

**Feature by feature catch and effort analysis of the ORH 1
fishery to the end of the 2007–08 fishing year**

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**Published by Ministry of Fisheries
Wellington
2010**

**ISSN 1175-1584 (print)
ISSN 1179-5352 (online)**

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**Ministry of Fisheries
2010**

Mormede, S. (2010).
Feature by feature catch and effort analysis of the ORH 1 fishery
to the end of the 2007–08 fishing year.
New Zealand Fisheries Assessment Report 2010/28.

This series continues the informal
New Zealand Fisheries Assessment Research Document series
which ceased at the end of 1999.

EXECUTIVE SUMMARY

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The orange roughy fishery around both sides of the North Island of New Zealand (ORH 1) started in 1994 and was initially managed through a Total Allowable Catch (TAC) of 190 t. From 1996 it was managed under various Adaptive Management Programmes (AMPs). As a result, the orange roughy TACC in that area was increased to 1190 t, initially in exchange for increased data collection and a more complex set of regulations. One of the aims of the AMPs was to reduce fishing pressure in some areas and increase exploration in new areas of ORH 1, which was achieved. This trend of new explorations is slowly declining, as is the total yearly catch of orange roughy from ORH 1.

Under the latest AMP (2001–2006), the fishery was managed on a feature-by-feature basis, with individual feature catch limits based on minimum raw catch per unit effort (CPUE) based on orange roughy target tows. The definition of orange roughy target tows was investigated, as orange roughy and cardinalfish are typically caught in similar depths. The concern was that the AMP rules might have influenced the species recorded as being the target. Data show that the cardinalfish fishery in ORH 1 was difficult to distinguish from the orange roughy fishery based on the location and characteristics of the tows. However, recording characteristics for the cardinalfish fishery do not seem to have changed since the inception of the AMPs, and therefore it may be reasonable to assume the recording of target species has not been seriously influenced by the AMP rules.

Catch and effort for ORH 1 were analysed on a feature-by-feature basis. Only 13 out of the 120 fished features have a total orange roughy catch over 150 t, and only 3 features (including the Manukau box) have a total orange roughy catch of more than 1000 t. Therefore the ORH 1 area is probably a low-production area for orange roughy, compared for example with the Andes hills on the Chatham Rise where over 16 000 t of orange roughy have been extracted to date.

Total catches per feature also suggest that the AMP yearly feature limits of 75 to 150 t per feature are likely to be too high. These feature limits were to be reduced if the raw CPUE on the feature dropped below 2 t/tow. Only three or four of those features have had a raw CPUE consistently over 2 t/tow, but it is not believed this rule was ever invoked under the AMP.

However, even though the feature limits are high compared with total catches on those features, and the CPUE was lower than the AMP threshold, the cumulative catches per cumulative tow are still increasing on most features. A number of features have had strongly reduced or zero fishing effort in recent years, linked with a reduction in CPUE. These might indicate localised hill depletion.

This is the final report on all the work carried out for the Ministry of Fisheries under projects SAP2007/20 and SAP2008/22.

1. INTRODUCTION

Orange roughy are the focus of an important deepwater fishery in New Zealand, and have been fished for over 30 years (e.g., Ministry of Fisheries Science Group 2007). The Quota Management Area ORH 1 covers both sides of the north of the North Island, with its coastline extending north from north of Wellington on the west coast, around the North Island to Cape Runaway east of the Bay of Plenty on the east coast. ORH 1 was further subdivided in 2001 into four management subareas (A to D) and specific feature-based small scale boxes were defined. The ORH 1 area, subareas, and feature-based small scale boxes are detailed in Figure 1.

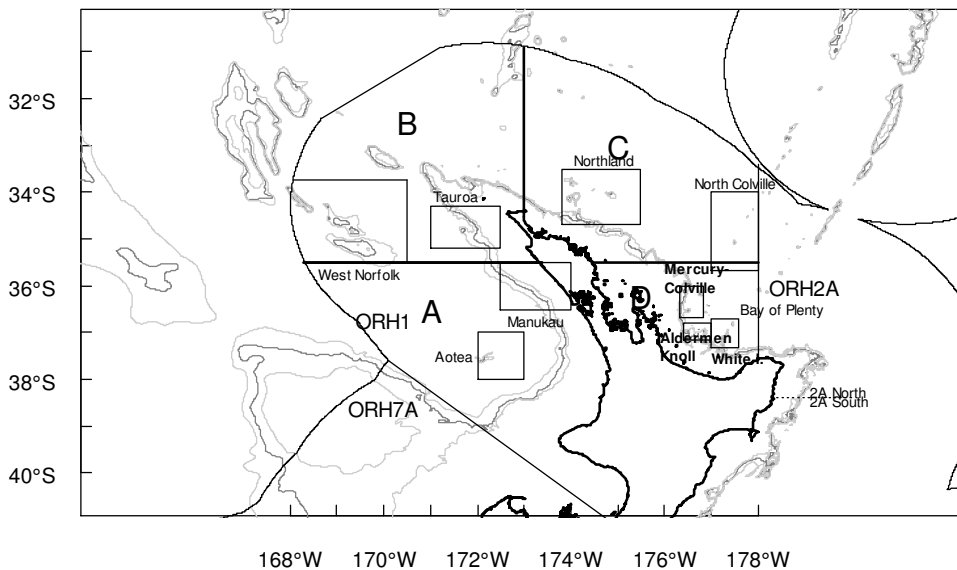


Figure 1: Map of the ORH 1 Quota Management Area, management subareas, and feature-based boxes; depth contours at 1000 m (dark grey), 750 m, and 1250 m (both light grey).

There was exploratory fishing in ORH 1 during the early to mid 1980s, with the commercial fishery first developing in the western Bay of Plenty after 1994, in the area now known as the Mercury-Colville box. A Total Allowable Commercial Catch (TACC) of 190 t was set from 1989–90. Before that there had been a 10 t TAC and various levels of exploratory quota.

From 1995–96, ORH 1 became subject to a five year Adaptive Management Programme (AMP), and the TACC was increased to 1190 t, with 1000 t applied to the Mercury-Colville box and the former 190 t TACC applicable to the remainder of ORH 1. Various levels of research and exploratory fishing were also carried out. The AMP was concluded in 2000 and the TACC was reduced to 800 t for the 2000–01 fishing year. Catch limits of 200 t were established in each of four areas in ORH 1, with an individual seamount feature limit of 100 t. From 1 October 2001, ORH 1 was reintroduced into the AMP with different design parameters for five years, and the TACC was increased from 800 to 1400 t. This programme ran for five years, ending on 30 September 2006. The TAC and management rules were not changed subsequently.

Catch and effort analyses have been carried out in most years throughout the AMP periods, with the most recent analysis covering up to the end of the 2005–06 fishing year (Anderson 2007). The only stock assessment for this fishery was conducted in 2001, and only for the Mercury-Colville box (Ministry of Fisheries Science Group 2007), which was found to be depleted.

The aim of the present report is to characterise this fishery at a finer spatial level, particularly in the light of the current management programme. Specific objectives of the research were as follows.

- How is the orange roughy fishery defined, and separated from the cardinalfish fishery; are there other definitions of “orange roughy-capable tows” that do not include recorded target information?
- What data should be selected for CPUE analyses and what impact does the selection have on the AMP regulations? Test the AMP data selections of 2-minute cut-off rule, 600m depth and target species.
- Analyse CPUE and cumulative catches per feature.

This is the final report on all the work carried out for the Ministry of Fisheries under projects SAP2007/20 and SAP2008/22.

2. THE ADAPTIVE MANAGEMENT PROGRAMME (AMP)

2.1 Details of the 2001–06 AMP rules and results

The following information is based on the latest report on ORH 1 from the Ministry of Fisheries Science Group (2007). The TACC was increased from 800 to 1400 t in October 2001–02 under the Adaptive Management Programme. The objectives of this AMP were to determine stock size, geographical extent, and long-term sustainable yield of the ORH 1 stock, as well as to encourage the spread of effort over the entire ORH 1 area. This was a complex AMP, with ORH 1 divided into four subareas (see Figure 1), each with total catch and “feature” catch limits (a “feature” was defined as being within a 10 n. mile radius of the shallowest point). Total and feature catch limits are detailed in Table 1.

Table 1: Limits applied to ORH 1 during the second AMP (2001–06).

ORH 1 subarea	Catch limit (per fishing year)	Feature limit (per fishing year)
Area A	200 t	100 t
Area B	500 t	150 t
Area C	500 t	150 t
Area D	200 t (30 t for Mercury Colville)	75 t (30 t for Mercury Colville)

Feature limits also served as limits to the total catch in any area due to the limited number of available productive features. The Mercury-Colville box (located within Area D) had been given a specific limit of 30 t per year to allow for the bycatch of orange roughy when fishing for black cardinalfish. The catch of orange roughy in the Mercury-Colville box was included in the overall limit for Area D. The AMP also proposed that if the raw CPUE of target orange roughy tows (of longer than 2 minutes at deeper than 600 m) dropped below 2 tonnes per tow, the feature limit be reduced; it is not believed that this rule has been used to date.

A full review of the AMP was carried out in 2007, and concluded that it was unknown where the stock was in relation to B_{msy} and whether the harvest was sustainable. It also concluded that there was no further data collection warranted that could provide further insights into the state of this fishery. Although the AMP is no longer in operation, the catch and feature limits are still in place.

2.2 Some issues arising from the AMP

The latest AMP on ORH 1 focussed on limiting catches on a feature-by-feature basis in order to avoid localised depletion such as that which has happened in the Mercury-Colville box, and to promote a spread of the fishing effort and catches over the entire ORH 1 area. The following questions arose from this management regime and are dealt with in the present document.

- Did the AMP succeed in spreading the effort on different features?
- What proportion of the catches was not assigned to features and therefore not liable to the feature limit, and what can be done about it?
- What was the cumulative catch on each feature, and were the feature limits proposed adequate in restraining the effort on those features?

The other main rule of the AMP was the 2 t/tow rule, whereby if the raw CPUE on a feature dropped below 2 t/tow, the feature limit would be reduced. This was a safeguard built in to avoid over-depletion in case a feature limit was too high for specific features. It is believed this rule was never employed. It raised some interesting issues since data selection would strongly impact on the raw CPUE figure calculated. This data selection included ORH target tows deeper than 600 m and longer than 2 minutes only. Definition of the fishery (ORH target vs. others) and qualifying tows are investigated further.

