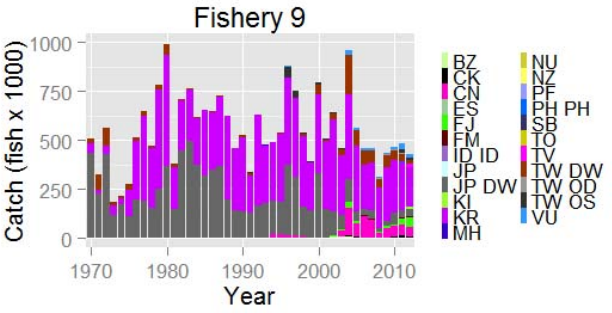

1
2
7
3
4
8
9
5
6
Google

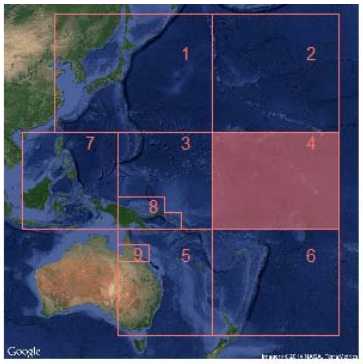

No. fish measured
20000
15000
10000
5000
0
1970
1980
1990
2000
2010
Year
CN
JP
JP DW
KR
KR DW
PG
TW
TW DW
TW OS
VU

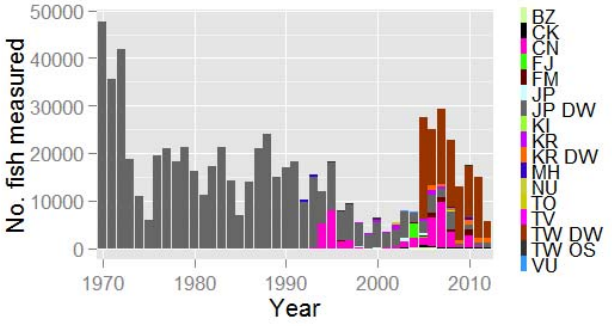

Median length (cm)
150
140
130
120
110
100
90
1970
1980
1990
2000
2010
Year
CN
JP
JP DW
KR
KR DW
PG
TW
TW DW
TW OS
VU

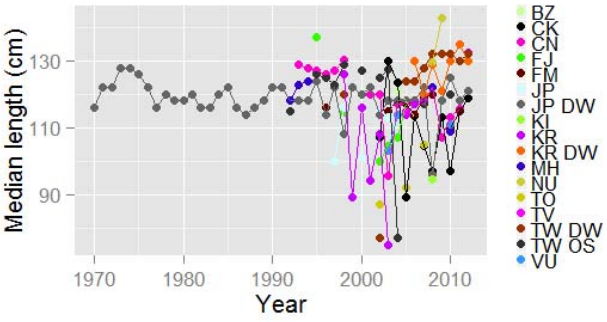

No. fish weighed
40000
30000
20000
10000
0
1970
1980
1990
2000
2010
Year
JP DW
JP OS
KR
PG
TW OS

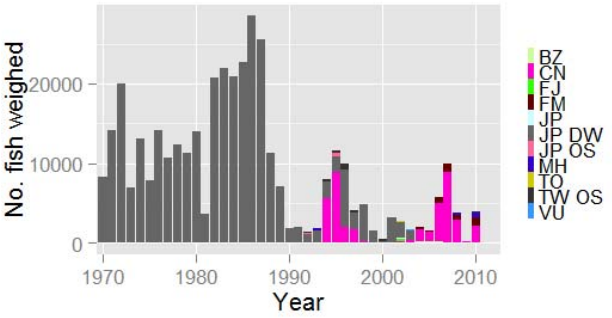

Median weight (kg)
30
20
10
1970
1980
1990
2000
2010
Year
JP DW
JP OS
KR
PG
TW OS

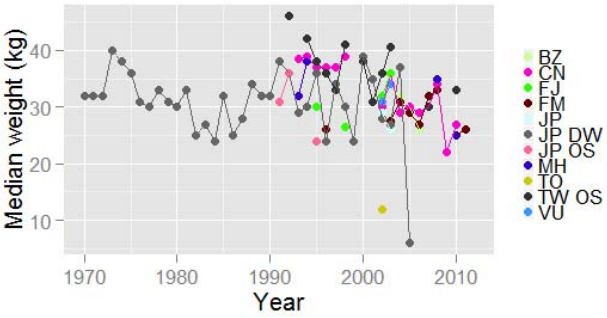

Fishery 9
Catch (fish x 1000)
1000
750
500
250
0
1970
1980
1990
2000
2010
Year
BZ
CK
CN
ES
FJ
FM
ID ID
JP
JP DW
KI
KR
MH
NU
NZ
PF
PH PH
SB
TO
TV
TW DW
TW OD
TW OS
VU

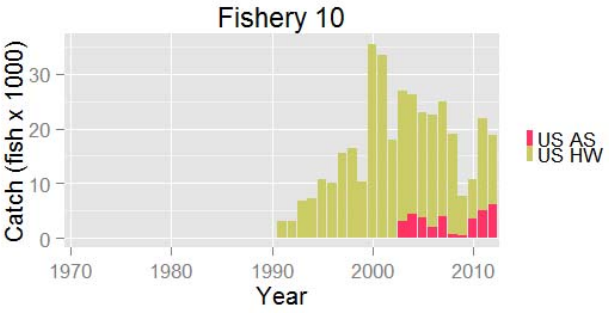

1
2
3
4
5
6
7
8
9
Google

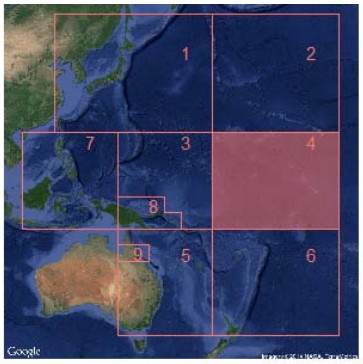

No. fish measured
50000
40000
30000
20000
10000
0
1970
1980
1990
2000
2010
Year
BZ
CK
CN
FJ
FM
JP
JP DW
KI
KR
KR DW
MH
NU
TO
TV
TW DW
TW OS
VU

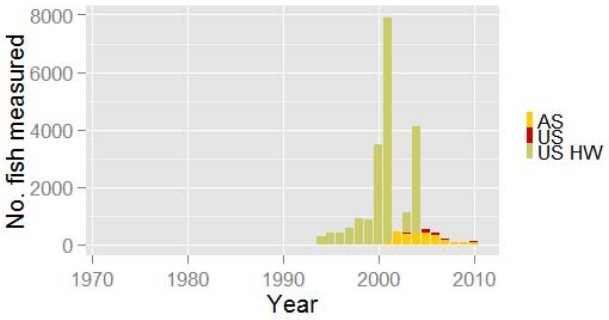

Median length (cm)
130
110
90
1970
1980
1990
2000
2010
Year
BZ
CK
CN
FJ
FM
JP
JP DW
KI
KR
KR DW
MH
NU
TO
TV
TW DW
TW OS
VU

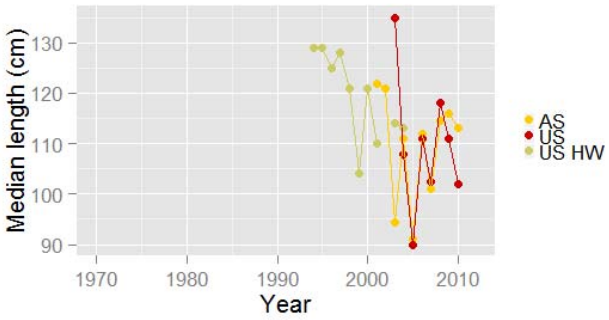

No. fish weighed
20000
10000
0
1970
1980
1990
2000
2010
Year
BZ
CN
FJ
FM
JP
JP DW
JP OS
MH
TO
TW OS
VU

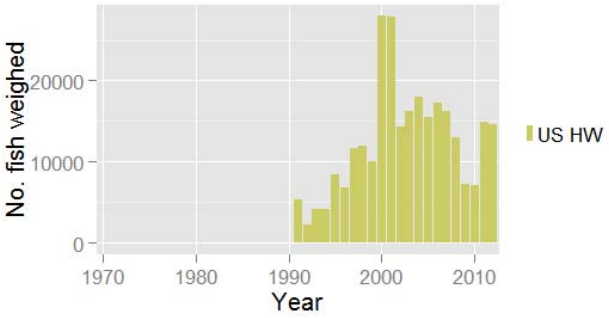

Median weight (kg)
40
30
20
10
1970
1980
1990
2000
2010
Year
BZ
CN
FJ
FM
JP
JP DW
JP OS
MH
TO
TW OS
VU

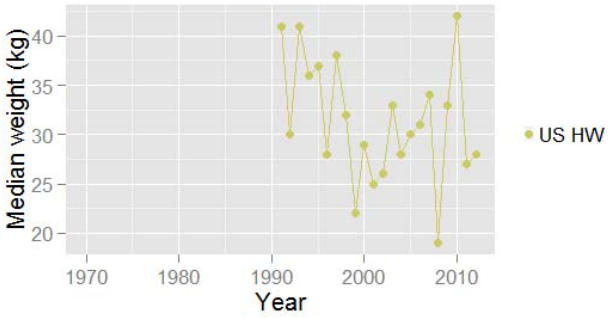

Fishery 10
Catch (fish x 1000)
0
10
20
30
1970
1980
1990
2000
2010
Year
US AS
US HW

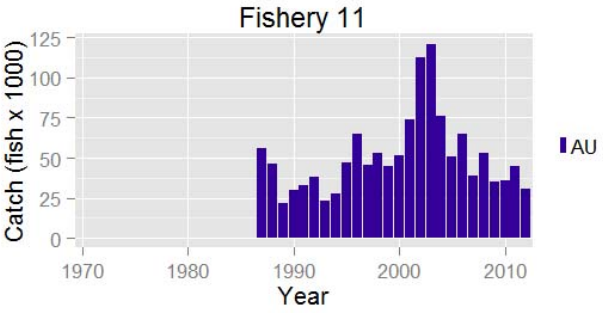

1
2
7
3
4
8
9
5
6
Google

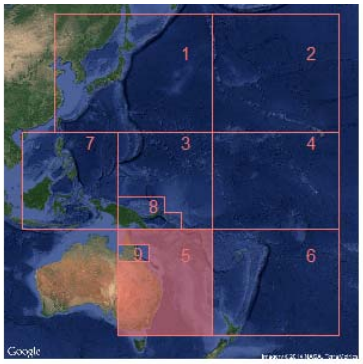

No. fish measured
0
2000
4000
6000
8000
1970
1980
1990
2000
2010
Year
AS
US
US HW

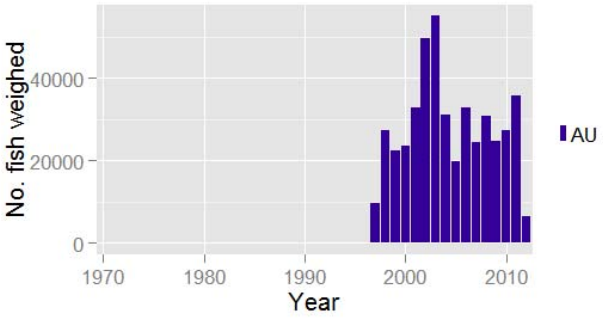

Median length (cm)
90
100
110
120
130
1970
1980
1990
2000
2010
Year
AS
US
US HW

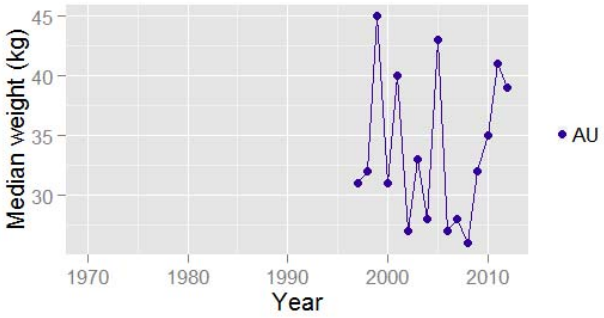

No. fish weighed
0
10000
20000
1970
1980
1990
2000
2010
Year
US HW

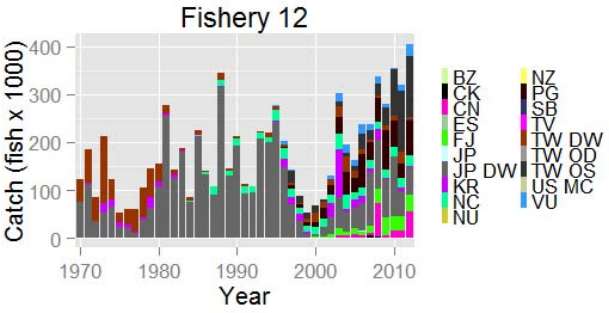

Median weight (kg)
20
25
30
35
40
1970
1980
1990
2000
2010
Year
US HW

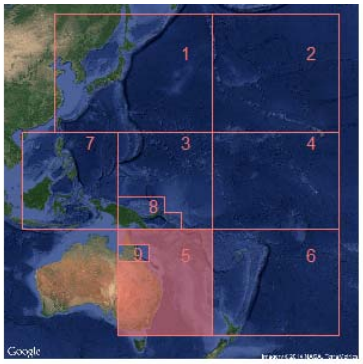

Fishery 11
Catch (fish x 1000)
125
100
75
50
25
0
1970
1980
1990
2000
2010
Year
AU

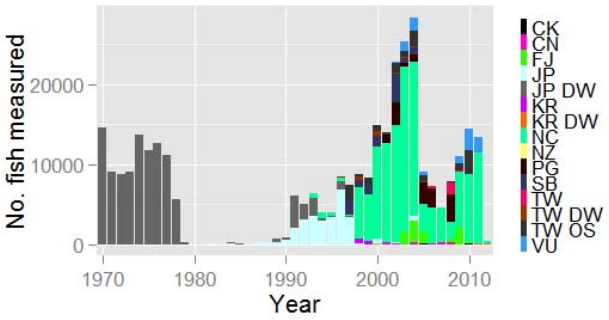

1
2
7
3
4
8
9
5
6
Google

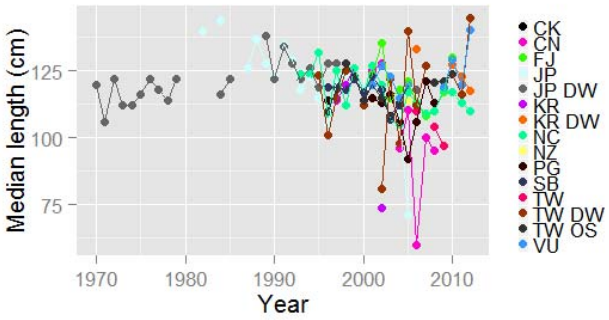

No. fish weighed
40000
20000
0
1970
1980
1990
2000
2010
Year
AU

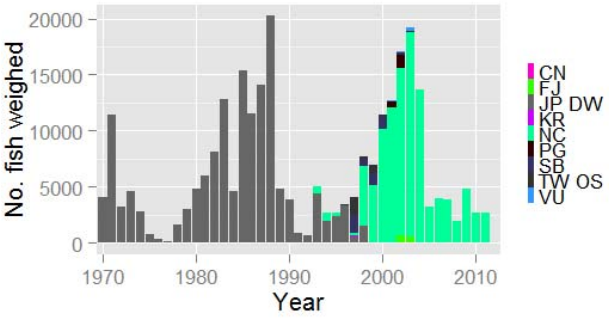

Median weight (kg)
45
40
35
30
1970
1980
1990
2000
2010
Year
AU

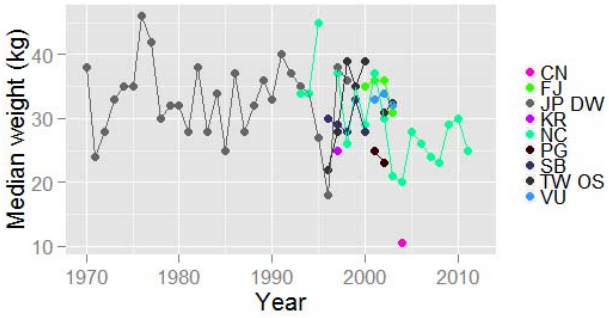

Fishery 12
Catch (fish x 1000)
400
300
200
100
0
1970
1980
1990
2000
2010
Year
BZ
CK
CN
ES
FJ
JP
JP DW
KR
NC
NU
NZ
PG
SB
TV
TW DW
TW OD
TW OS
US MC
VU

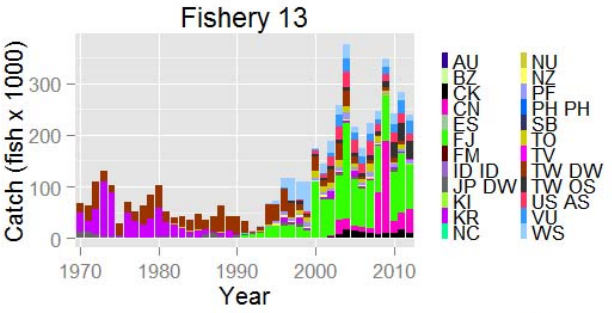

1
2
7
3
4
8
9
5
6
Google

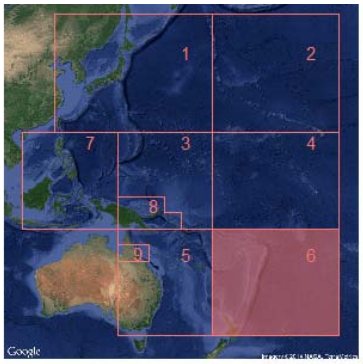

No. fish measured
20000
10000
0
1970
1980
1990
2000
2010
Year
CK
CN
FJ
JP
JP DW
KR
KR DW
NC
NZ
PG
SB
TW
TW DW
TW OS
VU

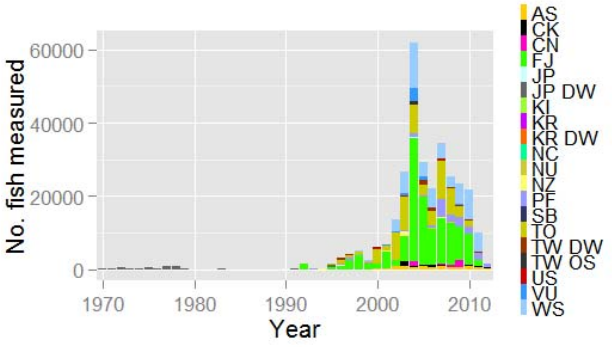

Median length (cm)
125
100
75
1970
1980
1990
2000
2010
Year
CK
CN
FJ
JP
JP DW
KR
KR DW
NC
NZ
PG
SB
TW
TW DW
TW OS
VU

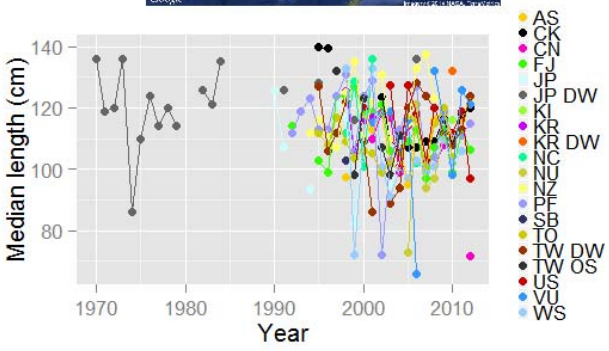

No. fish weighed
20000
15000
10000
5000
0
1970
1980
1990
2000
2010
Year
CN
FJ
JP DW
KR
NC
PG
SB
TW OS
VU

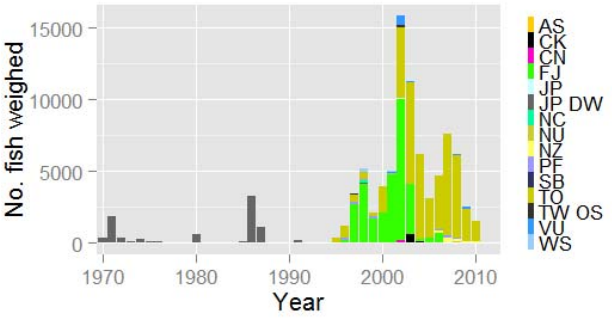

Median weight (kg)
40
30
20
10
1970
1980
1990
2000
2010
Year
CN
FJ
JP DW
KR
NC
PG
SB
TW OS
VU

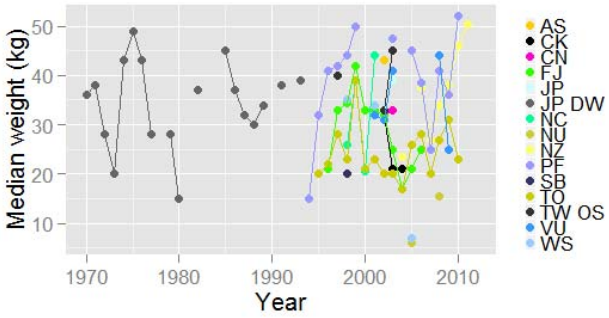

Fishery 13
Catch (fish x 1000)
0
100
200
300
1970
1980
1990
2000
2010
Year
AU
BZ
CK
CN
ES
FJ
FM
ID ID
JP DW
KI
KR
NC
NU
NZ
PF
PH PH
SB
TO
TV
TW DW
TW OS
US AS
VU
WS

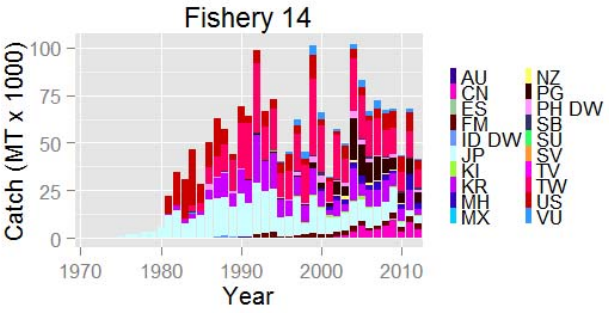

1
2
3
4
5
6
7
8
9
Google

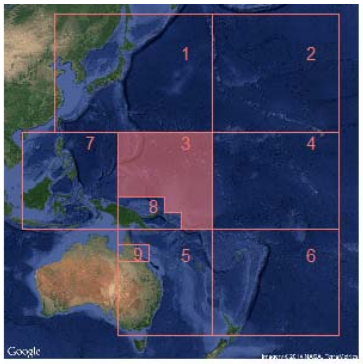

No. fish measured
0
20000
40000
60000
1970
1980
1990
2000
2010
Year
AS
CK
CN
FJ
JP
JP DW
KI
KR
KR DW
NC
NU
NZ
PF
SB
TO
TW DW
TW OS
US
VU
WS

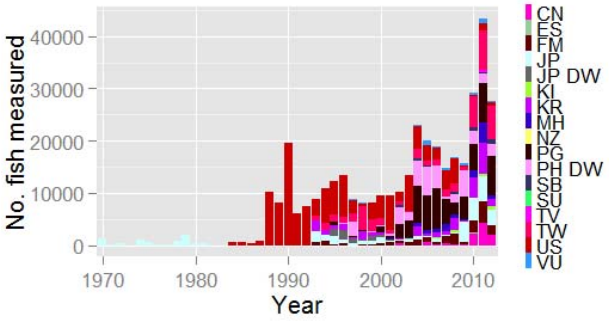

Median length (cm)
80
100
120
140
1970
1980
1990
2000
2010
Year
AS
CK
CN
FJ
JP
JP DW
KI
KR
KR DW
NC
NU
NZ
PF
SB
TO
TW DW
TW OS
US
VU
WS

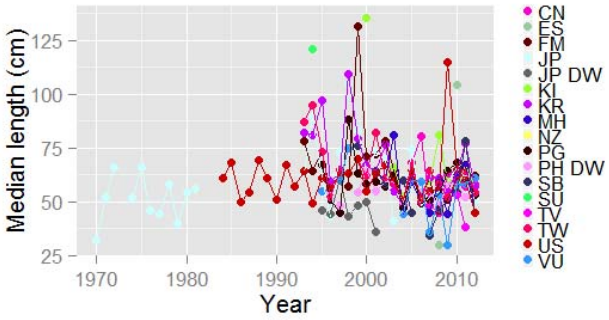

No. fish weighed
0
5000
10000
15000
1970
1980
1990
2000
2010
Year
AS
CK
CN
FJ
JP
JP DW
NC
NU
NZ
PF
SB
TO
TW OS
VU
WS

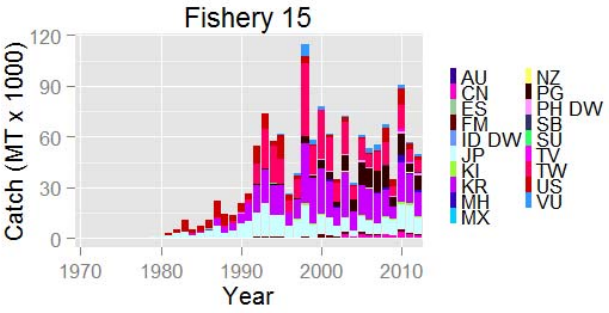

Median weight (kg)
10
20
30
40
50
1970
1980
1990
2000
2010
Year
AS
CK
CN
FJ
JP
JP DW
NC
NU
NZ
PF
SB
TO
TW OS
VU
WS

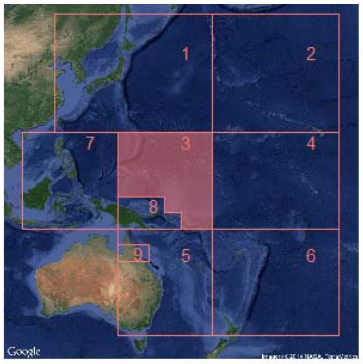

Fishery 14
Catch (MT x 1000)
100
75
50
25
0
1970
1980
1990
2000
2010
Year
AU
CN
ES
FM
ID DW
JP
KI
KR
MH
MX
NZ
PG
PH DW
SB
SU
SV
TV
TW
US
VU

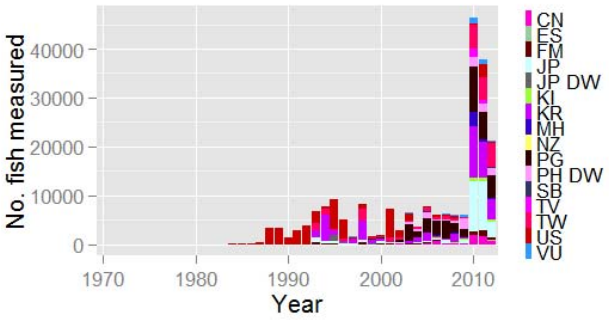

1
2
3
4
5
6
7
8
9
Google

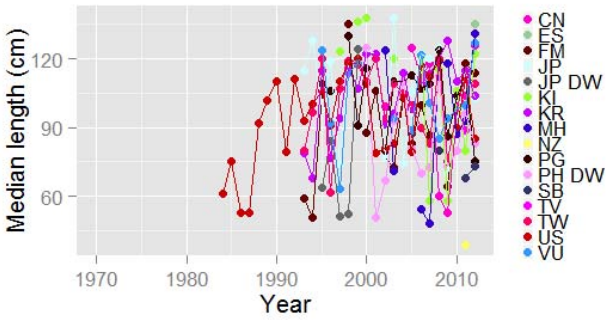

No. fish measured
40000
30000
20000
10000
0
1970
1980
1990
2000
2010
Year
CN
ES
FM
JP
JP DW
KI
KR
MH
NZ
PG
PH DW
SB
SU
TV
TW
US
VU

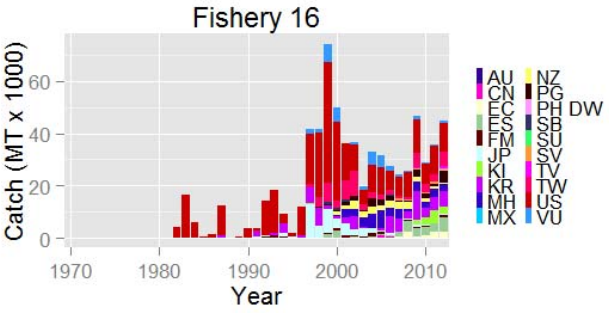

Median length (cm)
125
100
75
50
25
1970
1980
1990
2000
2010
Year
CN
ES
FM
JP
JP DW
KI
KR
MH
NZ
PG
PH DW
SB
SU
TV
TW
US
VU

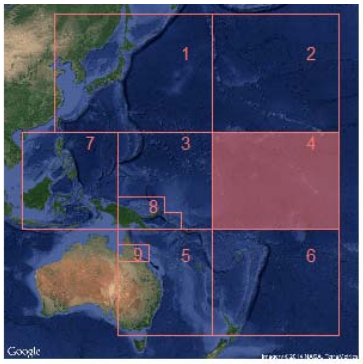

Fishery 15
Catch (MT x 1000)
120
90
60
30
0
1970
1980
1990
2000
2010
Year
AU
CN
ES
FM
ID DW
JP
KI
KR
MH
MX
NZ
PG
PH DW
SB
SU
TV
TW
US
VU

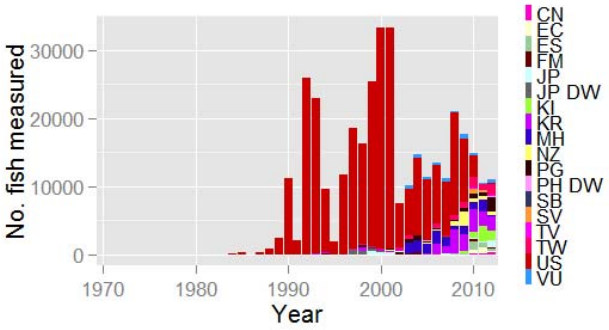

1
2
7
3
4
8
9
5
6
Google

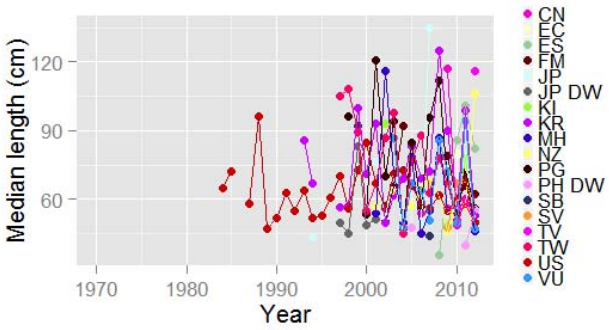

No. fish measured
40000
30000
20000
10000
0
1970
1980
1990
2000
2010
Year
CN
ES
FM
JP
JP DW
KI
KR
MH
NZ
PG
PH DW
SB
TV
TW
US
VU

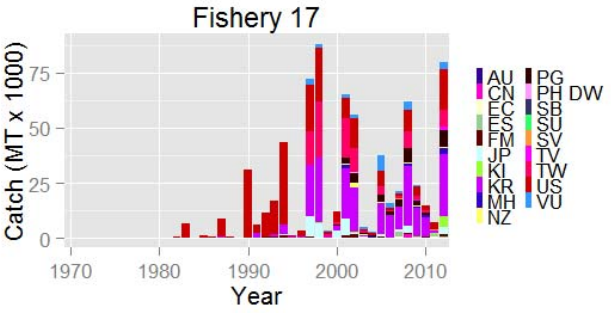

Median length (cm)
120
90
60
1970
1980
1990
2000
2010
Year
CN
ES
FM
JP
JP DW
KI
KR
MH
NZ
PG
PH DW
SB
TV
TW
US
VU

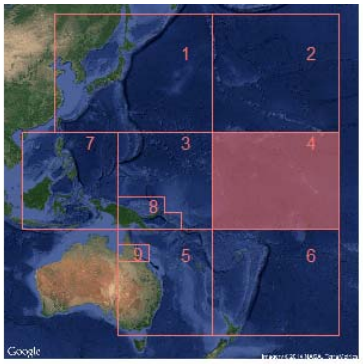

Fishery 16
Catch (MT x 1000)
0
20
40
60
1970
1980
1990
2000
2010
Year
AU
CN
EC
ES
FM
JP
KI
KR
MH
MX
NZ
PG
PH DW
SB
SU
SV
TV
TW
US
VU

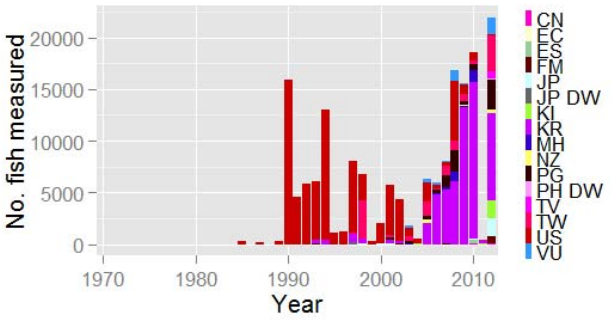

1
2
3
4
5
6
7
8
9
Google

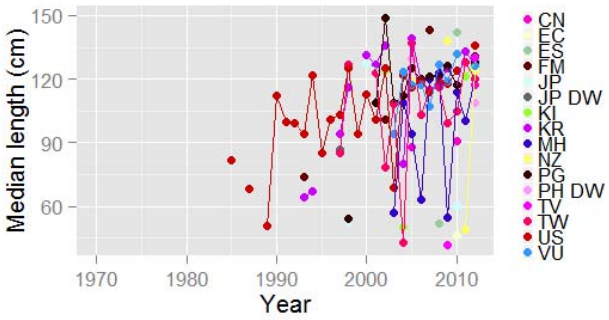

No. fish measured
0
10000
20000
30000
1970
1980
1990
2000
2010
Year
CN
EC
ES
FM
JP
JP DW
KI
KR
MH
NZ
PG
PH DW
SB
SV
TV
TW
US
VU

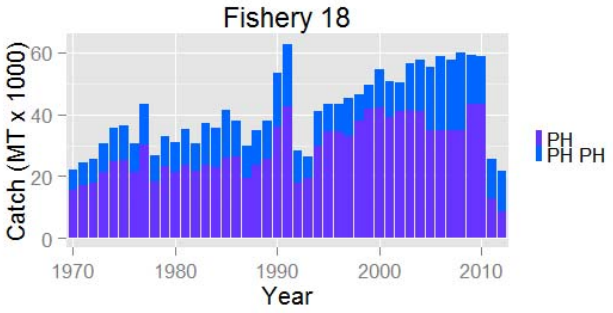

Median length (cm)
60
90
120
1970
1980
1990
2000
2010
Year
CN
EC
ES
FM
JP
JP DW
KI
KR
MH
NZ
PG
PH DW
SB
SV
TV
TW
US
VU

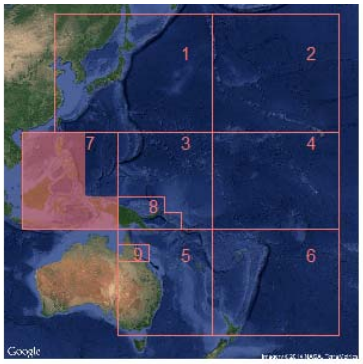

Fishery 17
Catch (MT x 1000)
0
25
50
75
1970
1980
1990
2000
2010
Year
AU
CN
EC
ES
FM
JP
KI
KR
MH
NZ
PG
PH DW
SB
SU
SV
TV
TW
US
VU