3. DATA SELECTION

3.1 The data available

Only data recorded on TCEPR forms were used for the present analysis since only 300 t of orange roughy was reported using CELR compared to over 13 000 t reported using TCEPR.

In some parts of the ORH 1 area, the cardinalfish and orange roughy fisheries overlap. In order to ensure the inclusion of all orange roughy data, two distinct datasets were defined for ORH 1, and subsequently analysed. Tows and orange roughy catches as a function of target fishery in both datasets are detailed in Table 2. The data were groomed by Anderson (2007).

- The orange roughy dataset, containing all tows which caught or targeted orange roughy. Over all years, about 15% of the effort did not target orange roughy but caught some.
- The cardinalfish dataset, which contains all tows that caught or targeted cardinalfish without catching orange roughy (those tows are included in the orange roughy dataset). About 5000 t of cardinalfish were caught without catching orange roughy on 200 tows, and just over 2300 t was caught in conjunction with orange roughy

Table 2: Description of the orange roughy and cardinalfish datasets for ORH 1, with number of tows targeting specific species, and total catches of orange roughy in tonnes detailed per target species.

target	ORH target		CDL target		ORH 1 dataset		CDL dataset	
	tows	t ORH	tows	t ORH	Other species target tows	t ORH	CDL target tows	Other tows
1981	1	0						
1982	20	0						
1986	12	0						
1988	3	0						
1989	3	15						
1990	22	62						
1991	1	0			1	<1		
1992	1	0						
1993	23	37						
1994	97	188			1	1	2	
1995	61	247	84	145	4	5	153	5
1996	413	712	101	224	1	1	206	2
1997	680	868	78	120			303	
1998	1069	500	57	14	2	<1	250	1
1999	851	1490	93	74			249	
2000	699	1371	124	67			276	
2001	122	396	101	339	8	39	128	2
2002	482	994	74	122	10	102	139	6
2003	614	1033	122	109	9	1	296	9
2004	501	860	96	91	31	22	218	54
2005	421	898	155	120	9	1	223	83
2006	535	1049	27	11	7	5	203	67
2007	554	945	35	19	2	<1	129	3

3.2 Defining the orange roughy fishery

For management purposes, the orange roughy fishery was defined in the AMP as tows that targeted orange roughy only. Such wording of the AMP could have influenced on the reported target, with the fishery moving away from recording orange roughy as a target towards stating cardinalfish as a target when the orange roughy catch was low. However, the data do not suggest such a shift, with the number of tows targeting either orange roughy or cardinalfish remaining relatively stable through time (Figure 2). Fishing year 2000–01 was an obvious outlier; it was the year before the second AMP when the TACC was reduced to 800 t, which might have influenced the species recorded and/or the catches themselves.

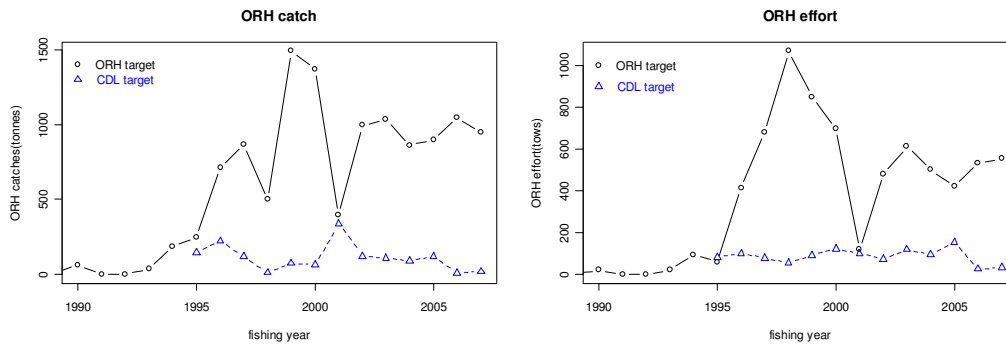


Figure 2: Yearly orange roughy catch and effort, split by recorded fishing target (orange roughy or cardinalfish). The years correspond to the latter of fishing years, for example 2001 corresponds to the 2000–01 fishing year.

Cardinalfish is also a species of commercial importance in the area, with a distribution that might be similar to that of orange roughy, and therefore cardinalfish target tows could be justifiably added to the orange roughy dataset. Some of the main characteristics of the tows in each dataset are summarised in Table 3. These results show that a tow fishing for cardinalfish is very difficult to distinguish from a tow fishing for orange roughy based on the location of fishing (relative to seamounts), speed, distance, duration, or depth of the tow. Therefore the definition used in the AMP might not be suitable to define an “orange roughy capable tow” and this criterion could be broadened to include those tows that targeted cardinalfish without catching orange roughy where the fisheries overlap.

Table 3: Quartiles of some fisheries characteristics of the orange roughy and cardinalfish datasets, 1981–82 to 2006–07.

Dataset	# Tows	Distance from hill (n. mile.)	Speed (kn)	Distance (km)	Duration (hrs)	Bottom depth at start (m)
Cardinalfish dataset	3007	0.7 – 2.0	2.8 – 3.3	0.0 – 3.0	0.15 – 0.50	745 – 825
Orange roughy dataset	8420	1.2 – 4.5	2.8 – 3.0	0.9 – 4.0	0.17 – 0.75	790 – 947

The obvious effect of including the cardinalfish dataset with the orange roughy dataset was to reduce the raw CPUE (by adding tows that didn’t catch orange roughy), while keeping the trends with time similar since the zero tows were relatively constant over time. In a similar fashion, excluding tows less than 2 minutes in duration tended to reduce the number of low-catches tows and therefore increased the raw CPUE. Mean yearly raw CPUEs for the entire ORH 1 using different data selection criteria are detailed in Table 4. Depending on which dataset is used, the AMP 2 t/tow rule might or might not have been breached in individual years (note that this table is for information only, as the AMP rule was on a feature by feature basis).

Table 4: Mean raw CPUE indices for the 2002 to 2007 fishing years for various datasets. Also provided are data cut-offs (minimum tow duration and depth as detailed in columns 2 and 3) if used and the number of tows considered in the dataset used.

Dataset	Cut-offs		# Tows	Raw CPUE (t/tow)					
	Time (min)	Depth (m)		2002	2003	2004	2005	2006	2007
AMP report	2	600	?	2.27	1.69	1.75	2.45	2.30	
ORH target + cutoff	2	600	6829	2.16	1.74	1.74	2.19	2.04	1.84
ORH target	0	0	7188	2.06	1.68	1.72	2.13	1.96	1.71
ORH dataset + cutoff	2	600	8030	2.24	1.60	1.58	1.78	1.94	1.75
ORH dataset	0	0	8420	2.15	1.54	1.55	1.74	1.87	1.63
ORH and CDL datasets	0	0	11427	1.71	1.09	1.08	1.14	1.27	1.33

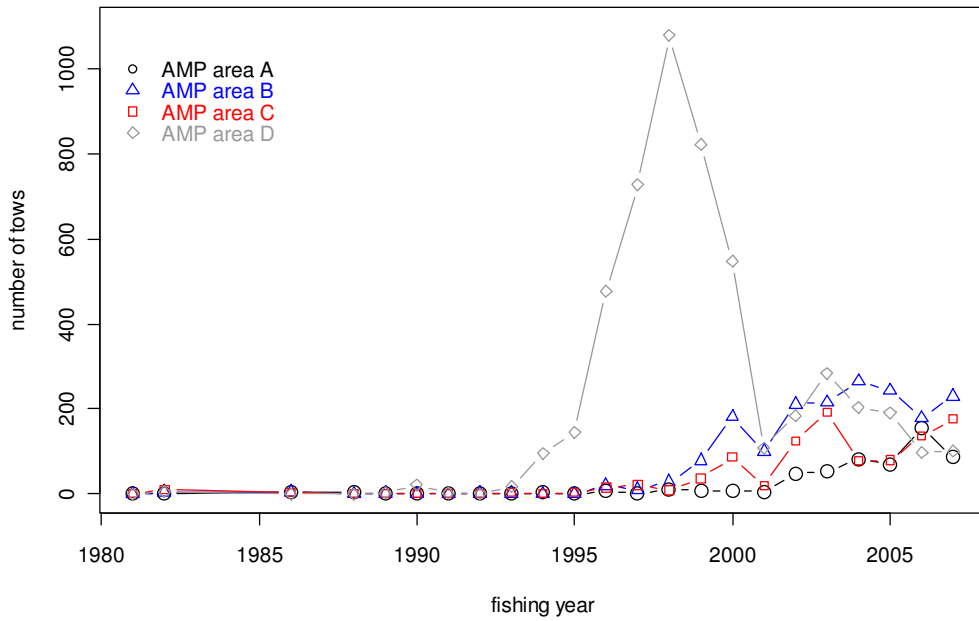
The aim of the 2 minute rule was to avoid including tows thought to have missed marks or come fast. However, they might also exclude short tows that have hit schools. Other selection criteria might be more appropriate, such as that used in other orange roughy fisheries where tows less than 6 minutes in duration and which caught less than 100 kg of fish are excluded from the analysis (e.g., Dunn et al. 2008).

3.3 Spatial spread of the fishery

The catch and effort trends of orange roughy in the four ORH 1 AMP areas are described in Figure 3. Both effort and catch were very limited until 1994 when the fishery developed in the Mercury-Colville box (AMP area D). AMP areas B and C were developed in 1998, which also coincided with the highest effort in AMP area D. AMP area A developed in 2002, following the second AMP inception.

In order to investigate the spread of effort through time, the fishery area was subdivided into small squares of 0°02' longitude by 0°02' latitude. The total numbers of those coordinates fished for the first time each year are plotted in Figure 4. Exploration of new grounds started in earnest in 1997 and remained at a relatively high level until 2005 when it dropped off a little; cumulative figures suggest a steady increase. The obvious exception is 2001, which could be due to the change in management programmes. Therefore it seems that the AMPs might have succeeded (or helped) in increasing the spread of the fishery.