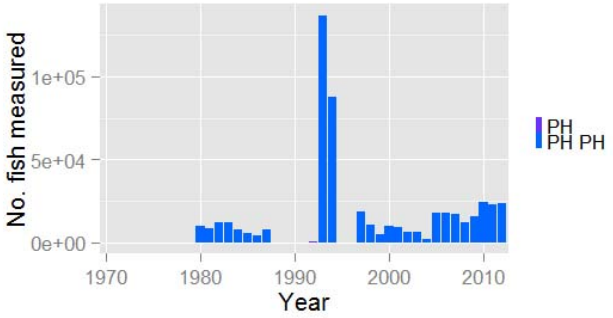

1
2
3
4
5
6
7
8
9
Google

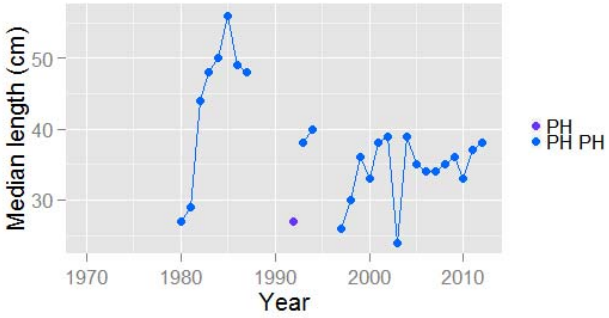

No. fish measured
0
5000
10000
15000
20000
1970
1980
1990
2000
2010
Year
CN
EC
ES
FM
JP
JP DW
KI
KR
MH
NZ
PG
PH DW
TV
TW
US
VU

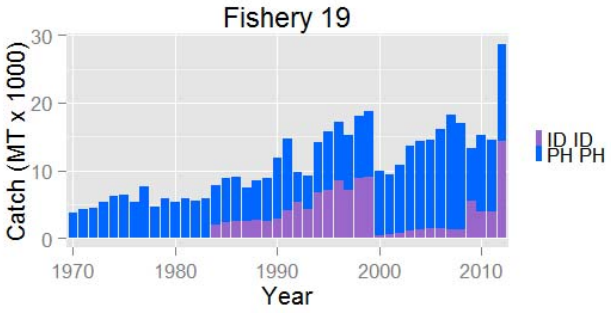

Median length (cm)
60
90
120
150
1970
1980
1990
2000
2010
Year
CN
EC
ES
FM
JP
JP DW
KI
KR
MH
NZ
PG
PH DW
TV
TW
US
VU

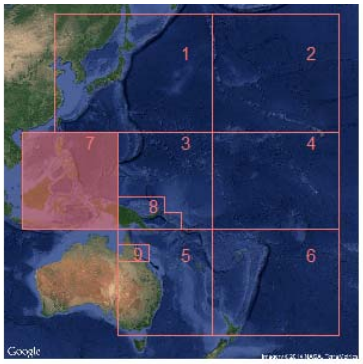

Fishery 18
Catch (MT x 1000)
60
40
20
0
1970
1980
1990
2000
2010
Year
PH
PH PH

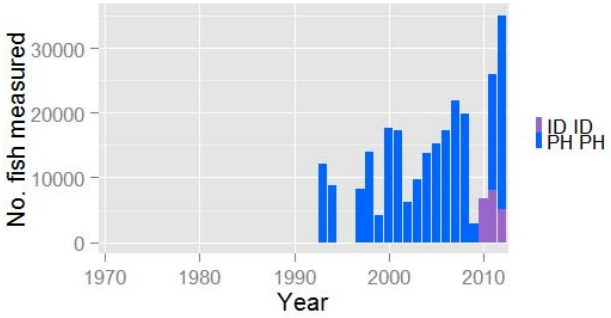

1
2
7
3
4
8
9
5
6
Google

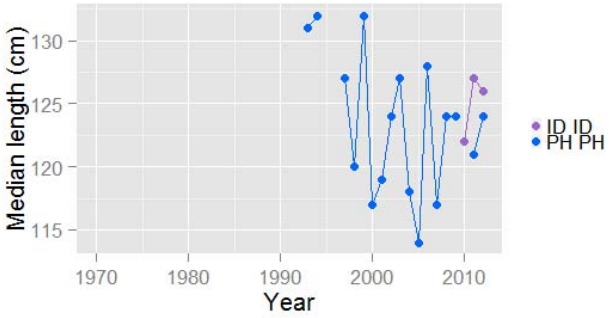

No. fish measured
1e+05
5e+04
0e+00
1970
1980
1990
2000
2010
Year
PH
PH PH

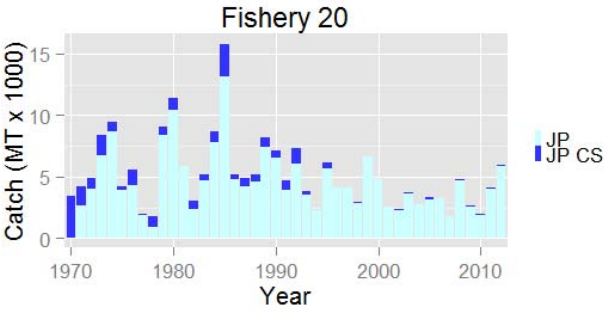

Median length (cm)
50
40
30
1970
1980
1990
2000
2010
Year
PH
PH PH

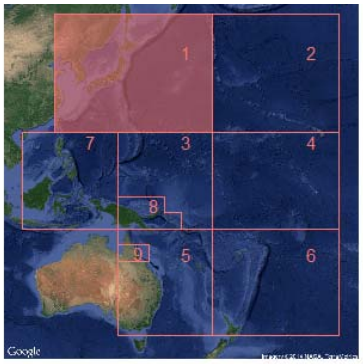

Fishery 19
Catch (MT x 1000)
30
20
10
0
1970
1980
1990
2000
2010
Year
ID ID
PH PH

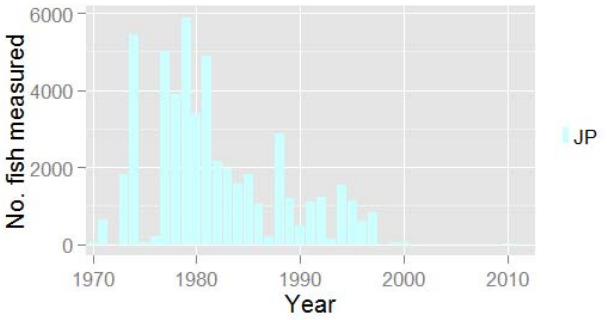

1
2
7
3
4
8
9
5
6
Google

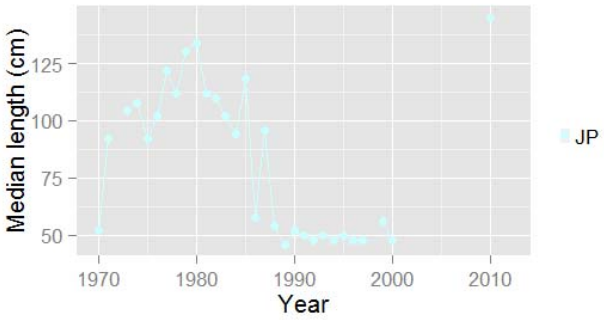

No. fish measured
30000
20000
10000
0
1970
1980
1990
2000
2010
Year
ID ID
PH PH

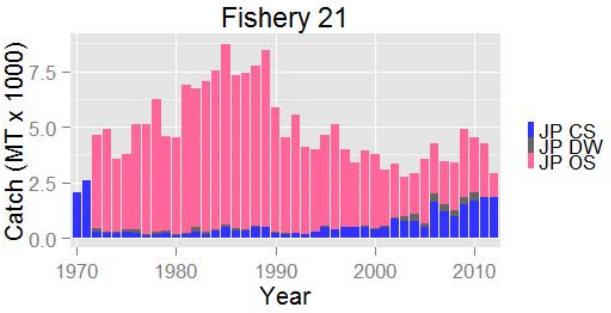

Median length (cm)
130
125
120
115
1970
1980
1990
2000
2010
Year
ID ID
PH PH

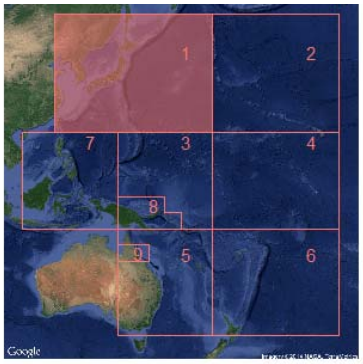

Fishery 20
Catch (MT x 1000)
15
10
5
0
1970
1980
1990
2000
2010
Year
JP
JP CS

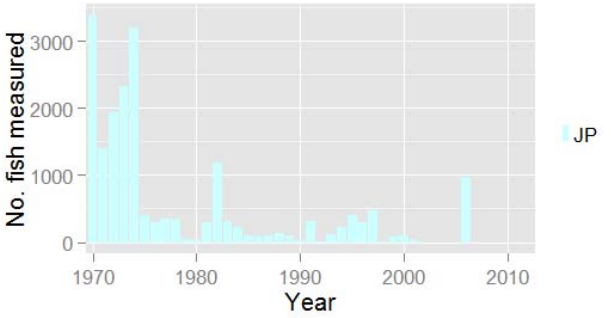

1
2
7
3
4
8
9
5
6
Google

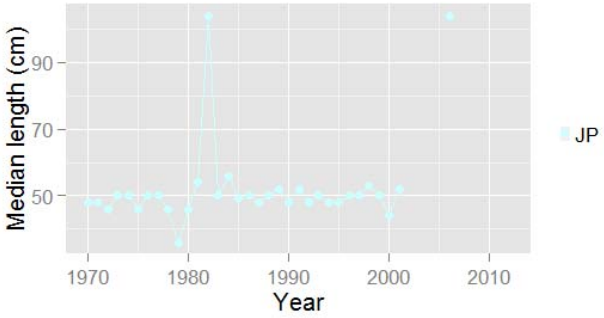

No. fish measured
6000
4000
2000
0
1970
1980
1990
2000
2010
Year
JP

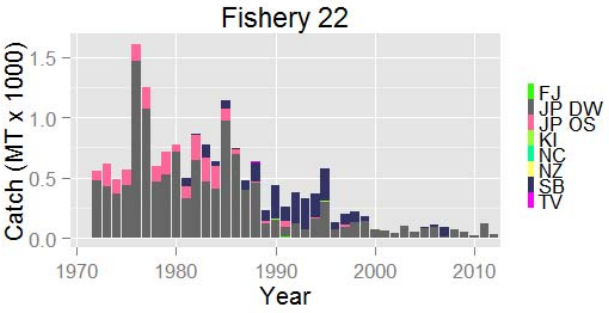

Median length (cm)
125
100
75
50
1970
1980
1990
2000
2010
Year
JP

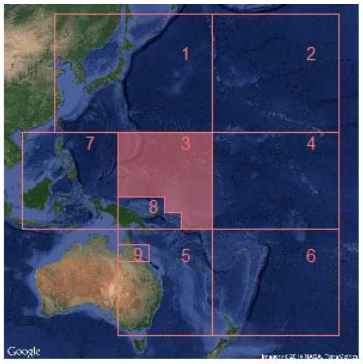

Fishery 21
Catch (MT x 1000)
7.5
5.0
2.5
0.0
1970
1980
1990
2000
2010
Year
JP CS
JP DW
JP OS

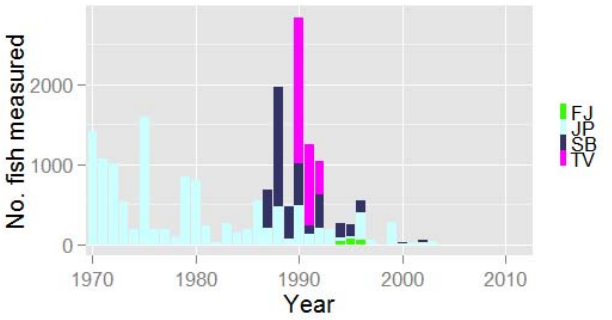

1
2
7
3
4
8
9
5
6
Google

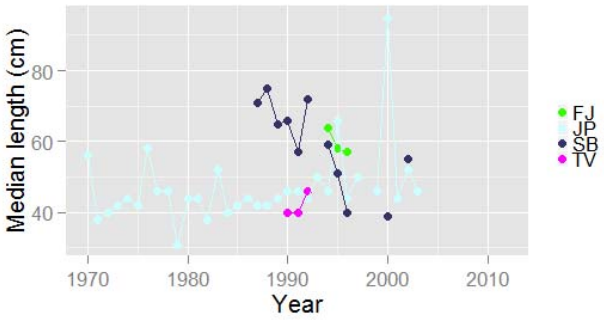

No. fish measured
3000
2000
1000
0
1970
1980
1990
2000
2010
Year
JP

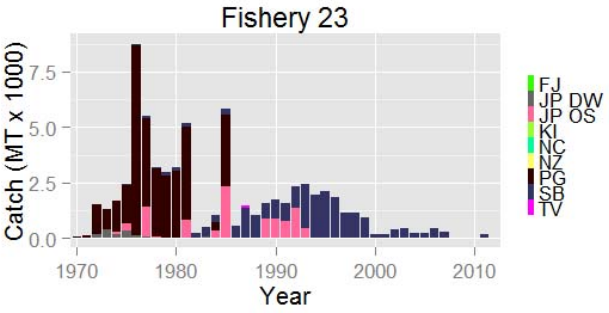

Median length (cm)
90
70
50
1970
1980
1990
2000
2010
Year
JP

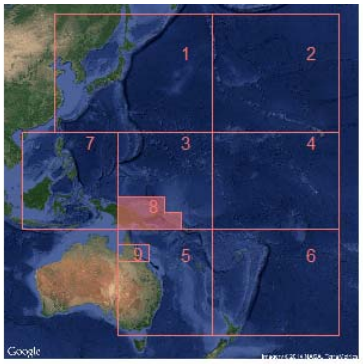

Fishery 22
Catch (MT x 1000)
1.5
1.0
0.5
0.0
1970
1980
1990
2000
2010
Year
FJ
JP DW
JP OS
KI
NC
NZ
SB
TV

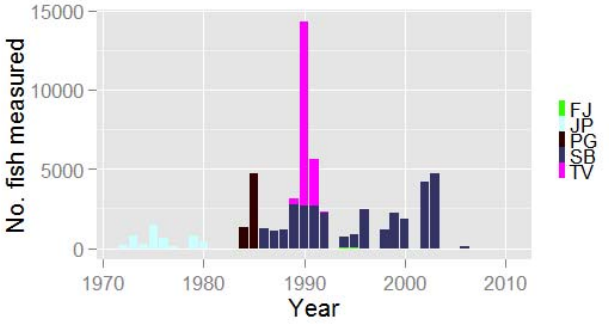

1
2
7
3
4
8
9
5
6
Google

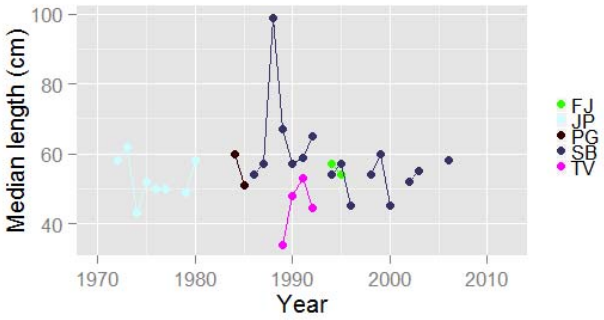

No. fish measured
2000
1000
0
1970
1980
1990
2000
2010
Year
FJ
JP
SB
TV

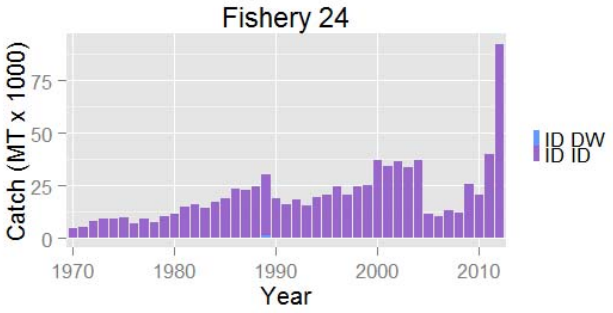

Median length (cm)
80
60
40
1970
1980
1990
2000
2010
Year
FJ
JP
SB
TV

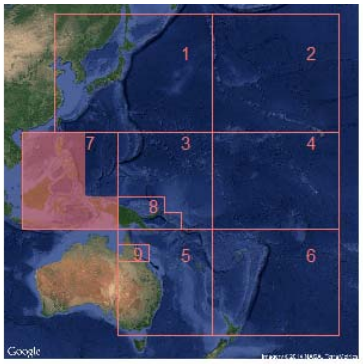

Fishery 23
Catch (MT x 1000)
7.5
5.0
2.5
0.0
1970
1980
1990
2000
2010
Year
FJ
JP DW
JP OS
KI
NC
NZ
PG
SB
TV

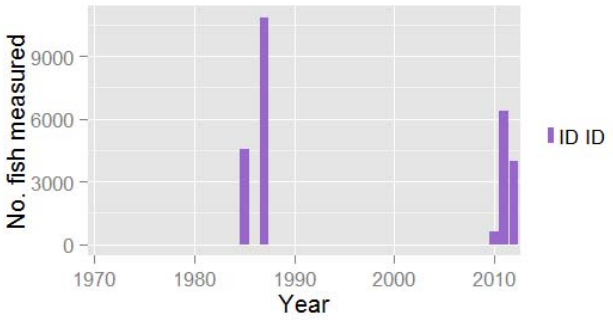

1
2
7
3
4
8
9
5
6
Google

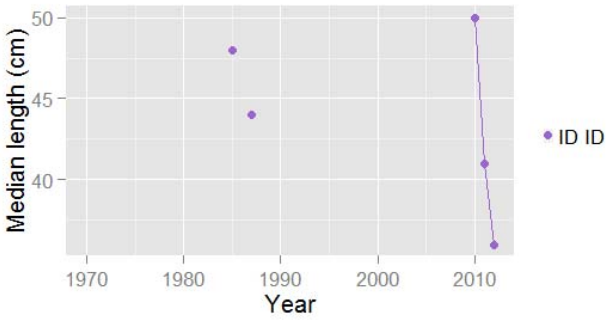

No. fish measured
15000
10000
5000
0
1970
1980
1990
2000
2010
Year
FJ
JP
PG
SB
TV