Number of tows per AMP area



ORH catch per AMP area

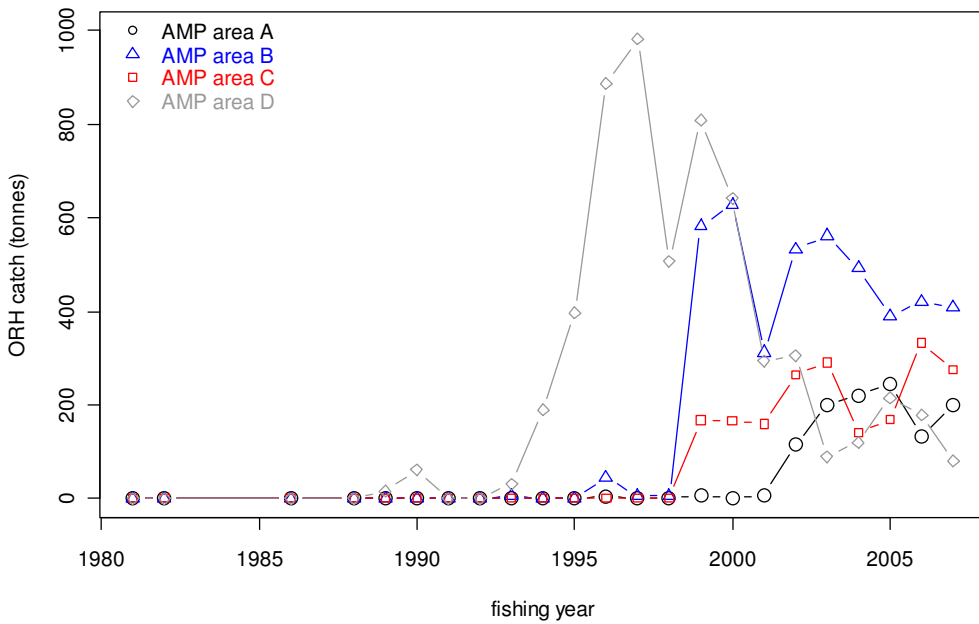


Figure 3: Effort and catch of orange roughy in ORH 1 detailed by AMP area.

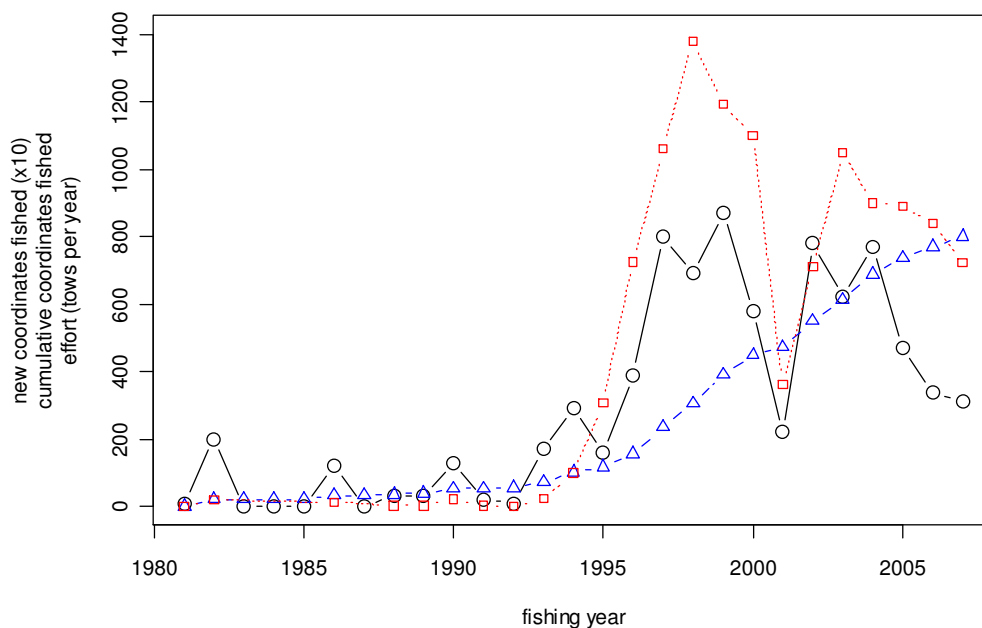


Figure 4: Yearly number of new coordinates fished in ORH 1 (squares), cumulative new coordinates (triangles) and yearly effort (circles).

4. FEATURE BY FEATURE ANALYSIS

4.1 Assigning tows to features

Since the inception of the second AMP in 2001, there have been catch limits for orange roughly associated with specific features. A list of features was compiled from the NIWA seamounts database (M. Clark, NIWA, pers. comm.) plus any features used in the ORH 1 AMP not recorded in the seamounts database. Each tow was assigned to a feature if its start position was within 10 n. miles of the feature. If a tow was within 10 n. miles of multiple features, the proportion of both tow and catch was allocated to each feature relative to its distance, which resulted in non-integer number of tows per feature.

About 20% of the orange roughly catches were not assigned to any feature, with this proportion varying in time and location. For example, tows in area A were almost 100% unassigned whereas those in area D were only 2% unassigned. The feature rule worked well for the historic fishery in area D, but not as well in new fisheries.

Some hot spots in the fishery, not already assigned to known features, were created based on fishing distribution (15 in total). These could be features not captured in the seamount database to date, or may be smaller features, ridges etc. These hot spots accounted for 45% of the unassigned effort and 38% of the unassigned catches. Most of the remaining unassigned effort and catches came from the Manukau and Tauroa boxes, where fishing is on the 1000 m contour rather than on specific features. These two boxes were treated as individual features in the present analysis. Only 3% of tows and catches were still not assigned and are not considered further.

4.2 Cumulative catch per feature

A feature-by-feature catch and effort analysis was carried out to ascertain the level of effort and catches on those features, and whether there was any trend. The orange roughy dataset was used, which included all tows that targeted or captured orange roughy. Two analyses were carried out: one used orange roughy target tows only, and one used both orange roughy and cardinalfish tows. They showed similar trends, but the absolute CPUE values were lower when using the cardinalfish tows (see Section 3.2 for further details). In this section, features will include the known features, hot spots, and also the Manukau and Tauroa boxes.

A table of cumulative catches per feature is provided in Appendix 1. Yearly orange roughy CPUE and cumulative catches per feature are shown in Appendix 2. Only features where more than two tows were carried out over the entire fishery were plotted, dropping 65 fished features from Appendix 2. Cumulative catch was plotted as the total catch as a function of the total tows carried out, each point representing a full fishing year of data.

For each AMP area, the total orange roughy catches per feature were very variable but usually small, with total catches on most features below 150 tonnes to date. The number of features that reached various thresholds per AMP area is detailed in Table 5. Because this table is to be compared with the total catch per feature in the AMP, the same data selection criteria were applied (only orange roughy target tows deeper than 600 m and over 2 minutes tow duration). The total catch in each AMP area might be slightly higher, hence values were rounded to the nearest 100 t.

Table 5: Number of features per AMP area per total orange roughy catch bands, where only tows targeting orange roughy, deeper than 600 m and over 2 minutes duration were considered.

ORH (t)	A	B	C	D
0	2	18	24	14
0 – 9		3	10	9
10 – 49		5	2	10
50 – 149		4	4	10
150 – 299		2	3	4
300 – 999		2	1	1
1000 +	1	1		2
Total ORH catch (t)	1100	4400	2000	5800
AMP catch limit (yearly)	200	500	500	200
AMP feature limit (yearly)	100	150	150	75

4.3 Discussion

There are only 58 known seamounts from the seamounts database which have not been fished yet, of which 46 are considered either too shallow (less than 600 m) or too deep (over 1500 m) for the orange roughy fishery. Therefore the spreading of the effort has been quite successful in this fishery, as attempted by the AMP management.

The fishery itself is still relatively small: the top four features have produced a total of 6600 t of orange roughy, an average of about 400 t per year in the last five years. By comparison, the eight hills of Andes have produced 16 600 t so far, with an average of 1500 t per year (Ministry of Fisheries Science Group 2007).

Only 13 fished features (including the Manukau box) out of 120 have produced over 150 t orange roughy each over their entire history. The feature limit set by the AMP in 2001 was of

150 t in AMP areas B and C and 75 t in area D (100 t in area A, but there is only one feature fished there, with no catches). The yearly limits do not appear to be limiting as most features have not sustained such catches over their entire fishing history. Moreover, out of those 13 features, only three or four have had raw CPUE consistently over 2 t/tow.

It is important to note that the cumulative catches per cumulative tow are still increasing on most features, and therefore CPUE on those features is not showing obvious localised depletion. A number of features have had reduced fishing effort in recent years, sometimes associated with a reduction in CPUE. As this fishery is mainly a mark fishery, it is possible that fishing on some hills stopped as marks became scarce; thus local depletion would not necessarily show up in CPUE trends.

5. CONCLUSIONS

Only 13 out of the 120 fished features examined had a total orange roughy catch over 150 t, and only three features (including the Manukau box) have a total orange roughy catch of more than 1000 t. Therefore the ORH 1 area is probably a low-production area for orange roughy, compared for example with the Andes hills on the Chatham Rise where over 16 000 t of orange roughy has been extracted to date.

Total catches per feature also suggest that the AMP yearly feature limits of 75 to 150 t per feature are likely to be too high. These feature limits were to be reduced if the raw CPUE on the feature dropped below 2 t/tow. Only three or four of those features have had a raw CPUE consistently over 2 t/tow, but it is believed this rule was never invoked under the AMP.

However, even though the feature limits are high compared with total catches on those features, and the CPUE is lower than the AMP threshold, the cumulative catches per cumulative tow are still increasing on most. A number of features have had strongly reduced or zero fishing effort in the recent years, linked with a reduction in CPUE. These might indicate localised hill depletion.

6. ACKNOWLEDGMENTS

This work was funded by the Ministry of Fisheries (Project ORH2007/02). Thanks to Ralph Coburn (NIWA) for loading the catch-effort data into a relational database and to Owen Anderson and Matthew Dunn for grooming the data.

7. REFERENCES

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Dunn, M.; Anderson, O.; McKenzie, A. (2008). Descriptive analysis of catch and effort data from New Zealand orange roughy fisheries in ORH 1, 2A, 2B, 3A, 3B and 7B to the end of the 2005–06 fishing year. New Zealand Fisheries Assessment Report. 2008/22. 75 p. Ministry of Fisheries. Unpublished report held by the NZ Ministry of Fisheries Wellington

Ministry of Fisheries Science Group (2007). Report from the Fishery Assessment Plenary, May 2007: stock assessments and yield estimates. 1015 p. Ministry of Fisheries. (Unpublished report held in NIWA library, Wellington.)

APPENDIX 1 – TABLE OF CUMULATIVE CATCHES AND TOWS PER FEATURE

Cumulative catches in tonnes of orange roughy (bold) and number of tows (superscript) per feature per year. Within each AMP area, features are listed in increasing order of total catch. All tows that caught or targeted orange roughy are used.