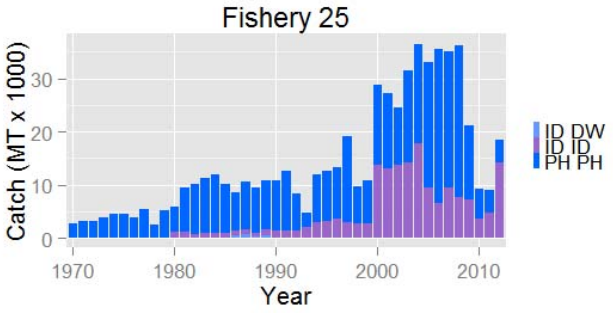

Median length (cm)
100
80
60
40
1970
1980
1990
2000
2010
Year
FJ
JP
PG
SB
TV

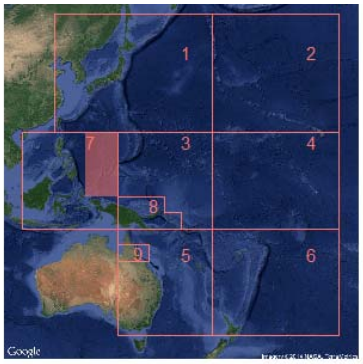

Fishery 24
Catch (MT x 1000)
75
50
25
0
1970
1980
1990
2000
2010
Year
ID DW
ID ID

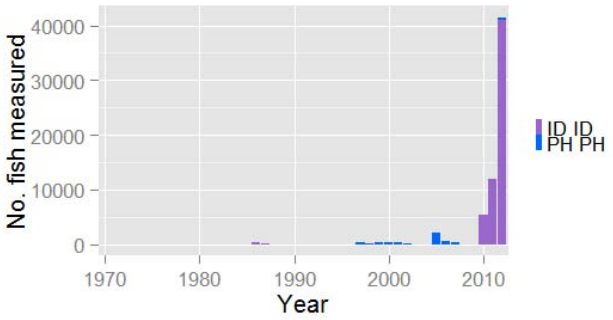

1
2
7
3
4
8
9
5
6
Google

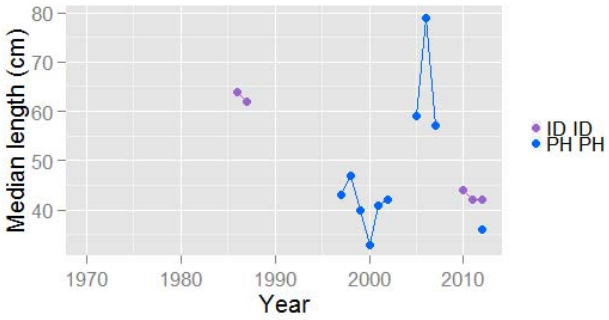

No. fish measured
9000
6000
3000
0
1970
1980
1990
2000
2010
Year
ID ID

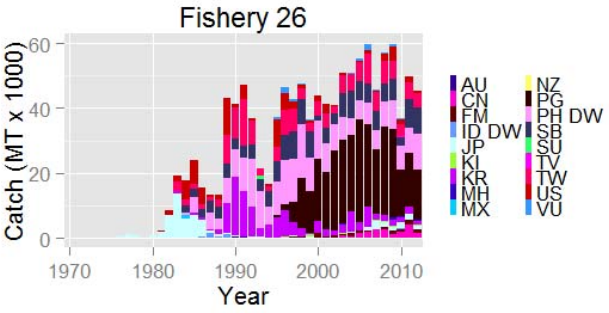

Median length (cm)
50
45
40
1970
1980
1990
2000
2010
Year
ID ID

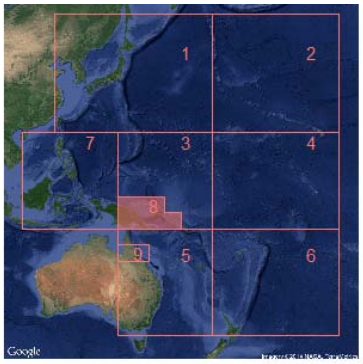

Fishery 25
Catch (MT x 1000)
0
10
20
30
1970
1980
1990
2000
2010
Year
ID DW
ID ID
PH PH

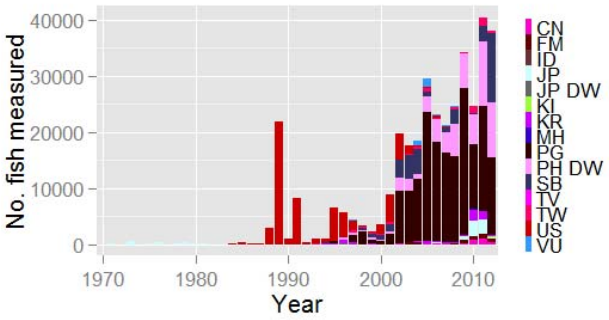

1
2
3
4
5
6
7
8
9
Google

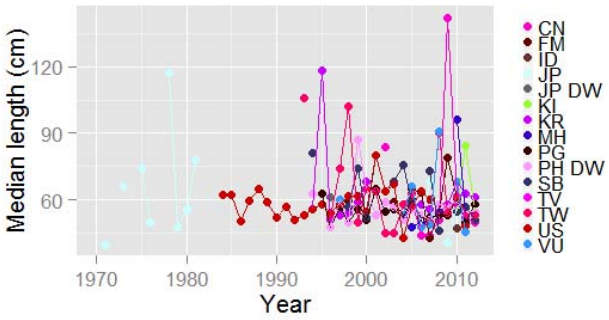

No. fish measured
0
10000
20000
30000
40000
1970
1980
1990
2000
2010
Year
ID ID
PH PH

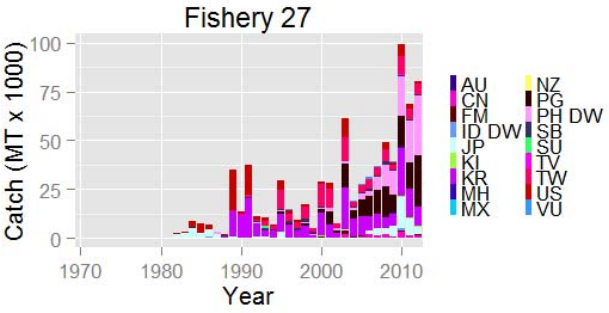

Median length (cm)
40
50
60
70
80
1970
1980
1990
2000
2010
Year
ID ID
PH PH

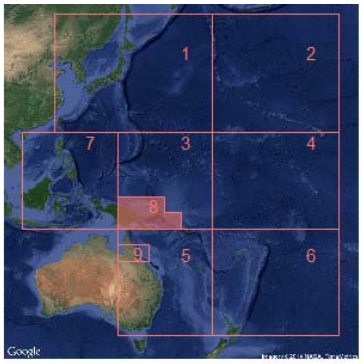

Fishery 26
Catch (MT x 1000)
Year
AU
CN
FM
ID DW
JP
KI
KR
MH
MX
NZ
PG
PH DW
SB
SU
TV
TW
US
VU

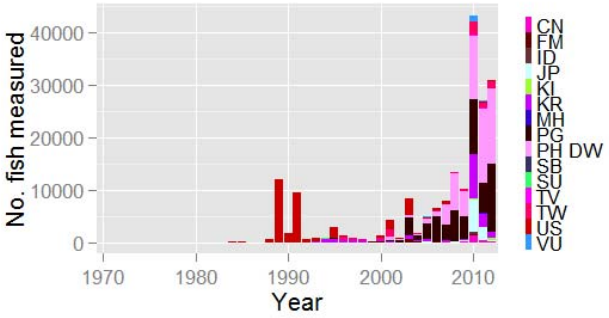

1
2
3
4
5
6
7
8
9

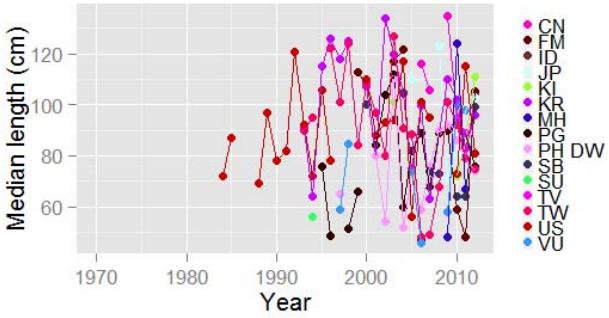

No. fish measured
Year
CN
FM
ID
JP
JP DW
KI
KR
MH
PG
PH DW
SB
TV
TW
US
VU

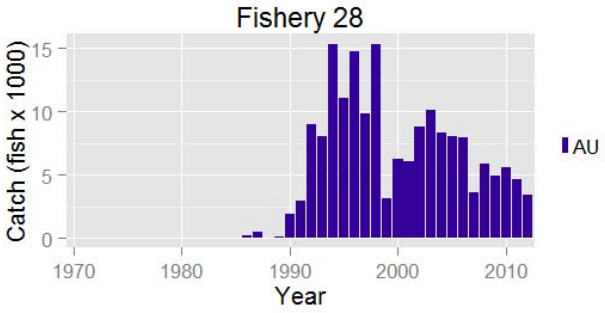

Median length (cm)
Year
CN
FM
ID
JP
JP DW
KI
KR
MH
PG
PH DW
SB
TV
TW
US
VU

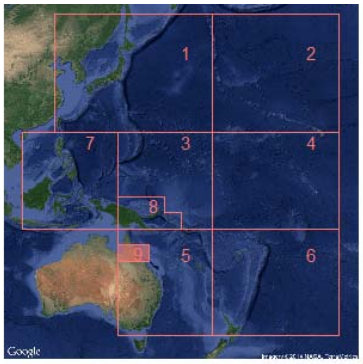

Fishery 27
Catch (MT x 1000)
100
75
50
25
0
1970
1980
1990
2000
2010
Year
AU
CN
FM
ID DW
JP
KI
KR
MH
MX
NZ
PG
PH DW
SB
SU
TV
TW
US
VU

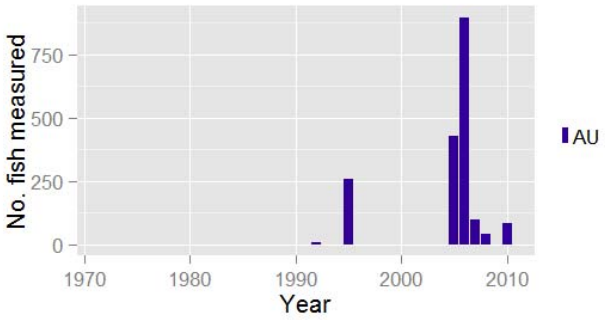

1
2
7
3
4
8
9
5
6
Google

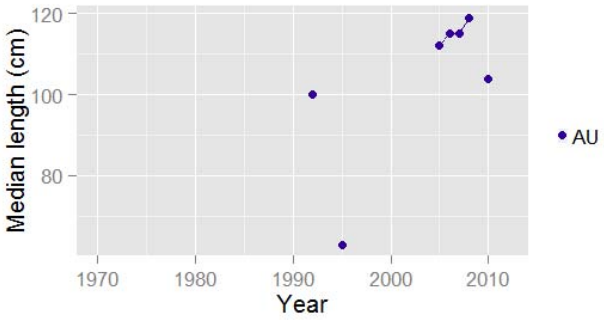

No. fish measured
40000
30000
20000
10000
0
1970
1980
1990
2000
2010
Year
CN
FM
ID
JP
KI
KR
MH
PG
PH DW
SB
SU
TV
TW
US
VU

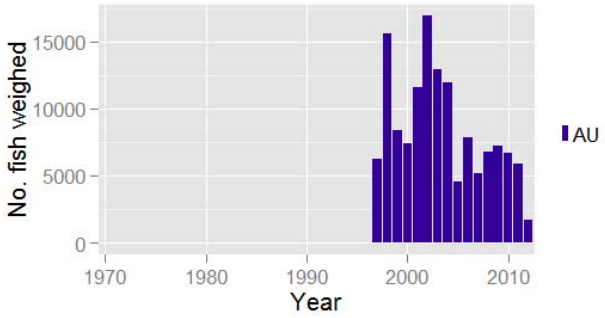

Median length (cm)
120
100
80
60
1970
1980
1990
2000
2010
Year
CN
FM
ID
JP
KI
KR
MH
PG
PH DW
SB
SU
TV
TW
US
VU

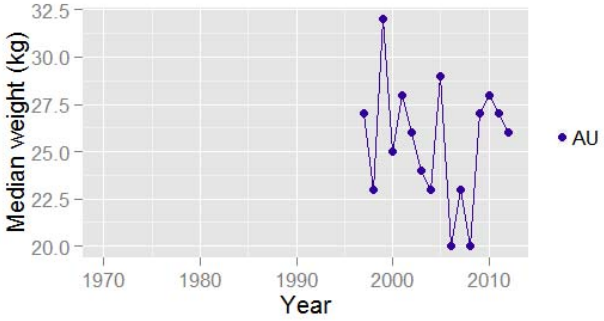

Fishery 28
Catch (fish x 1000)
15
10
5
0
1970
1980
1990
2000
2010
Year
AU

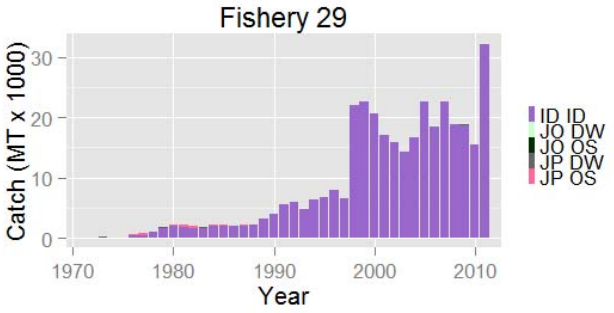

1
2
7
3
4
8
9
5
6
Google

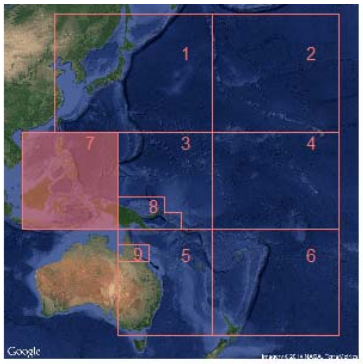

No. fish measured
750
500
250
0
1970
1980
1990
2000
2010
Year
AU

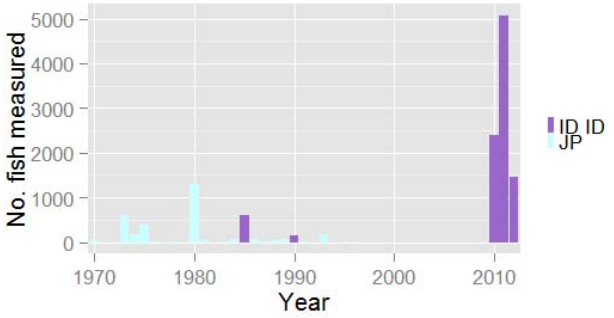

Median length (cm)
120
100
80
1970
1980
1990
2000
2010
Year
AU

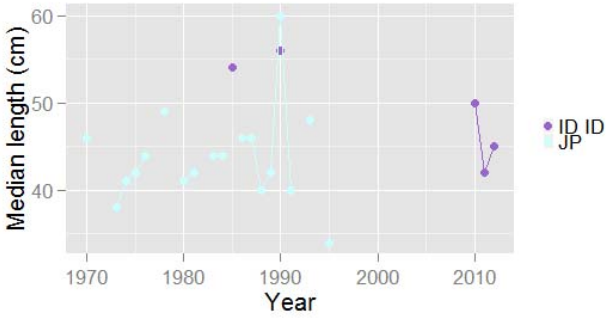

No. fish weighed
15000
10000
5000
0
1970
1980
1990
2000
2010
Year
AU

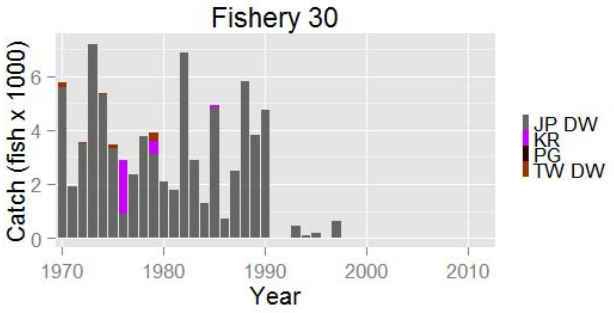

Median weight (kg)
32.5
30.0
27.5
25.0
22.5
20.0
1970
1980
1990
2000
2010
Year
AU

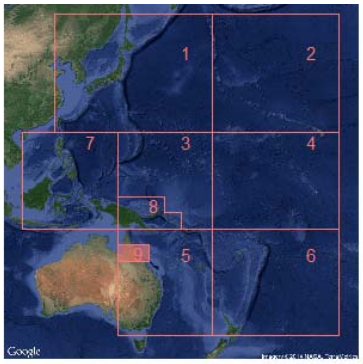

Fishery 29
Catch (MT x 1000)
30
20
10
0
1970
1980
1990
2000
2010
Year
ID ID
JO DW
JO OS
JP DW
JP OS

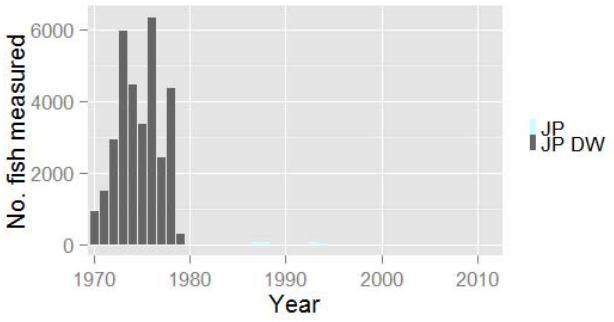

1
2
7
3
4
8
9
5
6
Google

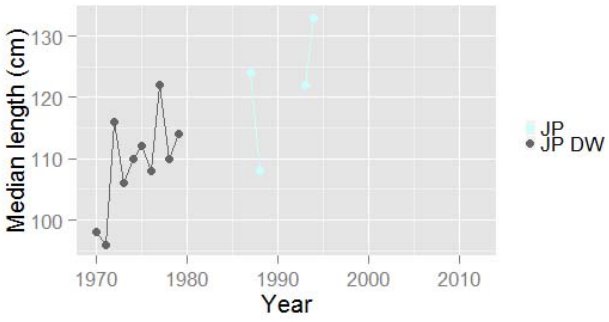

No. fish measured
5000
4000
3000
2000
1000
0
1970
1980
1990
2000
2010
Year
ID ID
JP

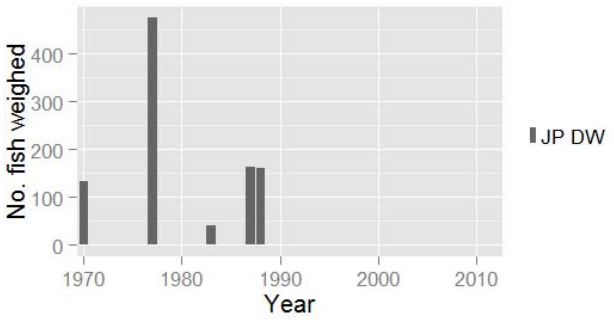

Median length (cm)
60
50
40
1970
1980
1990
2000
2010
Year
ID ID
JP

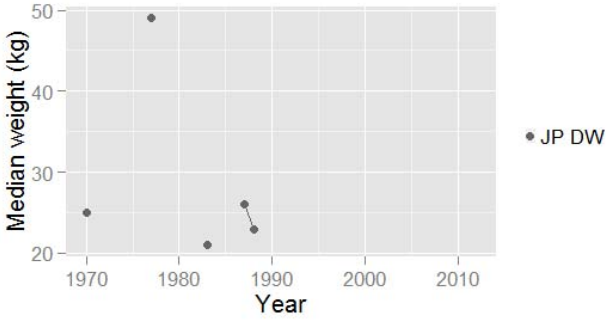

Fishery 30
Catch (fish x 1000)
0
2
4
6
1970
1980
1990
2000
2010
Year
JP DW
KR
PG
TW DW

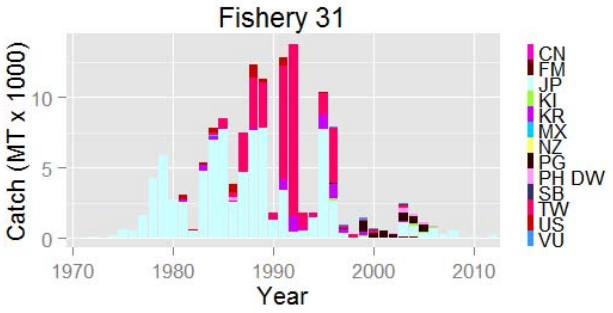

1
2
7
3
4
8
9
5
6
Google

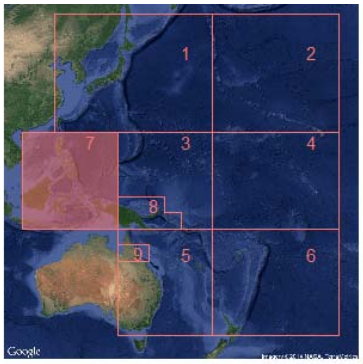

No. fish measured
0
2000
4000
6000
1970
1980
1990
2000
2010
Year
JP
JP DW

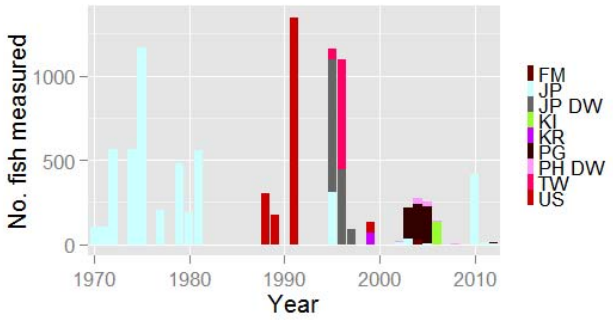

Median length (cm)
100
110
120
130
1970
1980
1990
2000
2010
Year
JP
JP DW

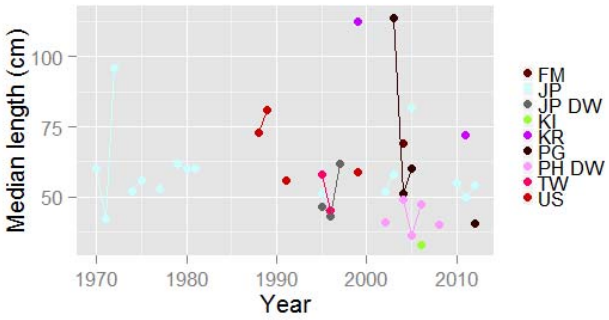

No. fish weighed
0
100
200
300
400
1970
1980
1990
2000
2010
Year
JP DW

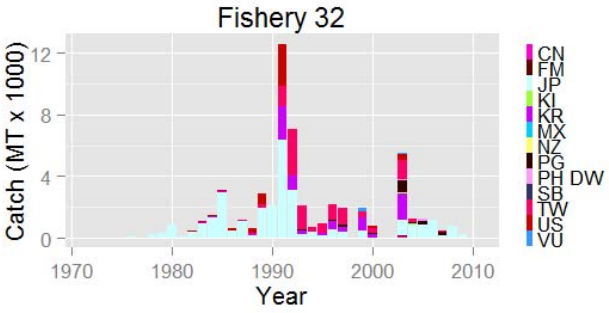

Median weight (kg)
20
30
40
50
1970
1980
1990
2000
2010
Year
JP DW

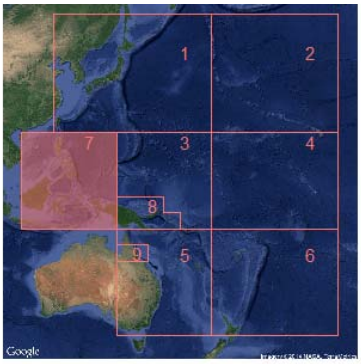

Fishery 31
Catch (MT x 1000)
10
5
0
1970
1980
1990
2000
2010
Year
CN
FM
JP
KI
KR
MX
NZ
PG
PH DW
SB
TW
US
VU

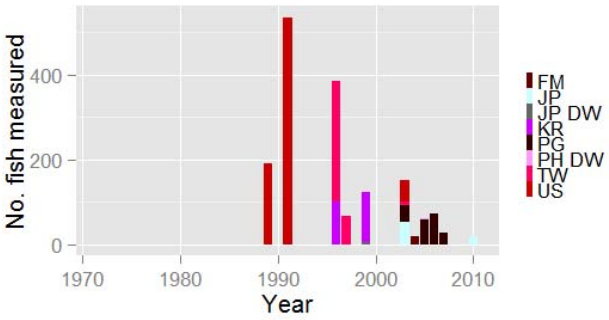

1
2
7
3
4
8
9
5
6
Google

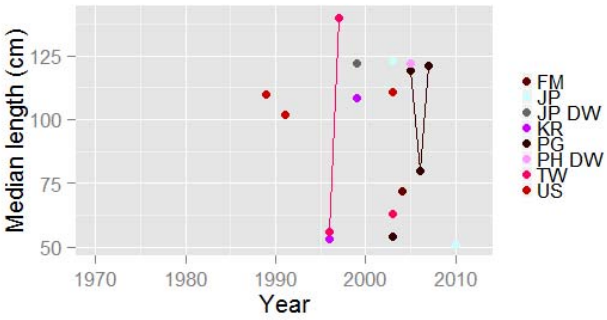

No. fish measured
1000
500
0
1970
1980
1990
2000
2010
Year
FM
JP
JP DW
KI
KR
PG
PH DW
TW
US

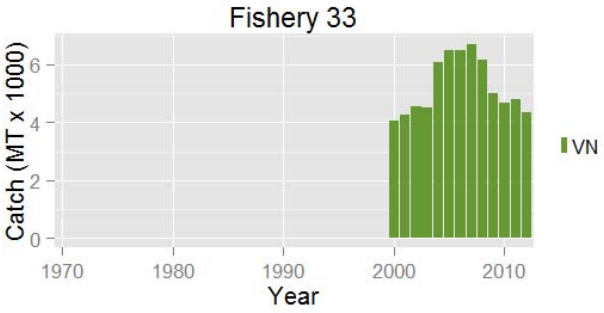

Median length (cm)
100
75
50
1970
1980
1990
2000
2010
Year
FM
JP
JP DW
KI
KR
PG
PH DW
TW
US

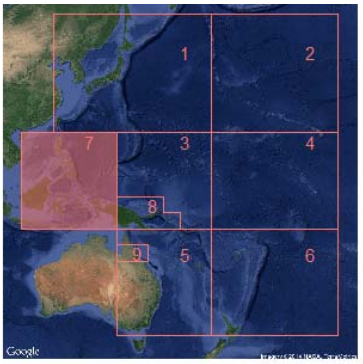

Fishery 32
Catch (MT x 1000)
12
8
4
0
1970
1980
1990
2000
2010
Year
CN
FM
JP
KI
KR
MX
NZ
PG
PH DW
SB
TW
US
VU


1
2
7
3
4
8
9
5
6
Google

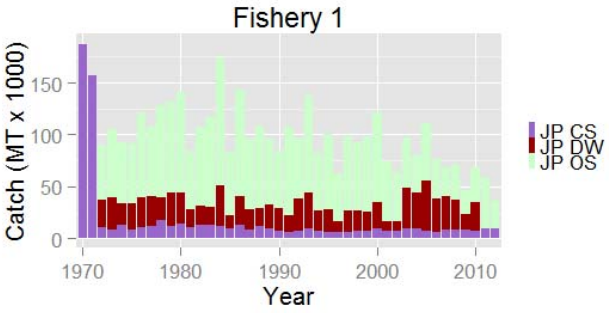

No. fish measured
400
200
0
1970
1980
1990
2000
2010
Year
FM
JP
JP DW
KR
PG
PH DW
TW
US

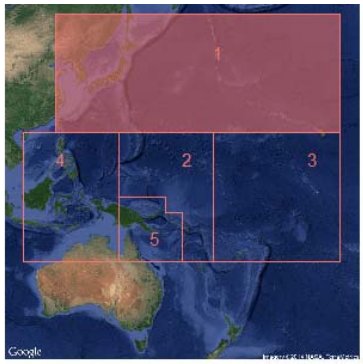

Median length (cm)
125
100
75
50
1970
1980
1990
2000
2010
Year
FM
JP
JP DW
KR
PG
PH DW
TW
US

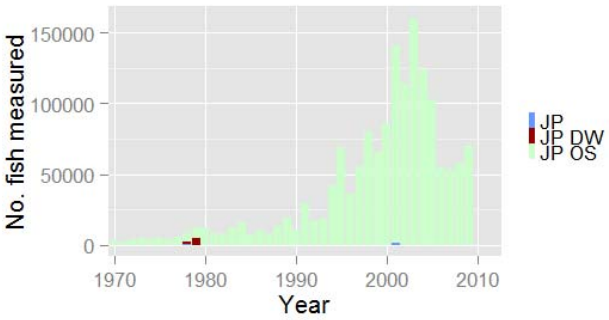

Fishery 33
Catch (MT x 1000)
0
2
4
6
1970
1980
1990
2000
2010
Year
VN

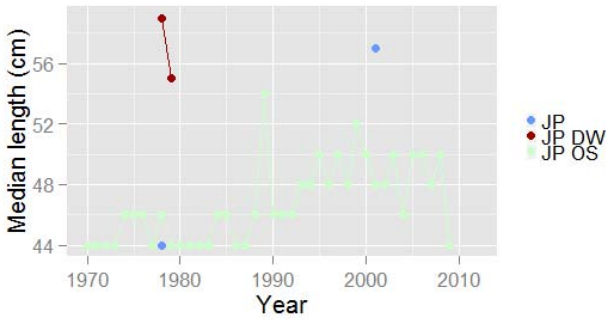

1
2
3
4
5
6
7
8
9
Google

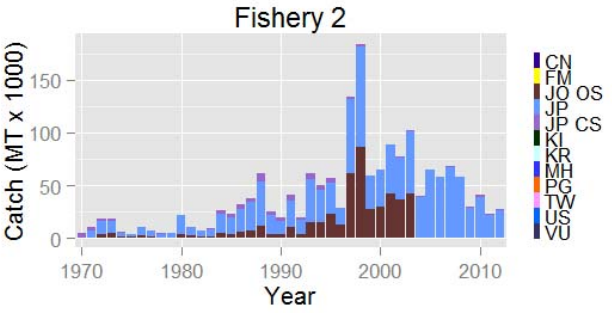
9.3. SKJ fishery definitions plots

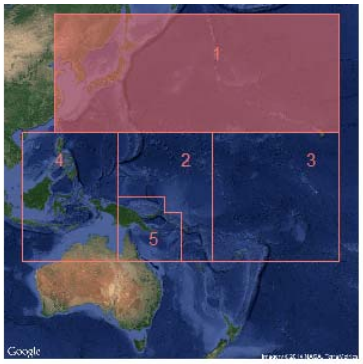


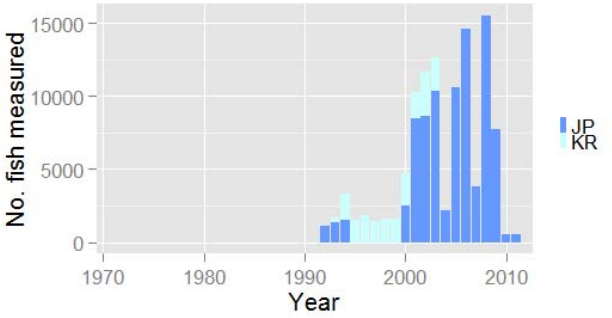


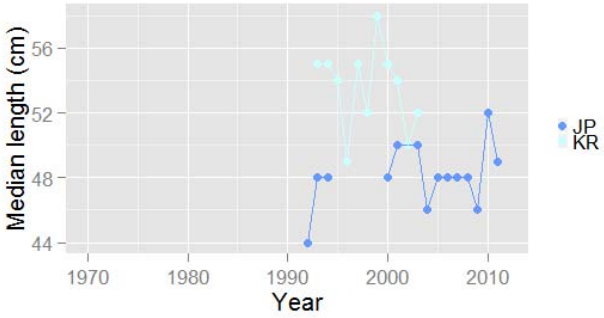


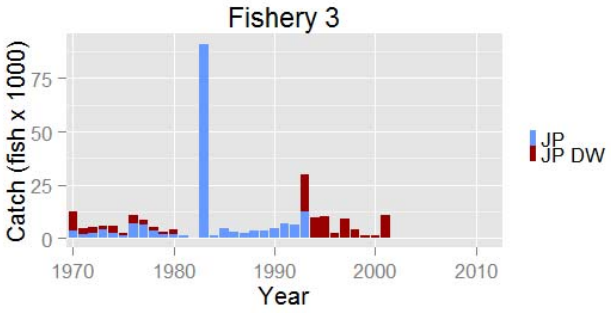


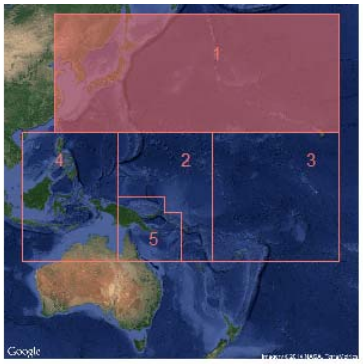

Fishery 2
Catch (MT x 1000)
150
100
50
0
1970
1980
1990
2000
2010
Year
CN
FM
JO OS
JP
JP CS
KI
KR
MH
PG
TW
US
VU

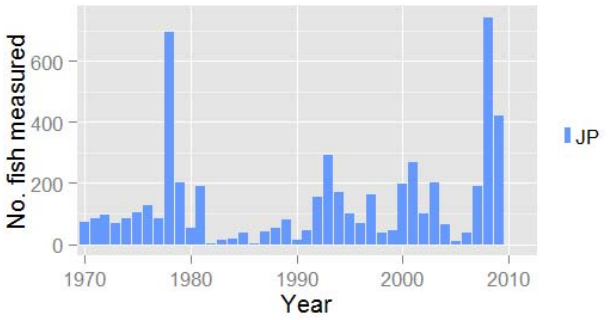

1
2
3
4
5
Google

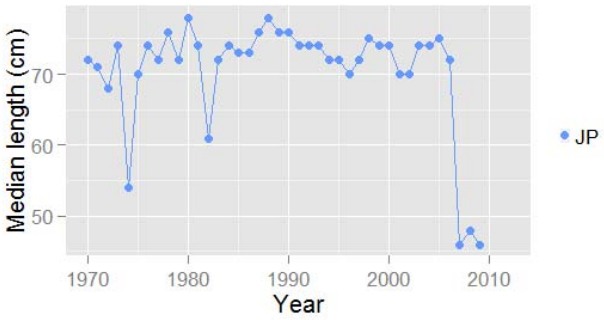

No. fish measured
15000
10000
5000
0
1970
1980
1990
2000
2010
Year
JP
KR

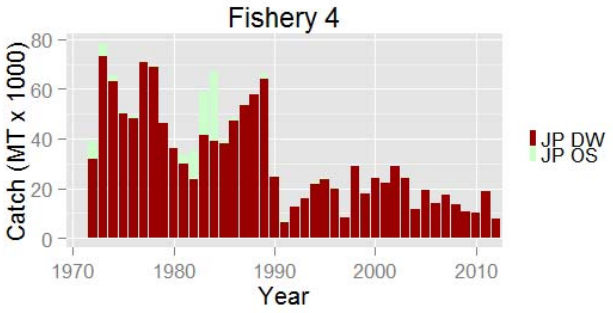

Median length (cm)
56
52
48
44
1970
1980
1990
2000
2010
Year
JP
KR

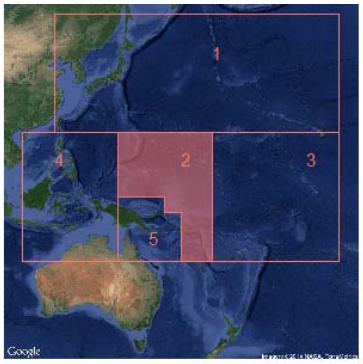

Fishery 3
Catch (fish x 1000)
75
50
25
0
1970
1980
1990
2000
2010
Year
JP
JP DW

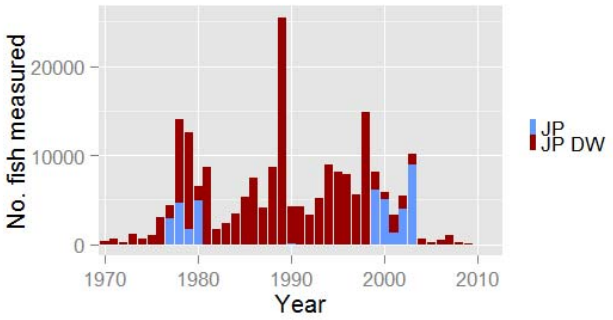

1
2
3
4
5
Google

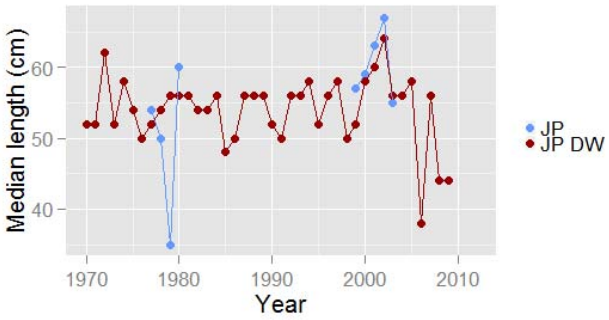

No. fish measured
600
400
200
0
1970
1980
1990
2000
2010
Year
JP

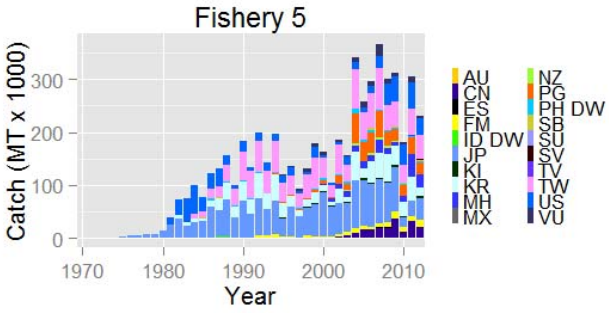

Median length (cm)
70
60
50
1970
1980
1990
2000
2010
Year
JP

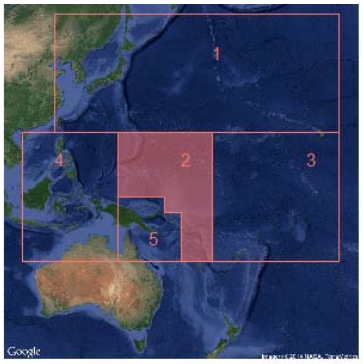

Fishery 4
Catch (MT x 1000)
80
60
40
20
0
1970
1980
1990
2000
2010
Year
JP DW
JP OS