APPENDIX 2 – FIGURES OF CUMULATIVE CATCH AND CATCH PER CUMULATIVE TOW PER FEATURE

For each feature (only features where over two tows were carried out over the entire fishery are plotted, ignoring 65 features);

- **Graphs on the left hand side show yearly orange roughy raw CPUE and associated number of tows from 1990; the horizontal line represents the 2 t/tow raw CPUE limit as per the AMP rules (note that data selection is not exactly as per the AMP).**
- **Graphs on the right hand side show yearly cumulative catches as a function of the number of tows from 1980, with each dot representing a year.**

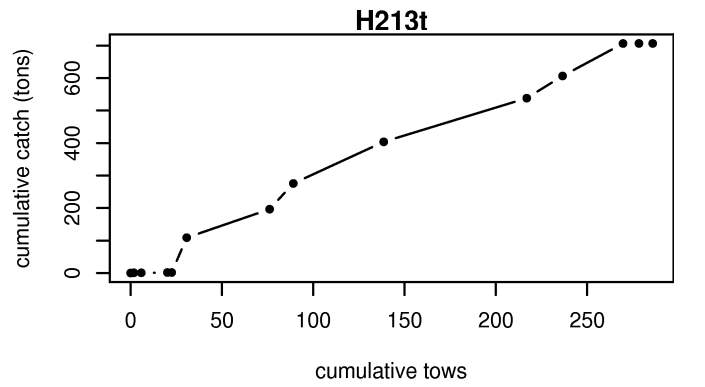
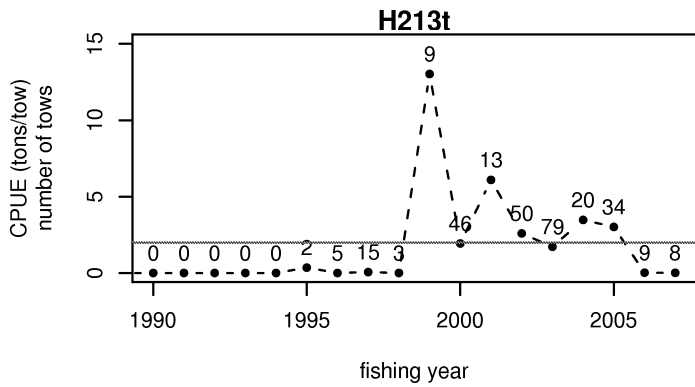
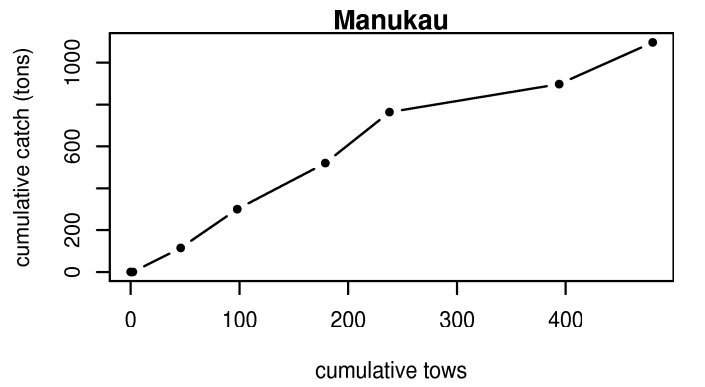
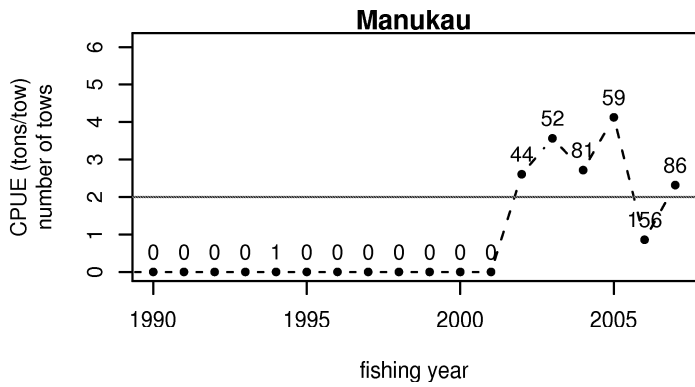
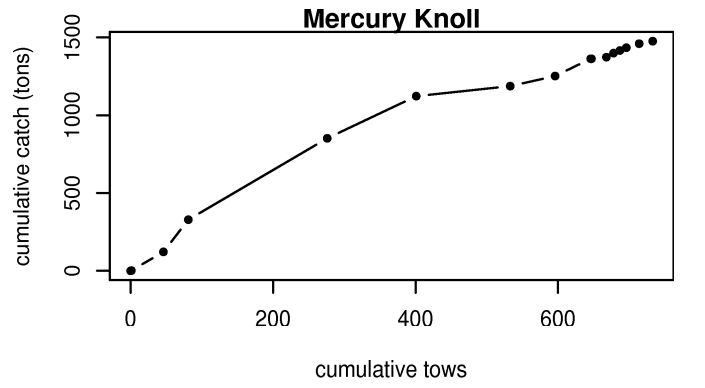
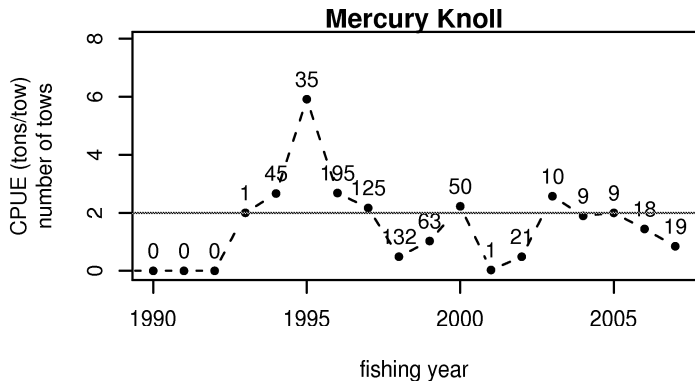
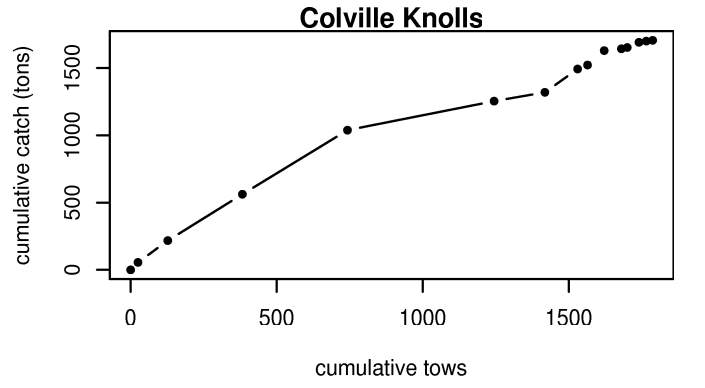
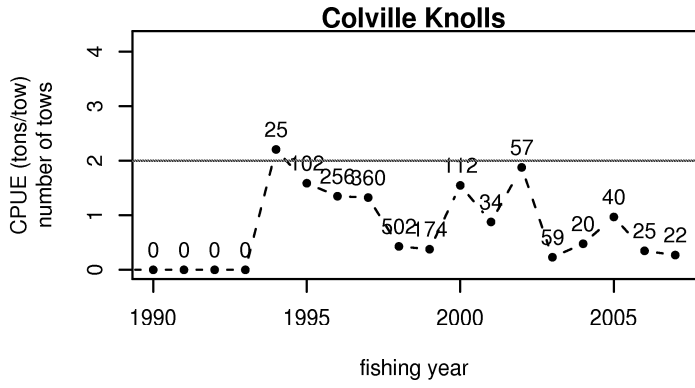
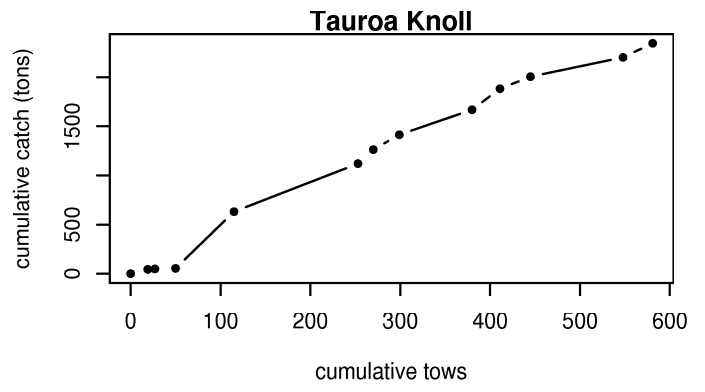
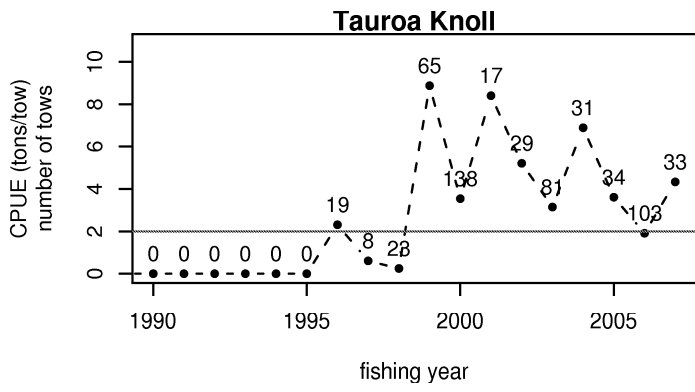
Data correspond to those in Appendix 1, i.e., all tows that caught or targeted orange roughy were used.