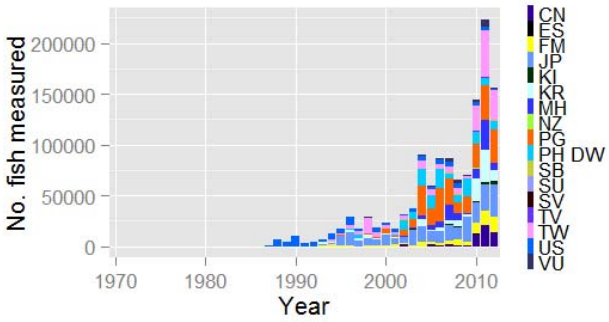

1
2
3
4
5
Google

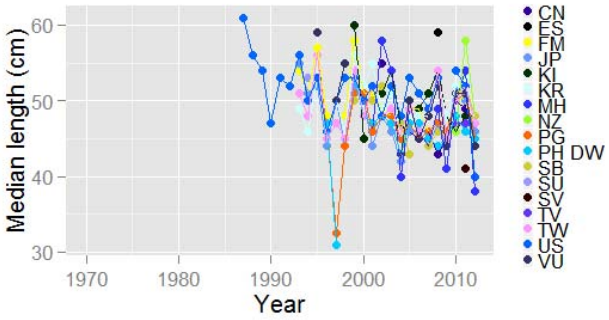

No. fish measured
20000
10000
0
1970
1980
1990
2000
2010
Year
JP
JP DW

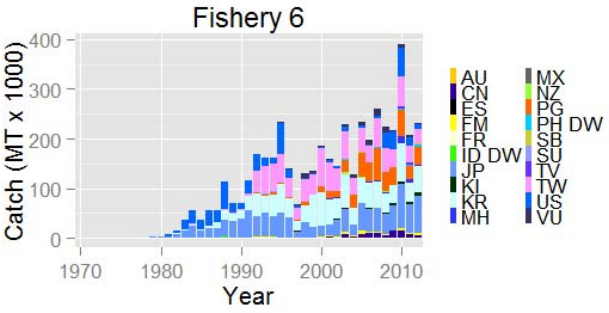

Median length (cm)
60
50
40
1970
1980
1990
2000
2010
Year
JP
JP DW

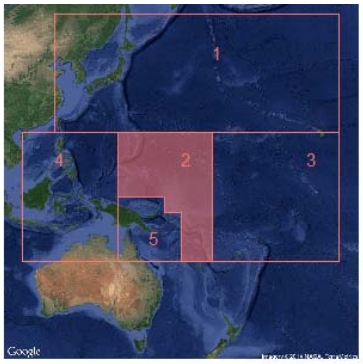

Fishery 5
Catch (MT x 1000)
0
100
200
300
1970
1980
1990
2000
2010
Year
AU
CN
ES
FM
ID DW
JP
KI
KR
MH
MX
NZ
PG
PH DW
SB
SU
SV
TV
TW
US
VU

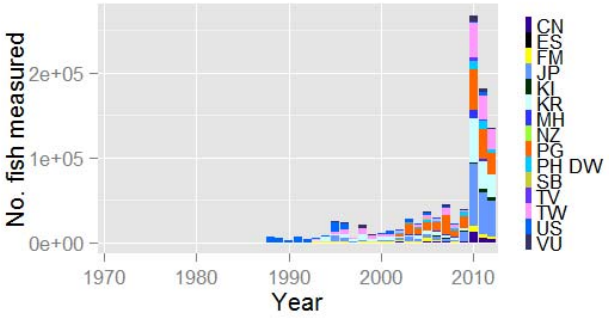

1
2
3
4
5
Google

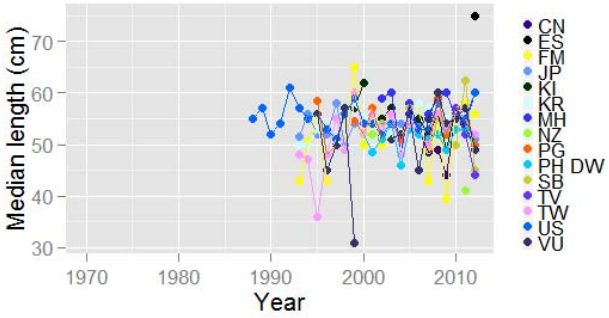

No. fish measured
0
50000
100000
150000
200000
1970
1980
1990
2000
2010
Year
CN
ES
FM
JP
KI
KR
MH
NZ
PG
PH DW
SB
SU
SV
TV
TW
US
VU

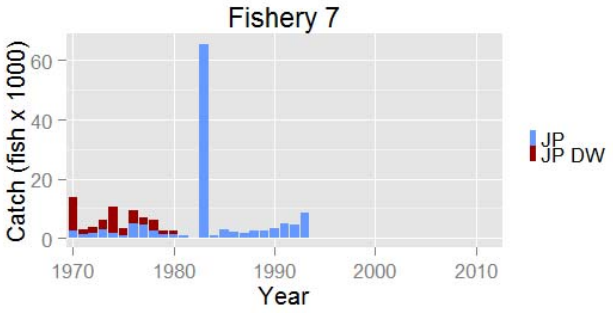

Median length (cm)
30
40
50
60
1970
1980
1990
2000
2010
Year
CN
ES
FM
JP
KI
KR
MH
NZ
PG
PH DW
SB
SU
SV
TV
TW
US
VU

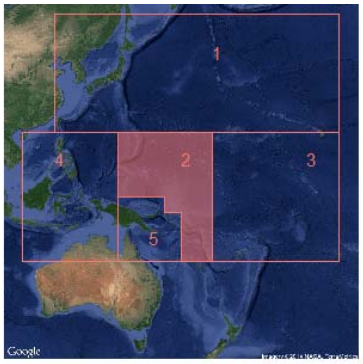

Fishery 6
Catch (MT x 1000)
400
300
200
100
0
1970
1980
1990
2000
2010
Year
AU
CN
ES
FM
FR
ID DW
JP
KI
KR
MH
MX
NZ
PG
PH DW
SB
SU
TV
TW
US
VU

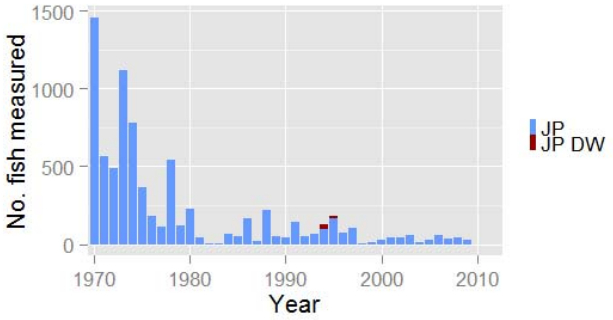

1
2
3
4
5
Google

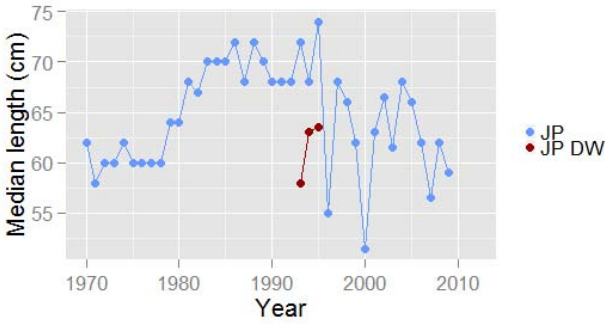

No. fish measured
2e+05
1e+05
0e+00
1970
1980
1990
2000
2010
Year
CN
ES
FM
JP
KI
KR
MH
NZ
PG
PH DW
SB
TV
TW
US
VU

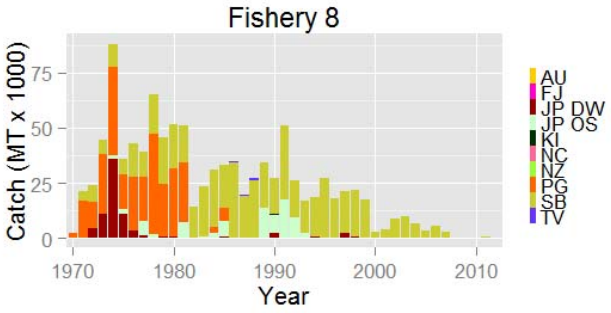

Median length (cm)
70
60
50
40
30
1970
1980
1990
2000
2010
Year
CN
ES
FM
JP
KI
KR
MH
NZ
PG
PH DW
SB
TV
TW
US
VU

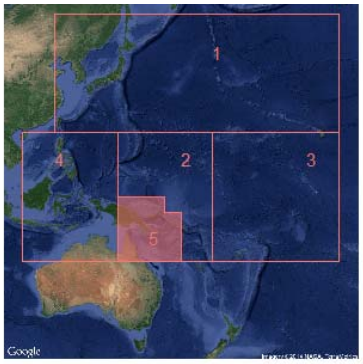

Fishery 7
Catch (fish x 1000)
60
40
20
0
1970
1980
1990
2000
2010
Year
JP
JP DW

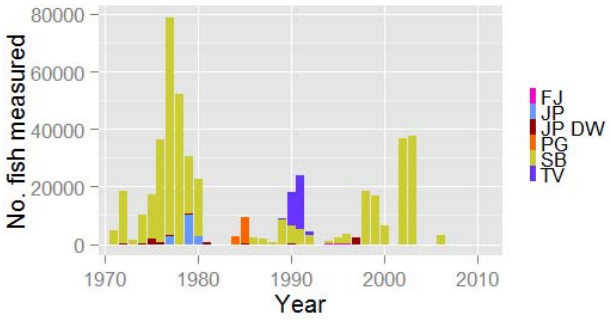

1
2
3
4
5
Google

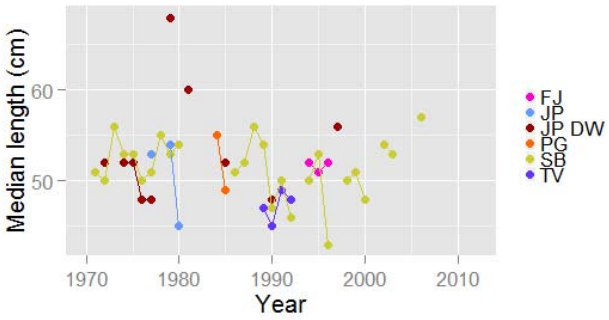

No. fish measured
1500
1000
500
0
1970
1980
1990
2000
2010
Year
JP
JP DW

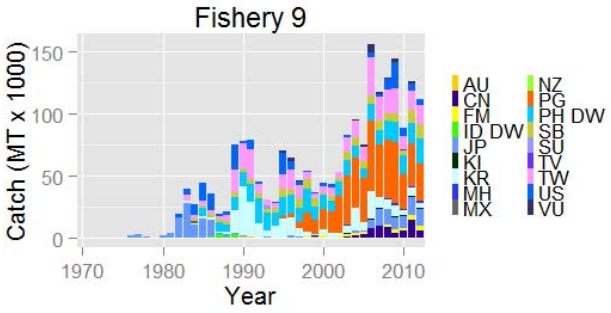

Median length (cm)
75
70
65
60
55
1970
1980
1990
2000
2010
Year
JP
JP DW

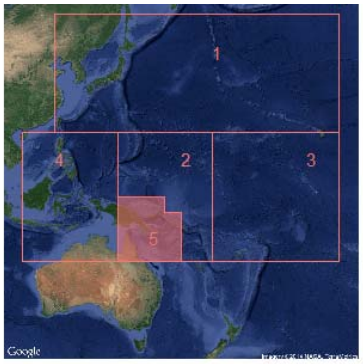

Fishery 8
Catch (MT x 1000)
75
50
25
0
1970
1980
1990
2000
2010
Year
AU
FJ
JP DW
JP OS
KI
NC
NZ
PG
SB
TV

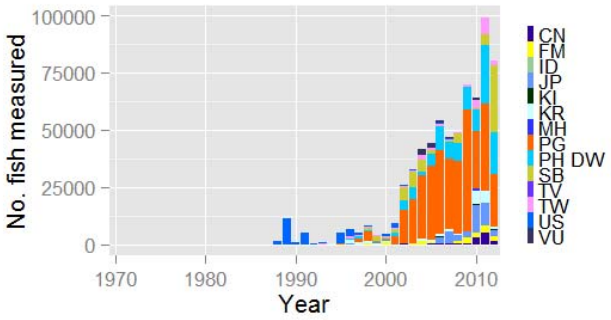

1
2
3
4
5
Google

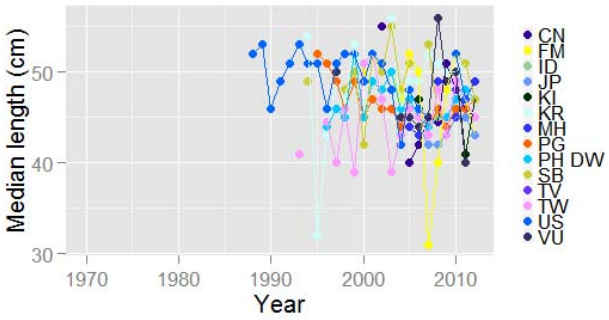

No. fish measured
80000
60000
40000
20000
0
1970
1980
1990
2000
2010
Year
FJ
JP
JP DW
PG
SB
TV

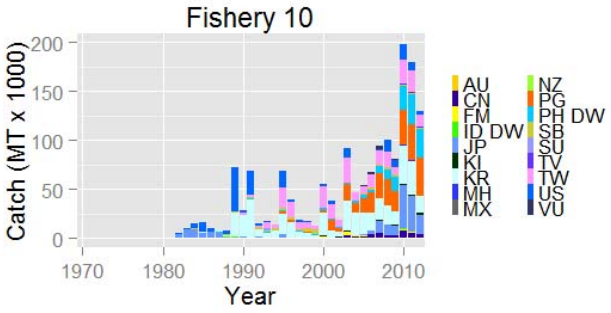

Median length (cm)
60
50
1970
1980
1990
2000
2010
Year
FJ
JP
JP DW
PG
SB
TV

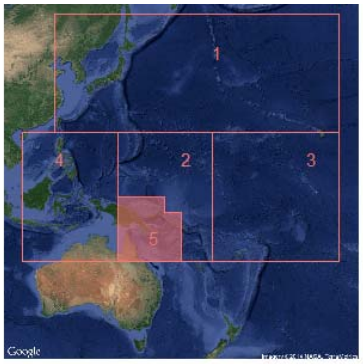

Fishery 9
Catch (MT x 1000)
150
100
50
0
1970
1980
1990
2000
2010
Year
AU
CN
FM
ID DW
JP
KI
KR
MH
MX
NZ
PG
PH DW
SB
SU
TV
TW
US
VU

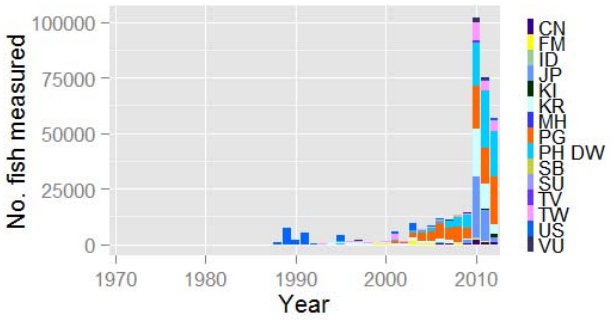

1
2
3
4
5
Google

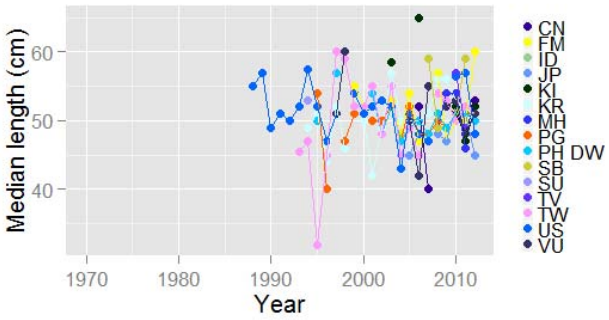

No. fish measured
100000
75000
50000
25000
0
1970
1980
1990
2000
2010
Year
CN
FM
ID
JP
KI
KR
MH
PG
PH DW
SB
TV
TW
US
VU

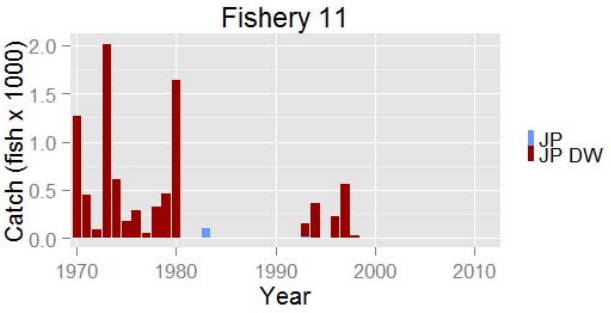

Median length (cm)
50
40
30
1970
1980
1990
2000
2010
Year
CN
FM
ID
JP
KI
KR
MH
PG
PH DW
SB
TV
TW
US
VU

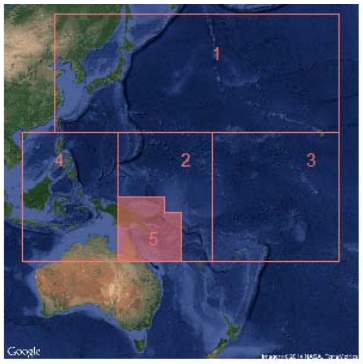

Fishery 10
Catch (MT x 1000)
200
150
100
50
0
1970
1980
1990
2000
2010
Year
AU
CN
FM
ID DW
JP
KI
KR
MH
MX
NZ
PG
PH DW
SB
SU
TV
TW
US
VU

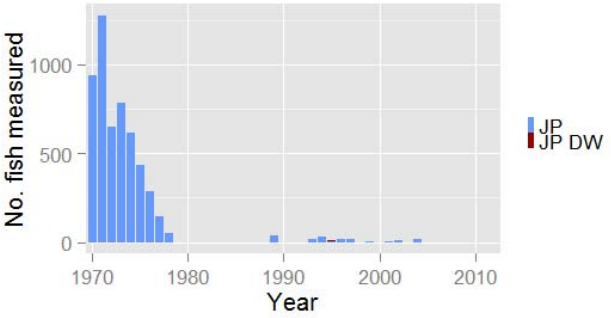

1
2
3
4
5
Google

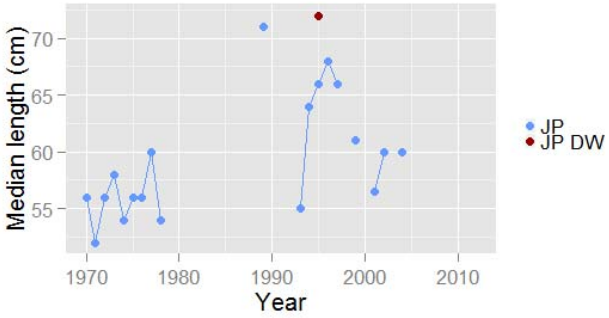

No. fish measured
100000
75000
50000
25000
0
1970
1980
1990
2000
2010
Year
CN
FM
ID
JP
KI
KR
MH
PG
PH DW
SB
SU
TV
TW
US
VU

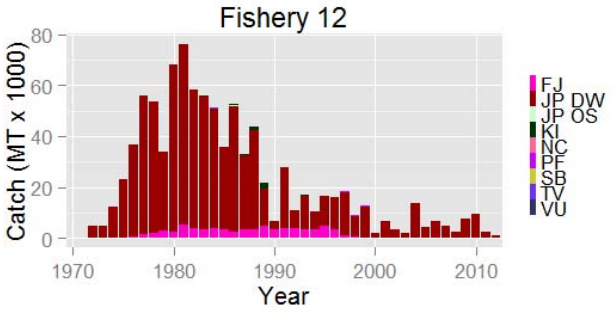

Median length (cm)
60
50
40
1970
1980
1990
2000
2010
Year
CN
FM
ID
JP
KI
KR
MH
PG
PH DW
SB
SU
TV
TW
US
VU

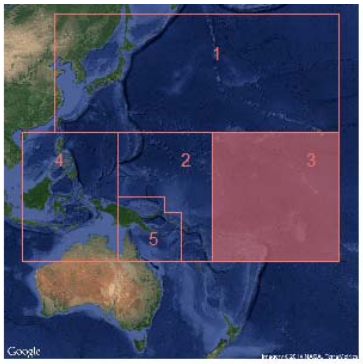

Fishery 11
Catch (fish x 1000)
2.0
1.5
1.0
0.5
0.0
1970
1980
1990
2000
2010
Year
JP
JP DW

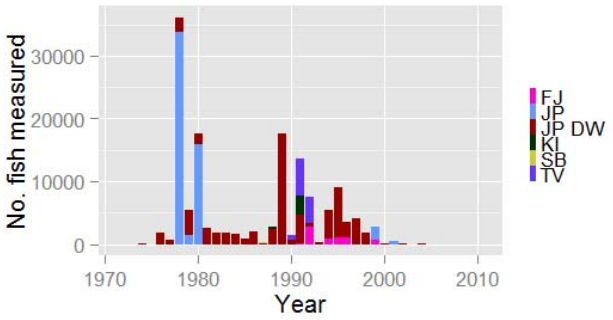

1
2
3
4
5
Google

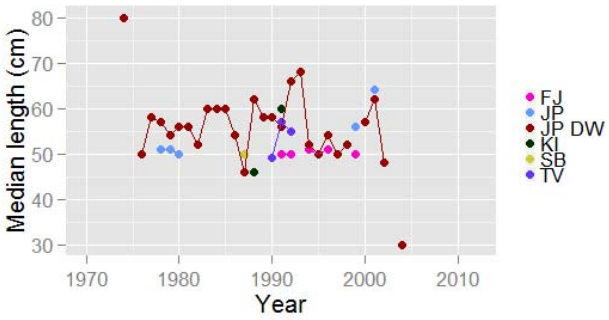

No. fish measured
1000
500
0
1970
1980
1990
2000
2010
Year
JP
JP DW

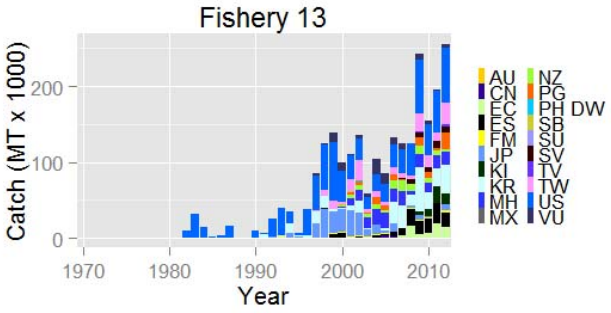

Median length (cm)
70
65
60
55
1970
1980
1990
2000
2010
Year
JP
JP DW

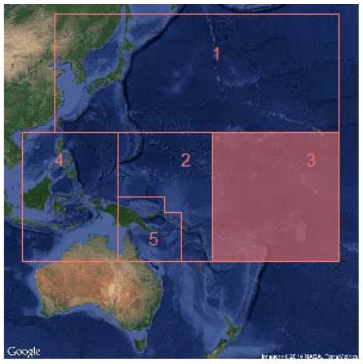

Fishery 12
Catch (MT x 1000)
Year
FJ
JP DW
JP OS
KI
NC
PF
SB
TV
VU

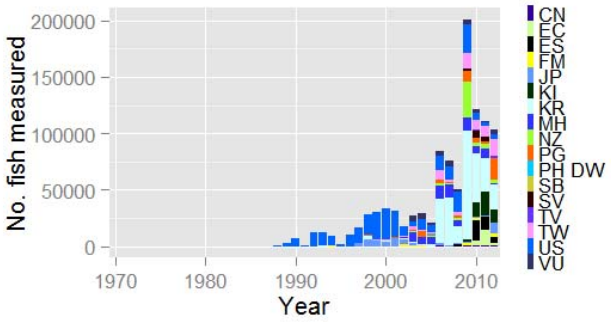

1
2
3
4
5
Google

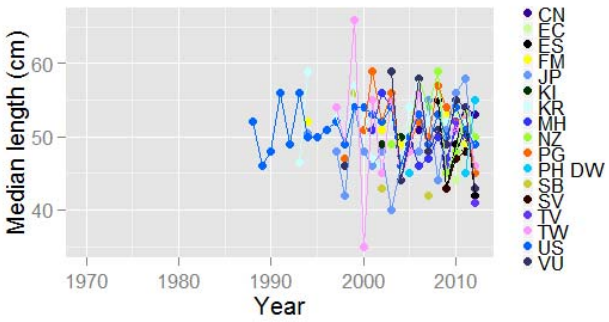

No. fish measured
Year
FJ
JP
JP DW
KI
SB
TV

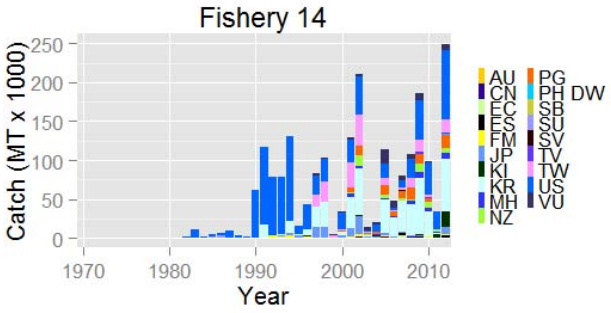

Median length (cm)
Year
FJ
JP
JP DW
KI
SB
TV

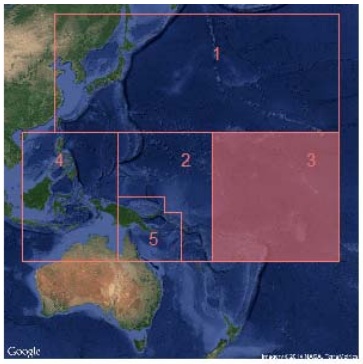

Fishery 13
Catch (MT x 1000)
0
100
200
1970
1980
1990
2000
2010
Year
AU
CN
EC
ES
FM
JP
KI
KR
MH
MX
NZ
PG
PH DW
SB
SU
SV
TV
TW
US
VU

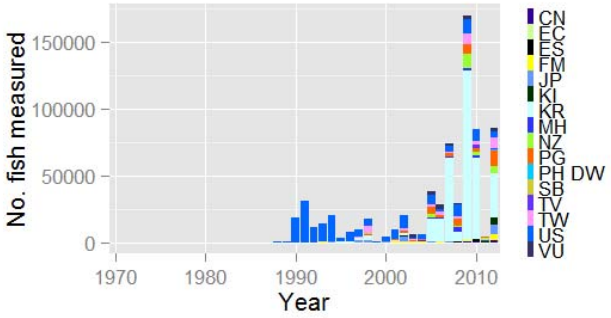

1
2
3
4
5
Google

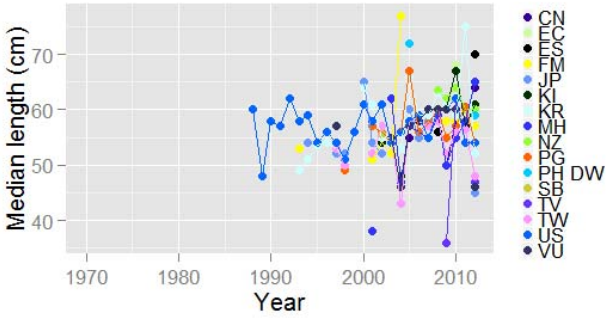

No. fish measured
0
50000
100000
150000
200000
1970
1980
1990
2000
2010
Year
CN
EC
ES
FM
JP
KI
KR
MH
NZ
PG
PH DW
SB
SV
TV
TW
US
VU

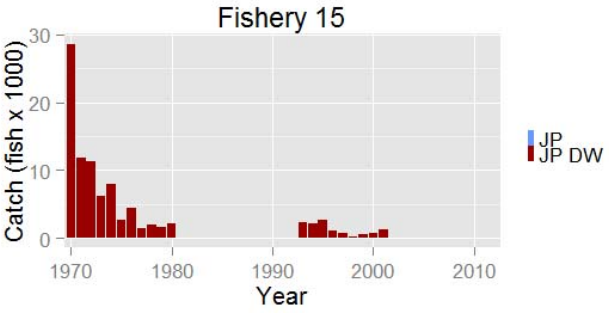

Median length (cm)
40
50
60
1970
1980
1990
2000
2010
Year
CN
EC
ES
FM
JP
KI
KR
MH
NZ
PG
PH DW
SB
SV
TV
TW
US
VU

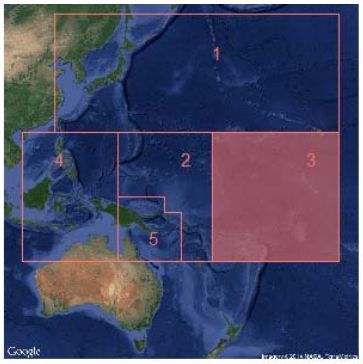

Fishery 14
Catch (MT x 1000)
250
200
150
100
50
0
1970
1980
1990
2000
2010
Year
AU
CN
EC
ES
FM
JP
KI
KR
MH
NZ
PG
PH
SB
SU
SV
TV
TW
US
VU
DW

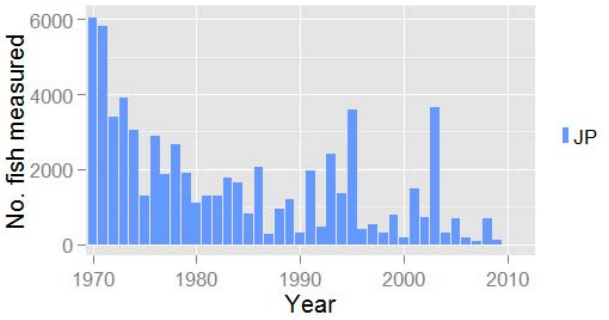

1
2
3
4
5
Google

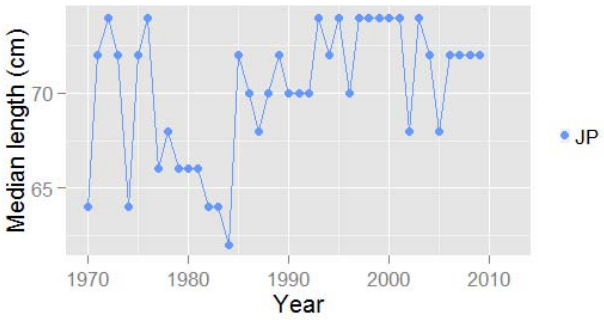

No. fish measured
150000
100000
50000
0
1970
1980
1990
2000
2010
Year
CN
EC
ES
FM
JP
KI
KR
MH
NZ
PG
PH
SB
TV
TW
US
VU
DW

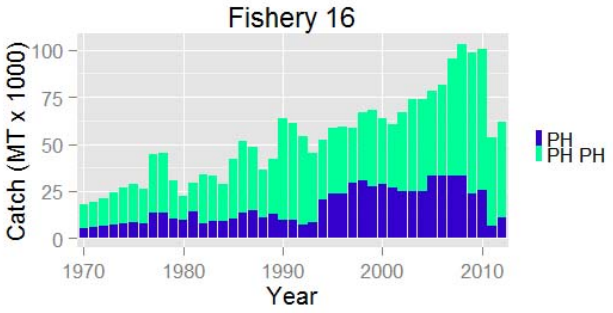

Median length (cm)
70
60
50
40
1970
1980
1990
2000
2010
Year
CN
EC
ES
FM
JP
KI
KR
MH
NZ
PG
PH
SB
TV
TW
US
VU
DW

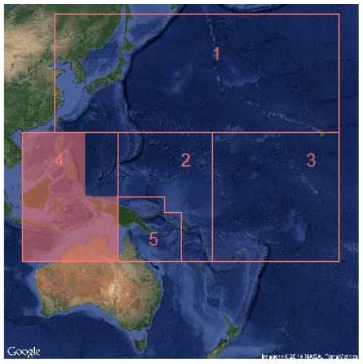

Fishery 15
Catch (fish x 1000)
30
20
10
0
1970
1980
1990
2000
2010
Year
JP
JP DW

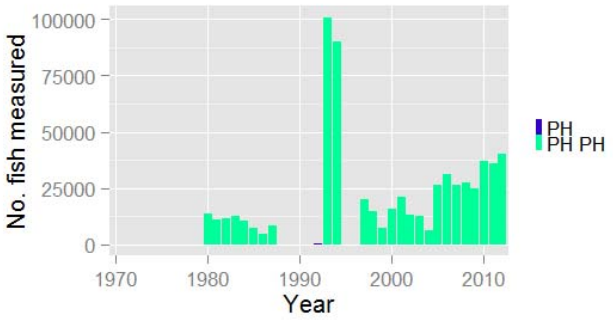

1
2
3
4
5
Google

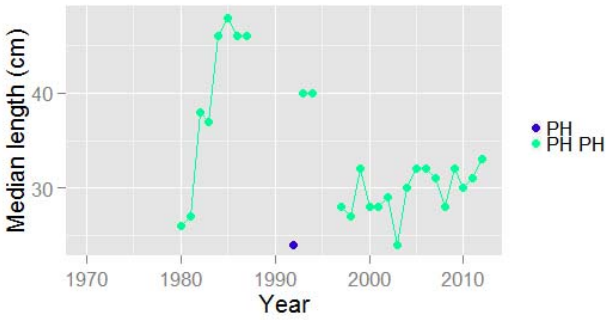

No. fish measured
6000
4000
2000
0
1970
1980
1990
2000
2010
Year
JP

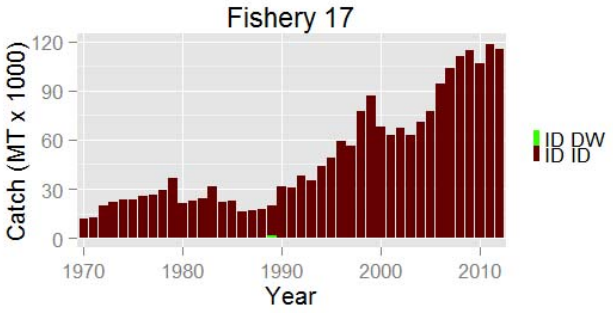

Median length (cm)
70
65
1970
1980
1990
2000
2010
Year
JP

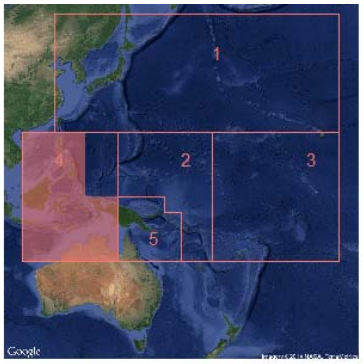

Fishery 16
Catch (MT x 1000)
100
75
50
25
0
1970
1980
1990
2000
2010
Year
PH
PH PH