Feature	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	sum	depth top	depth bottom	area km2
AMP AREA A																			
Telecom Knoll																0.0	1500	1750	18.5
Aotea				1.0	11.0		4.0	5.0								21.0			
				0.0	0.5	0.0	0.1									0.6	897	2147	504
Manukau	1.0									44.0	52.0	81.0	59.0	156.0	86.0	480.0			
	0.0									114.7	185.3	220.0	243.4	133.8	199.3	1096.6			
AMP AREA B																			
Black Eye																0.0			
																0.2			
Devi's Spur																0.0			
H117t																0.0	486	1236	289
H129t																0.0	1887	2750	46.1
H140t																0.0	1750	4657	591
H146t																0.0	571	1514	104
H147t																0.0	2750	3250	160
H152t																0.0	2750	3485	94.7
H153t																0.0	826	2006	169
H154t																0.0	2159	3402	171
H160t																0.0	4000	4250	106
H163t																0.0	1203	1959	481
H164t																0.0	2167	3000	48.2
H181t																0.0	789	1500	25.5
H431t																0.0	2000	2788	101
H432t																0.0	2000	2250	59.7
H889t																0.0	3395	3945	80.3
Red Eye																0.0			
					1.0	2.0										3.0			
H447t					0.0	0.1										0.1	615	1272	116
																7.0			
H178t											7.0					7.5	1250	2336	37.3
																5.0			
Whangape Bk							1.0			1.0						7.8	450	550	
																13.0			
Doogies												3.1	5.7	1.2	3.0	13.5			
																13.0			
UA3t				1.0												32.8			
				0.0												15.1	0.7	17.0	
UA6t																76.7			
																67.3			
UA5t																74.2			
																70.8			
Yasmin's																47.2			
																70.8			
UA2t																42.8			
																73.1			
UA4t																59.9			
																81.4			
Hiroshima																58.5			
																90.1			
UA1t																38.4			
																113.1			
Tauroa																84.0			
																176.6			
Coral Hill																195.0			
																311.0			
Tony B																131.0			
																403.6			
Explorer Hill																302.0			
																448.9			
Tauroa Knoll																581.0			
																2344.1	950	1350	49
AMP AREA C																			
H124t																0.0	696	2000	43.2
H132t																0.0	1238	1841	136
H136t																0.0	1500	3250	176
H143t																0.0	676	3012	227
H145t																0.0	1303	1813	126
H165t																0.0	3000	3250	103
H166t																0.0	2500	3000	74.7

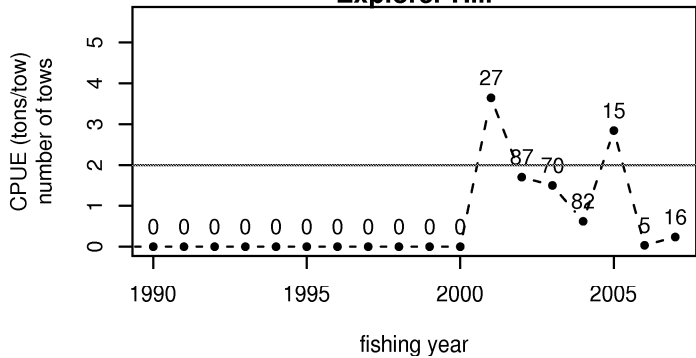
Feature	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	sum	top	bottom	km2	
H169t																0.0	2675	3452	113	
H174t																0.0	2000	3000	235	
H176t																0.0	1492	2575	120	
H179t																0.0	1750	2500	41.7	
H180t																0.0	2250	2918	31.3	
H185t																0.0	1612	2636	403	
H196t														1.0		1.0	1500	1750	98	
H209t													0.0			0.0	1750	2000	16.3	
H434t																0.0	1585	2250	49.8	
H445t																0.0	1750	2000	12.4	
H891t				0.2												0.2	1150	1700	18.9	
H895t				0.0												0.0	1500	2000	28.1	
H898t																0.0	1950	2250	1.75	
H899t																0.0	2000	2300	2.57	
Purerua																0.0	1250	2950	246	
UA10t												1.0				1.0				
H148t								0.5								0.0	677	3300	193	
H782t								0.5								0.0	677	3300		
UA11t		1.0			1.0											2.0				
Whangaroa B							0.7				0.4	0.2				0.0	1100	1550	5.3	
Cavalli	1.4				1.0			1.2								3.7	500	1567	126	
Whangaroa A							1.3				2.6	0.8				4.7	850	1400	43.5	
H443t	2.6							8.8								11.3	850	1250	19.6	
UA13t					1.0					7.5	2.5					3.5				
Milan's										1.0		6.0	3.0	5.0		15.0				
H892t				0.2				0.5								0.6				
H896t				0.0				11.4								11.4	1400	1800	9.2	
UA14t							1.0									1.5				
UA7t	0.9	8.1			0.8						1.9		0.4	8.3	7.0	28.5				
UA12t										11.5						11.5				
Boulder Ridge							0.8				3.3	0.5		8.7	8.2	22.8				
H218t	0.3	0.9	1.7	0.7	1.8	8.6	1.0	8.5	8.7	6.4	6.9	1.3	1.5			48.1	1400	1505	11.1	
H441t	1.0				20.0	4.0	2.0	14.0	19.0	9.0	2.0	18.0	62.0			151.0	822	2303	214	
UA8t	0.1	0.9		0.2						0.1		0.6	28.7	32.0		62.5				
UA9t			1.0		2.0	5.0		37.0	57.0	34.0	33.0	24.0	17.0			210.0				
Birdflue							1.2			13.7	0.5		32.3	39.8		88.2				
H213t	1.7	4.1	14.3	2.3	8.2	45.4	13.0	49.5	78.3	19.6	33.1	8.7	7.5			285.9	912	1500	70.7	
	0.6	0.0	0.8	0.0	107.3	87.7	79.1	128.2	134.5	68.2	99.9	0.2	0.1			706.5				
AMP AREA D																				
Barrier Bk																0.0	330	360	93.4	
H223t																0.0	1699	2535	26.9	
H224t																0.0	1035	2739	16.5	
H451t				0.2												0.2	1750	2052	73	
H452t									2.0							2.0	1536	2090	54.1	
H893t				0.2						0.0						0.0	1700	2000	11	
				0.2												0.2				

Feature	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	sum	top	bottom	km2
H894t				0.0												0.0	1550	1950	5.41
Kawithu A																0.0	1570	2378	11.5
Kawithu C																0.0	1335	3479	6.6
Kawithu D																0.0	1661	2347	5.7
Kawithu West																0.0	1079	2357	9.3
H862t																1.0	2700	2950	3.82
H237t																0.7	1250	1525	21.5
Rungapapa Knoll																0.2	134	300	7.6
Tumokemoke Knoll																0.5	213	600	12.2
Tuatoro Knoll																0.6	175	350	3.8
Maha Knoll																0.0	400	650	4.4
Matatara Knoll																0.2	750	1200	13.7
Rangatira Knoll																0.1	150	500	42.4
Mayor Knolls																1.0	2.6		
H460t																2.6	1500	2053	58.2
Whakatane																2.0	880	2196	88
UA15t																1.0	4.3		
Double Knolls																0.8	1200	1500	57.5
H858t																0.4	1338	1600	1.36
H462t																1.2	1448	2948	16.5
Mokohinau Knoll																1.0	85.0		
Tuakana Knoll																0.7	250	850	10.6
Needle Knoll																1.0	1700	2050	
Koruenga Knoll																1.0	1150	1800	5.5
H860t																1.0	1350	1650	18.4
Alderman Knoll																0.7	705	1100	10.8
East Ngatoro																2.8	1450	1950	9.1
Ohena Knoll																1.2	858	1700	3
Kapukairo Knoll																0.8	1050	1350	9.2
Otara (nth) and Waioeka (sth) Kri																1.4	1500	2157	26.5
Teina Knoll																0.8	950	1150	5.7
Papamoa Knoll																1.4	850	1100	5.1
Clark West Ngatoro Knoll																0.5	629	1300	8.9
Otara Knoll																2.0	1060	1900	22.6
Jasons Hill																1.6	979	1070	0.16
H470t																2.1	901	1491	11.3
Mahina Knoll																0.2	256	650	35.3
Maungaiti Knoll																0.8	450		
H859t																1.0	1399	1817	0.741
Waiotahi Knoll																1.5	719	1000	28.7
Nukuhou																1.3	348.8		

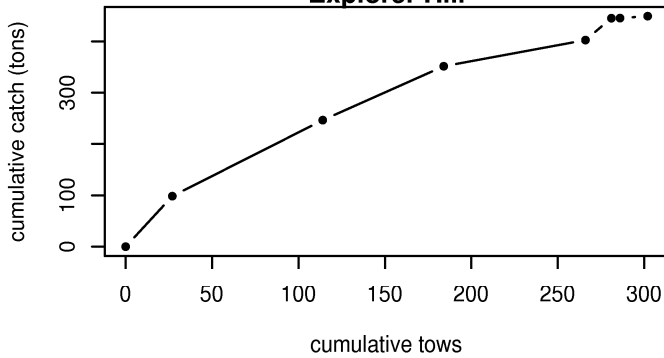
Feature	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	sum	top	bottom	km2
Knoll	0.7	0.0		2.9	10.9	156.3	51.1	43.2	36.8	3.3	15.0	36.4	20.6	6.0		387.5	690	1000	31.5
Mercury	1.0	45.0	35.0	195.0	125.0	132.0	63.0	50.0	1.0	21.0	10.0	9.0	9.0	18.0	19.0	733.0			
Knoll	2.0	119.9	207.0	523.0	270.9	64.5	64.8	111.2	0.0	10.2	25.7	17.0	18.0	26.0	16.1	1476.3	906	1250	44.7
Colville		25.0	102.0	255.5	359.8	502.0	174.0	112.0	34.0	57.0	59.0	20.0	40.0	25.0	22.0	1787.4			
Knolls	55.1	161.8	344.7	476.3	215.5	65.6	173.2	29.8	107.0	13.6	9.6	38.7	8.7	6.0		1705.7	735	1700	35