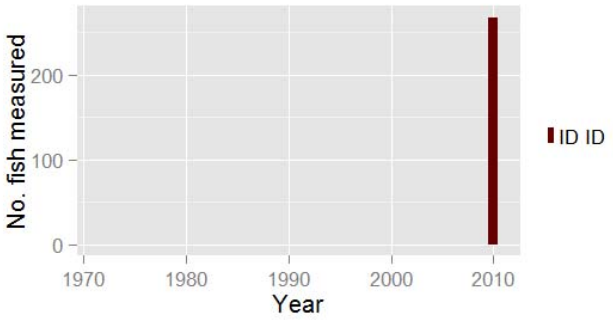

1
2
3
4
5
Google

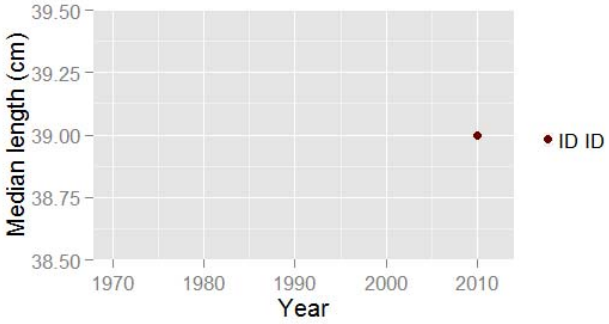

No. fish measured
100000
75000
50000
25000
0
1970
1980
1990
2000
2010
Year
PH
PH PH

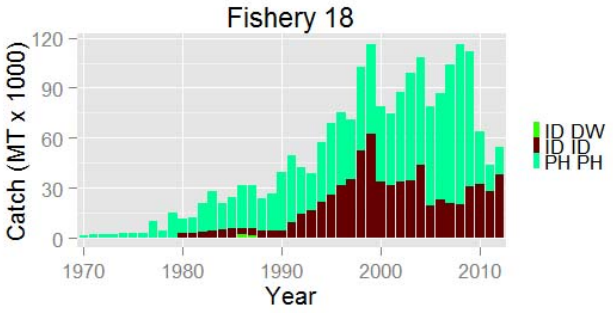

Median length (cm)
40
30
1970
1980
1990
2000
2010
Year
PH
PH PH

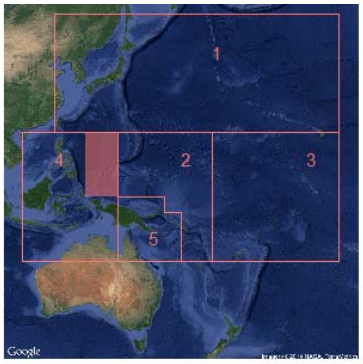

Fishery 17
Catch (MT x 1000)
120
90
60
30
0
1970
1980
1990
2000
2010
Year
ID DW
ID ID

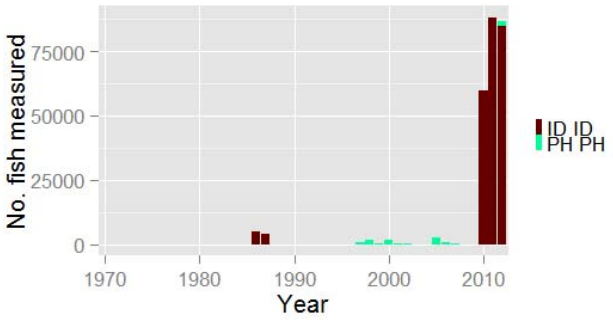

1
2
3
4
5
Google

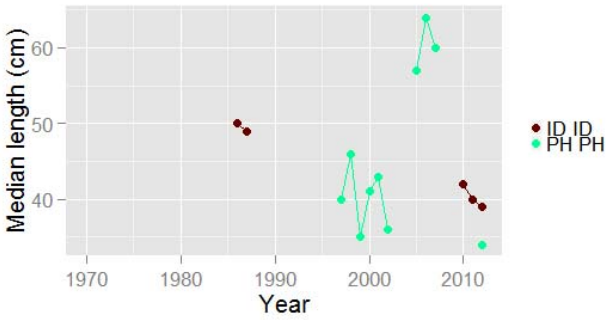

No. fish measured
200
100
0
1970
1980
1990
2000
2010
Year
ID ID

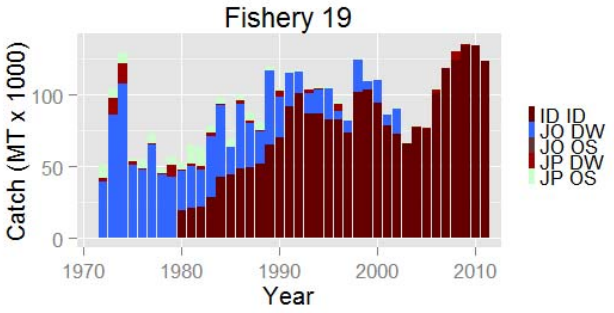

Median length (cm)
39.50
39.25
39.00
38.75
38.50
1970
1980
1990
2000
2010
Year
ID ID

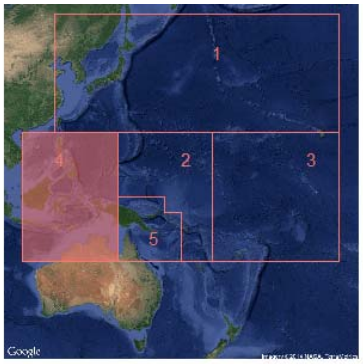

Fishery 18
Catch (MT x 1000)
120
90
60
30
0
1970
1980
1990
2000
2010
Year
ID DW
ID ID
PH PH

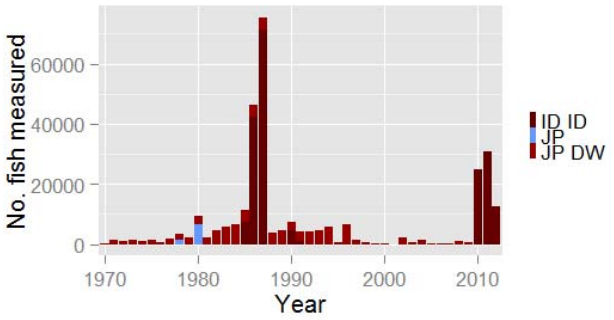

1
2
3
4
5
Google

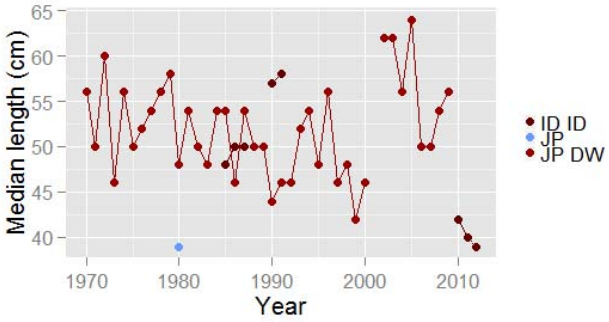

No. fish measured
75000
50000
25000
0
1970
1980
1990
2000
2010
Year
ID ID
PH PH

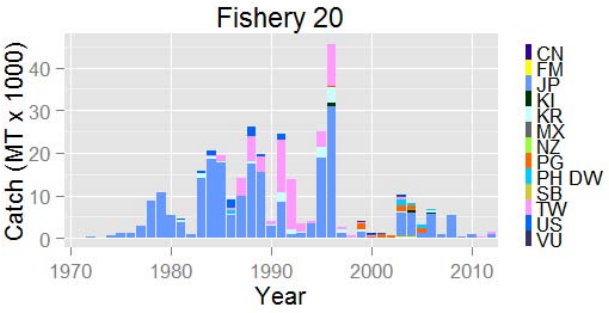

Median length (cm)
60
50
40
1970
1980
1990
2000
2010
Year
ID ID
PH PH

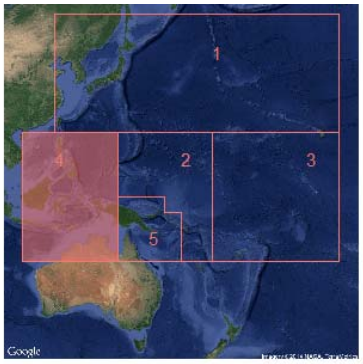

Fishery 19
Catch (MT x 1000)
100
50
0
1970
1980
1990
2000
2010
Year
ID ID
JO DW
JO OS
JP DW
JP OS

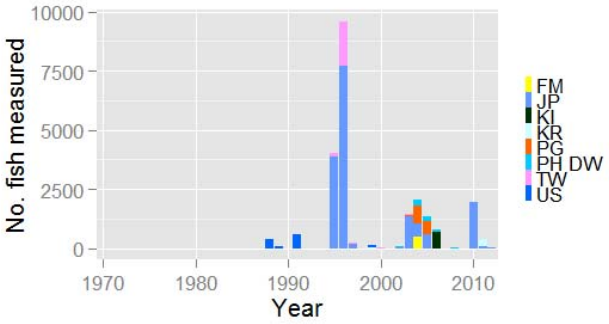

1
2
3
4
5
Google

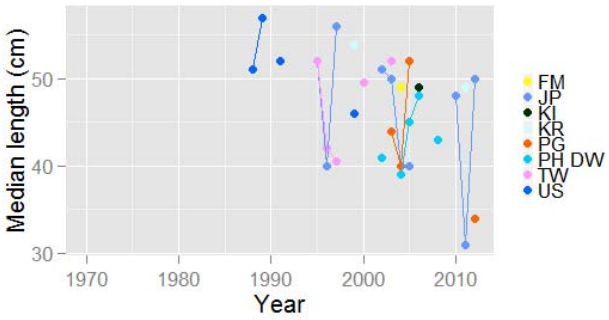

No. fish measured
60000
40000
20000
0
1970
1980
1990
2000
2010
Year
ID ID
JP
JP DW

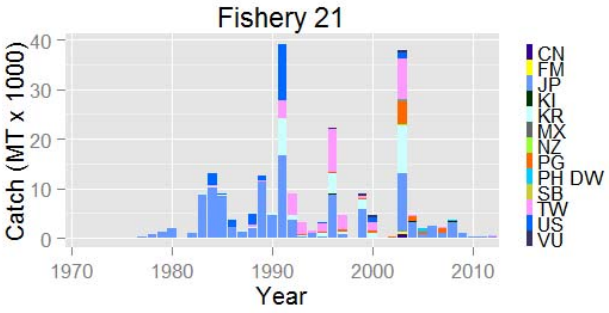

Median length (cm)
65
60
55
50
45
40
1970
1980
1990
2000
2010
Year
ID ID
JP
JP DW

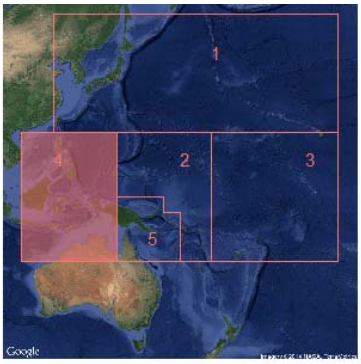

Fishery 20
Catch (MT x 1000)
0
10
20
30
40
1970
1980
1990
2000
2010
Year
CN
FM
JP
KI
KR
MX
NZ
PG
PH DW
SB
TW
US
VU

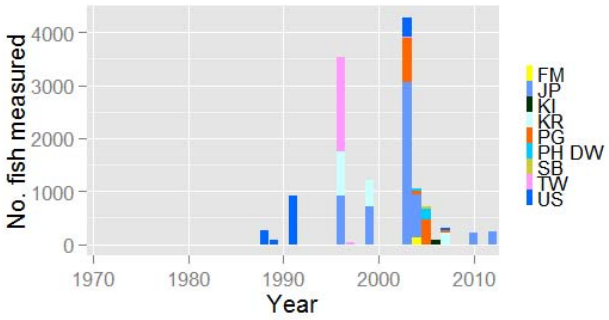

1
2
3
4
5
Google

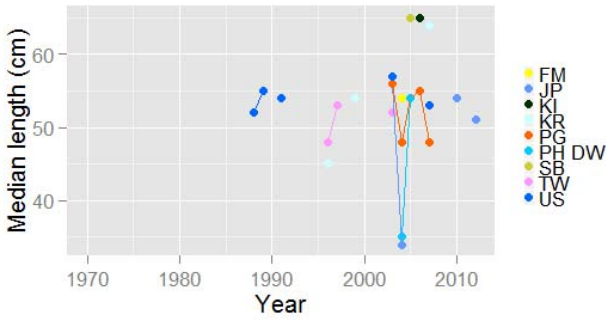

No. fish measured
0
2500
5000
7500
10000
1970
1980
1990
2000
2010
Year
FM
JP
KI
KR
PG
PH DW
TW
US

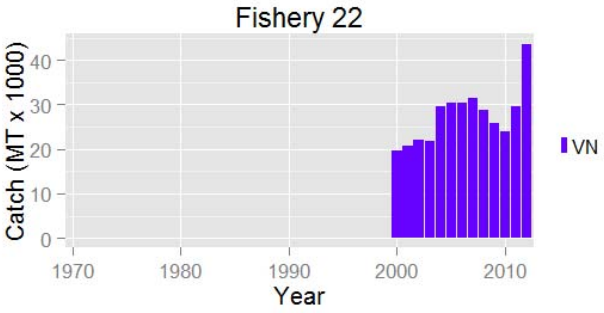

Median length (cm)
30
40
50
1970
1980
1990
2000
2010
Year
FM
JP
KI
KR
PG
PH DW
TW
US

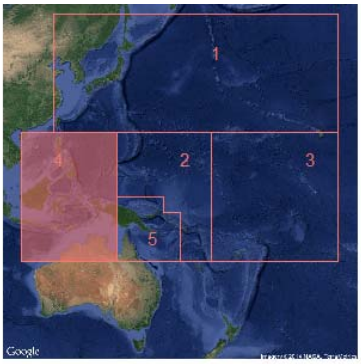

Fishery 21
Catch (MT x 1000)
40
30
20
10
0
1970
1980
1990
2000
2010
Year
CN
FM
JP
KI
KR
MX
NZ
PG
PH DW
SB
TW
US
VU

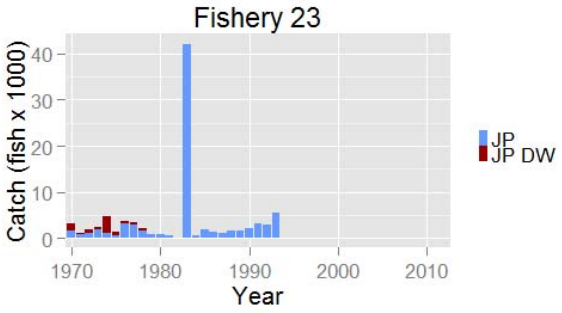

1
2
3
4
5
Google

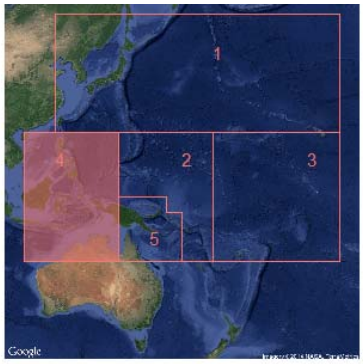

No. fish measured
4000
3000
2000
1000
0
1970
1980
1990
2000
2010
Year
FM
JP
KI
KR
PG
PH DW
SB
TW
US

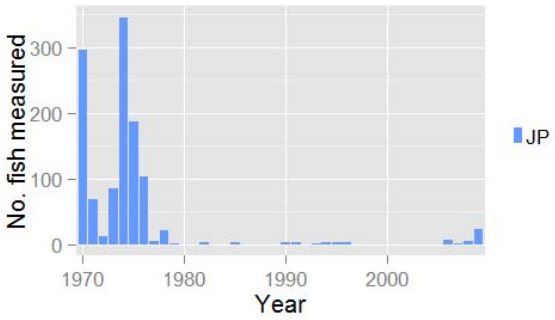

Median length (cm)
60
50
40
1970
1980
1990
2000
2010
Year
FM
JP
KI
KR
PG
PH DW
SB
TW
US

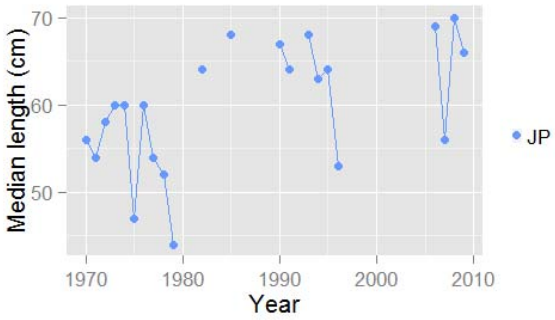

Fishery 22
Catch (MT x 1000)
40
30
20
10
0
1970
1980
1990
2000
2010
Year
VN


1
2
3
4
5
Google


Fishery 23
Catch (fish x 1000)
0
10
20
30
40
1970
1980
1990
2000
2010
Year
JP
JP DW


1
2
3
4
5
Google


No. fish measured
0
100
200
300
1970
1980
1990
2000
Year
JP


Median length (cm)
50
60
70
1970
1980
1990
2000
2010
Year
JP