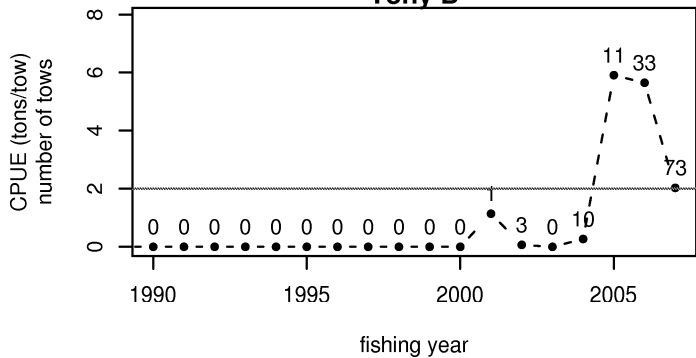
Explorer Hill



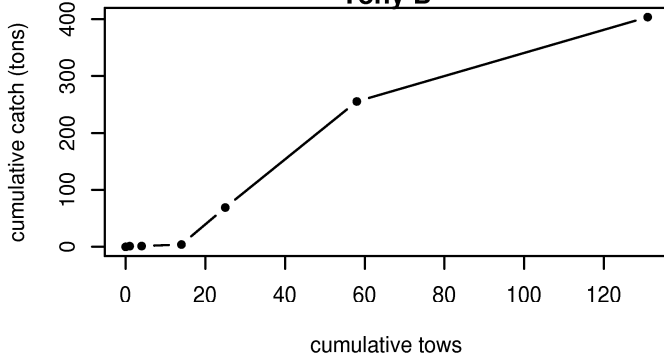
Explorer Hill



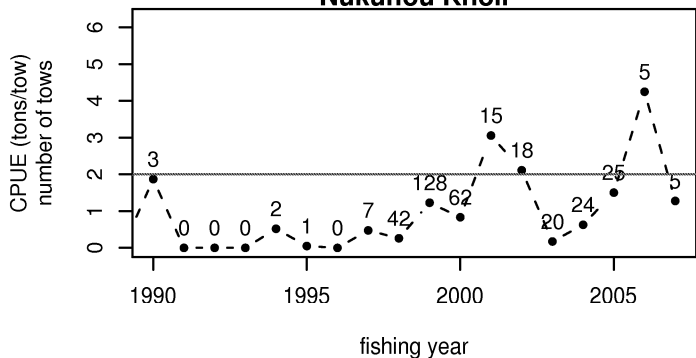
Tony B



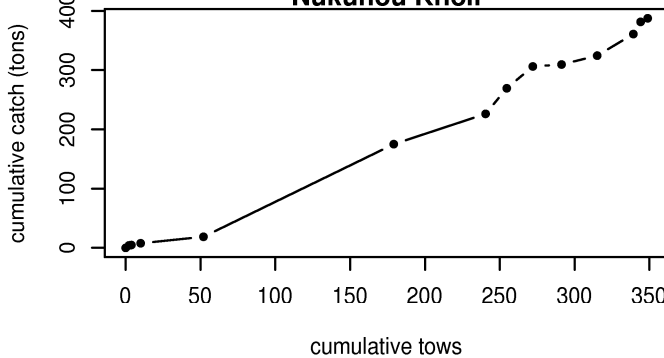
Tony B



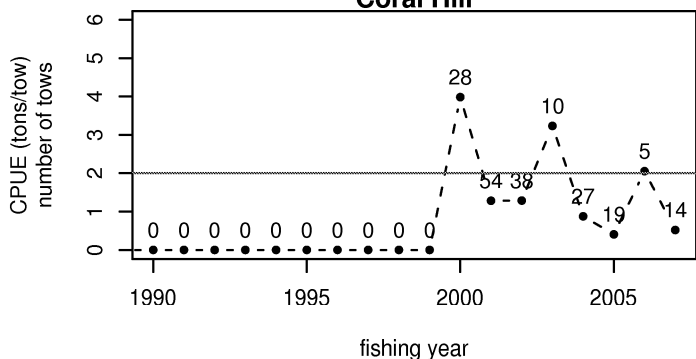
Nukuhou Knoll



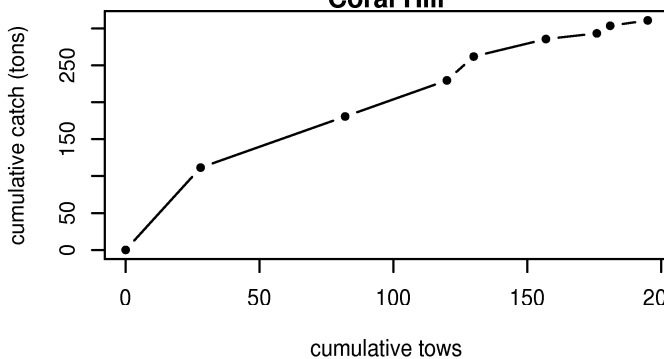
Nukuhou Knoll



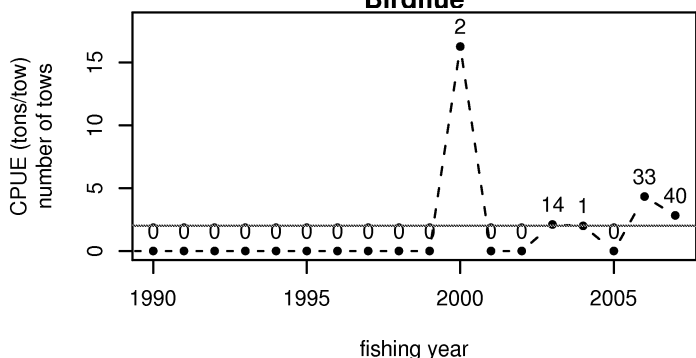
Coral Hill



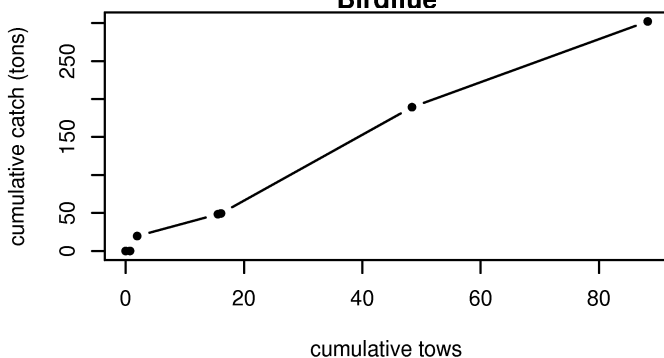
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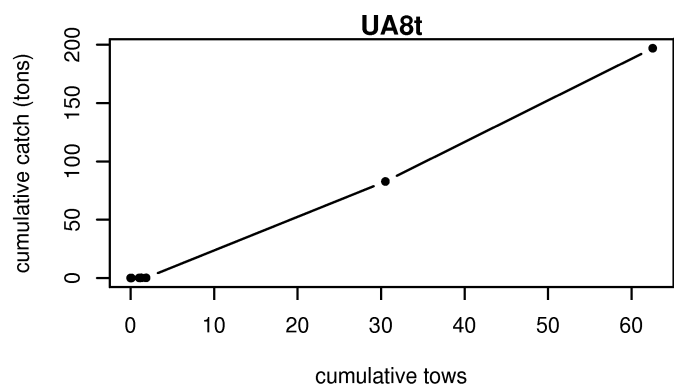
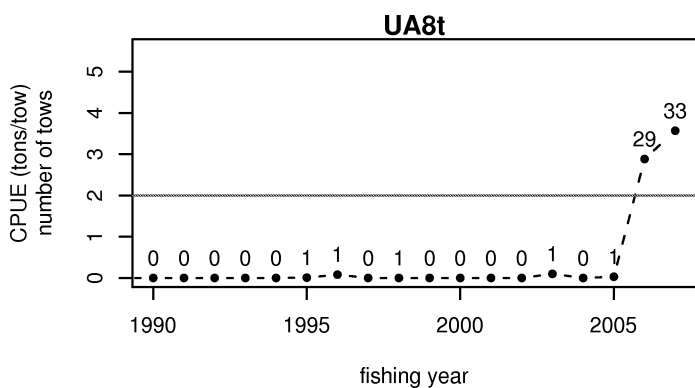
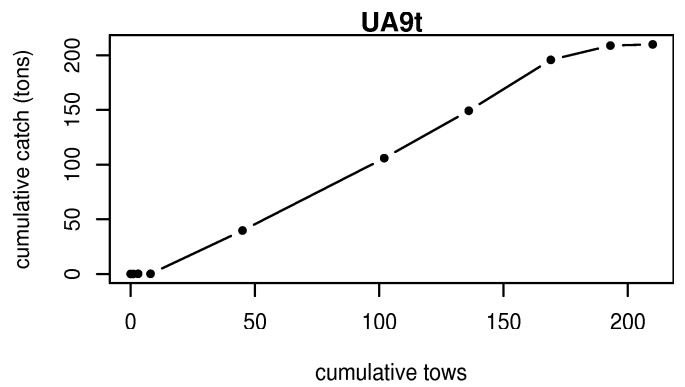
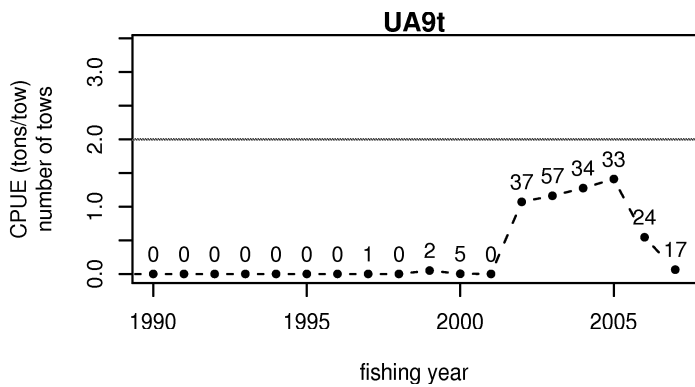
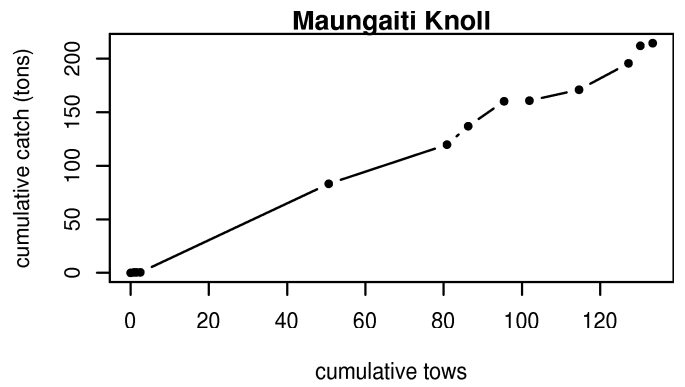
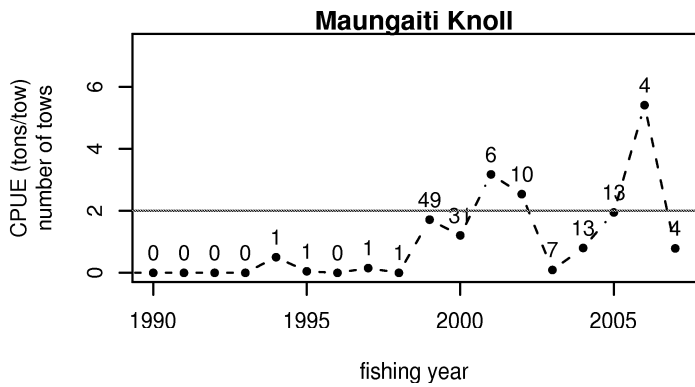
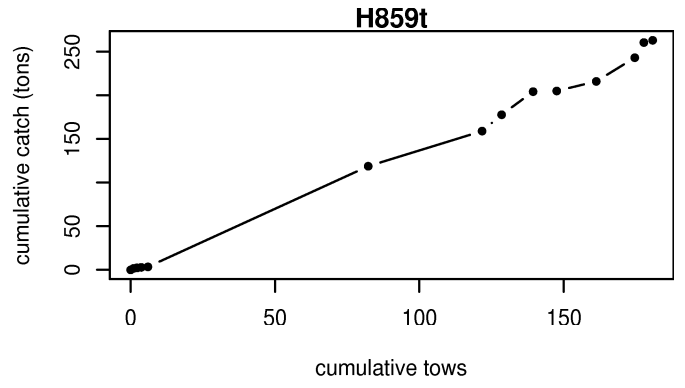
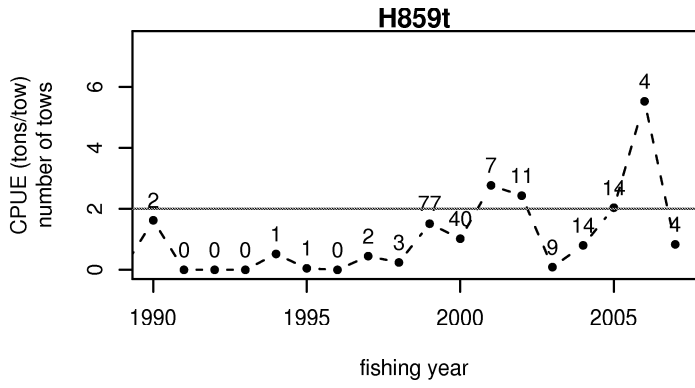
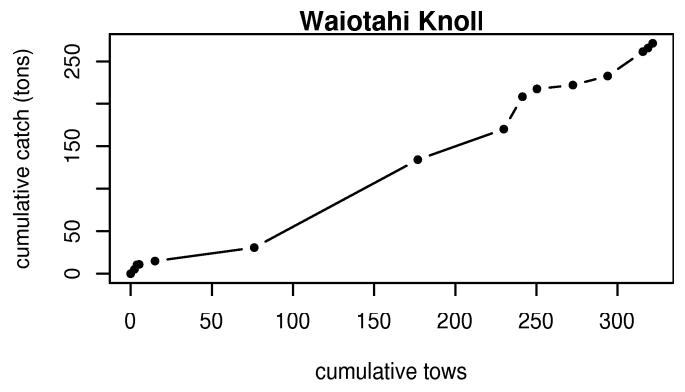
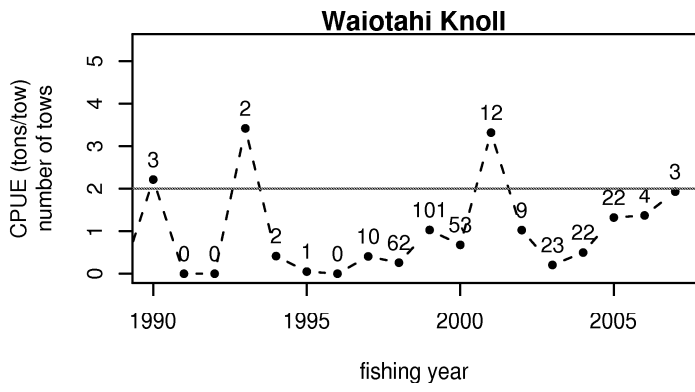


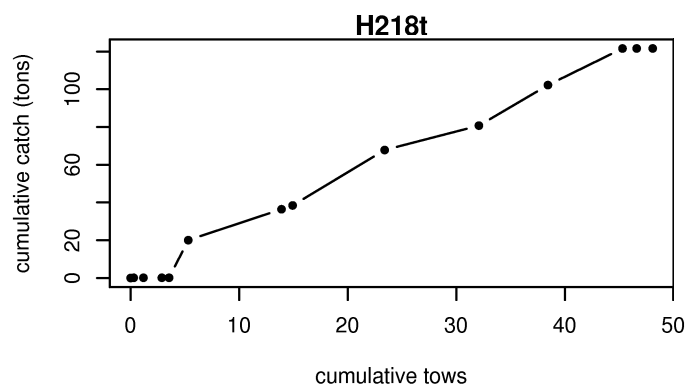
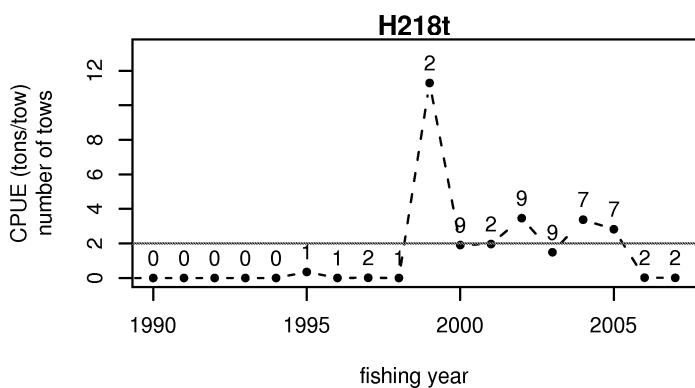
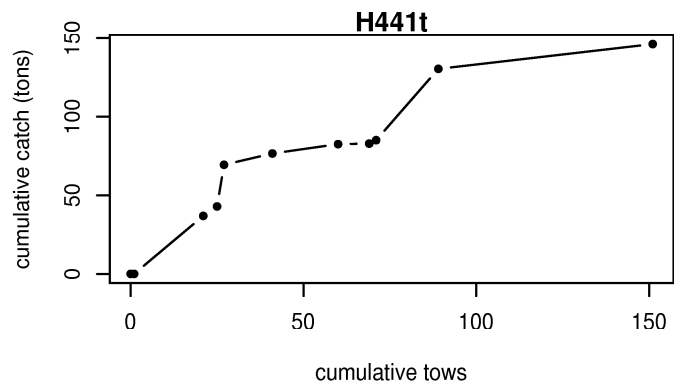
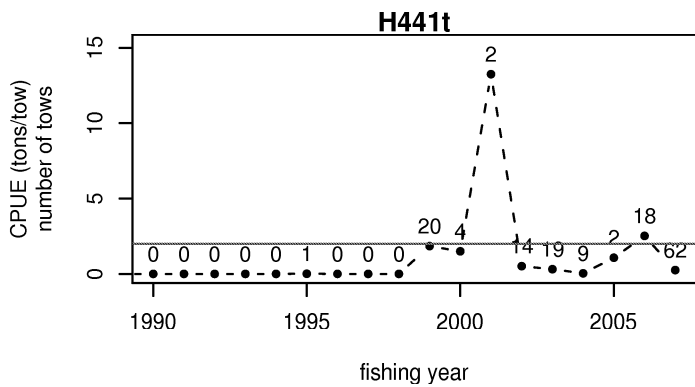
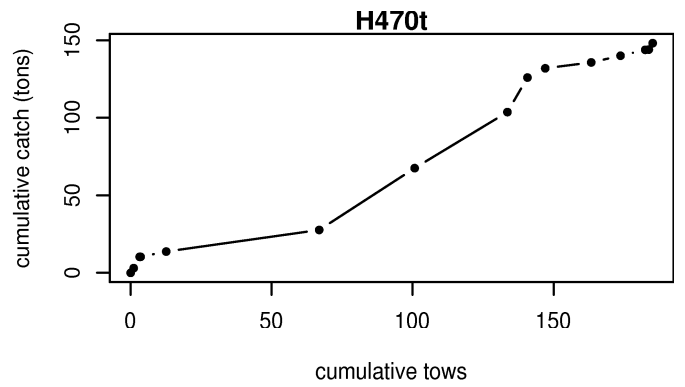
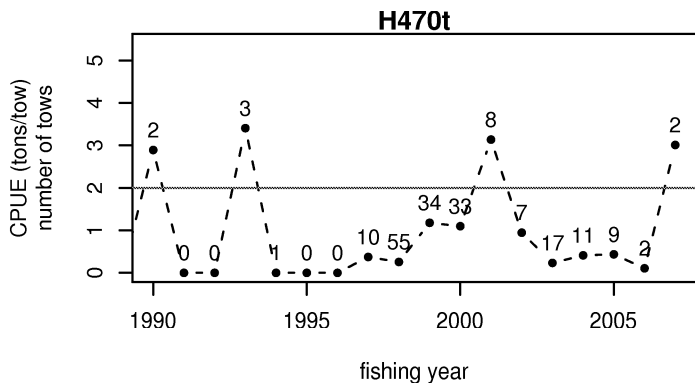
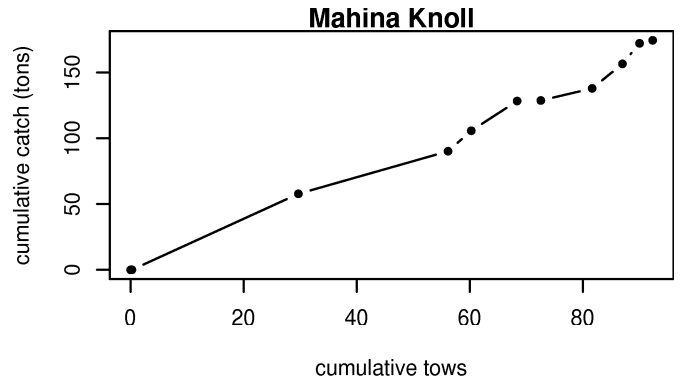
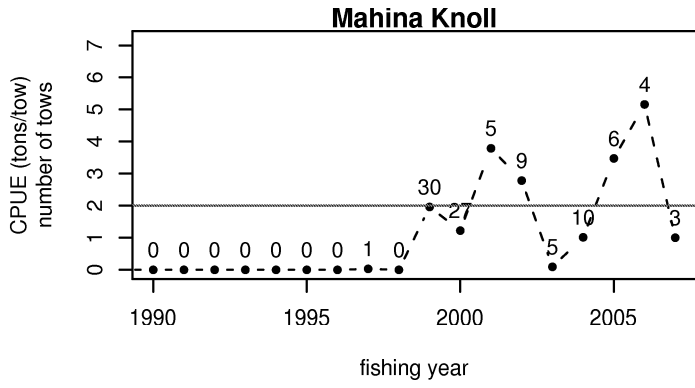
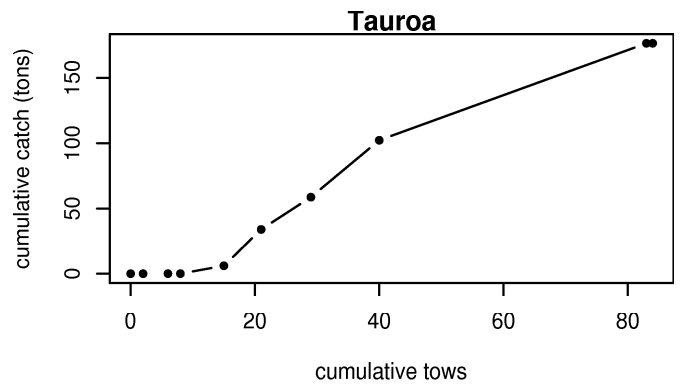
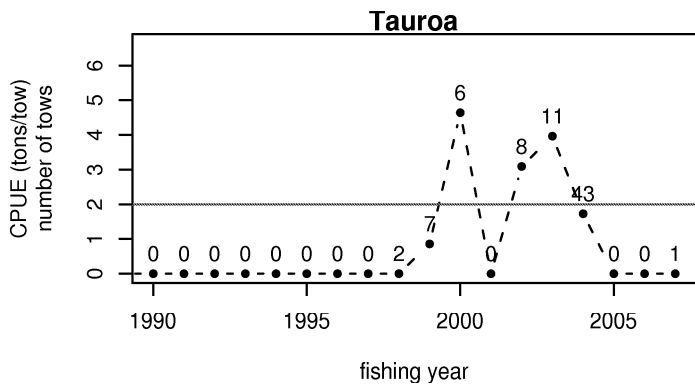
Birdflue

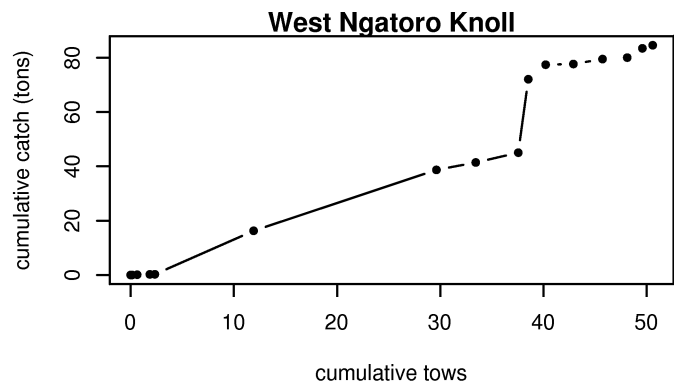
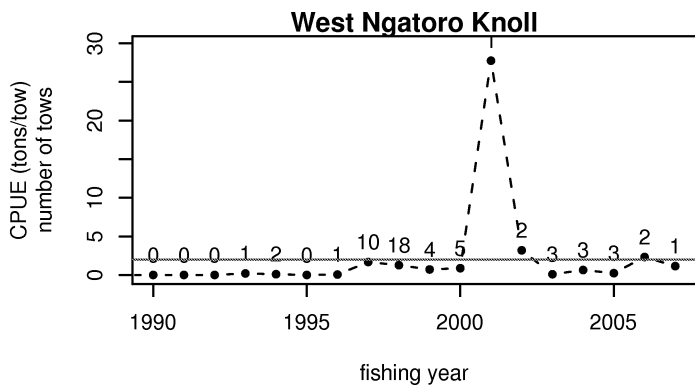
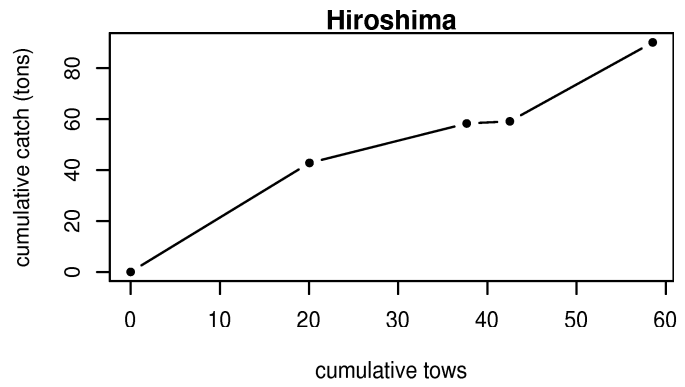
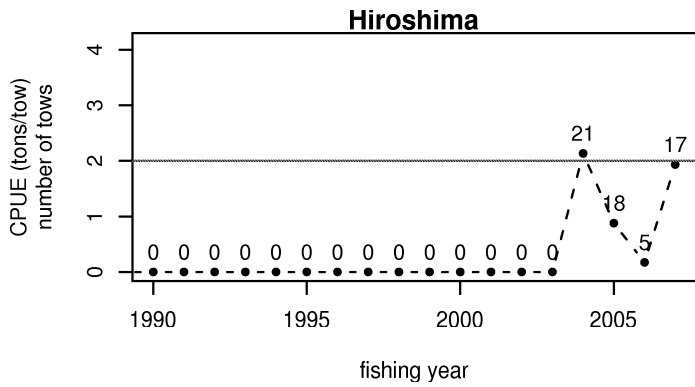
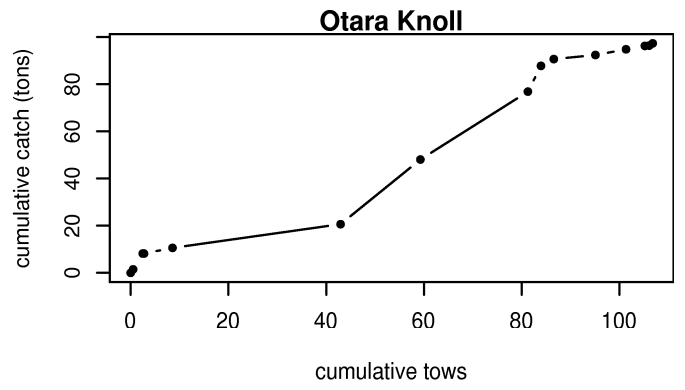
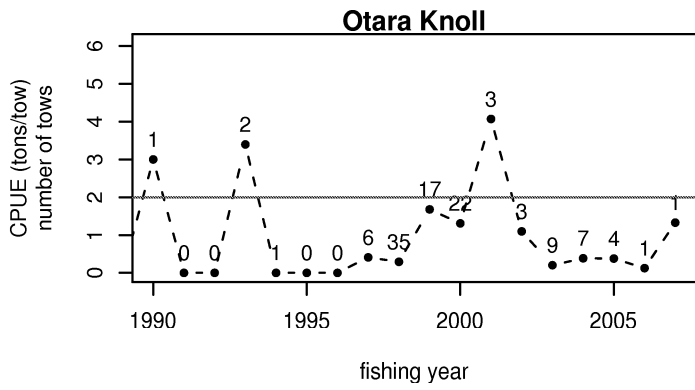
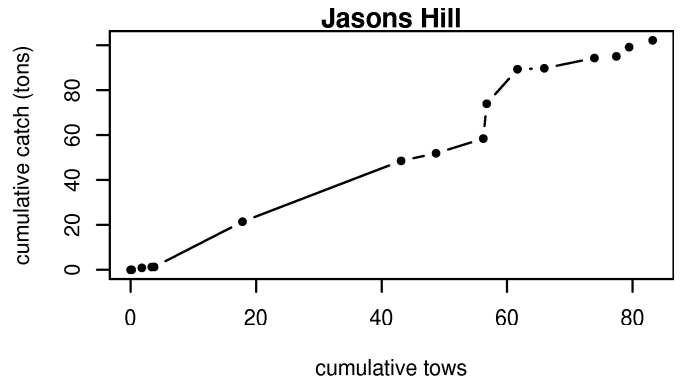
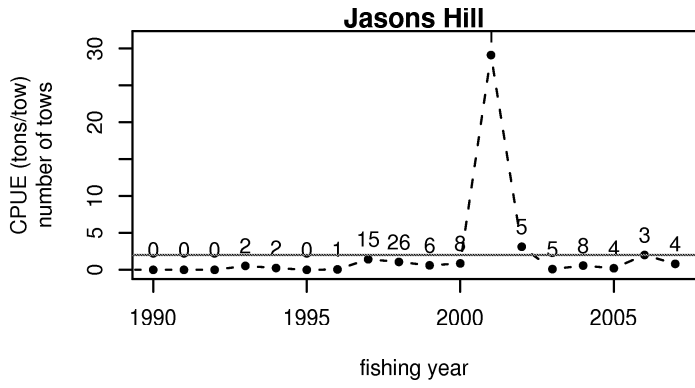
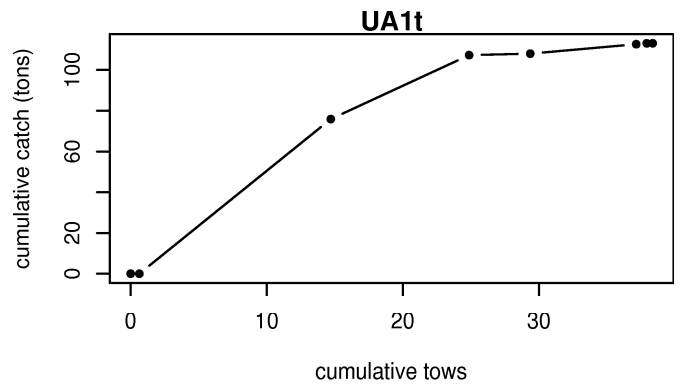
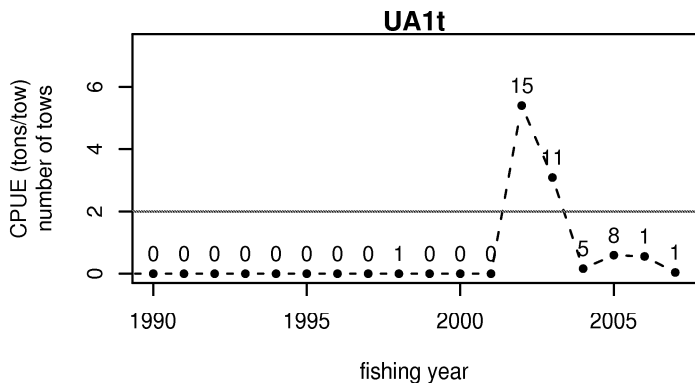


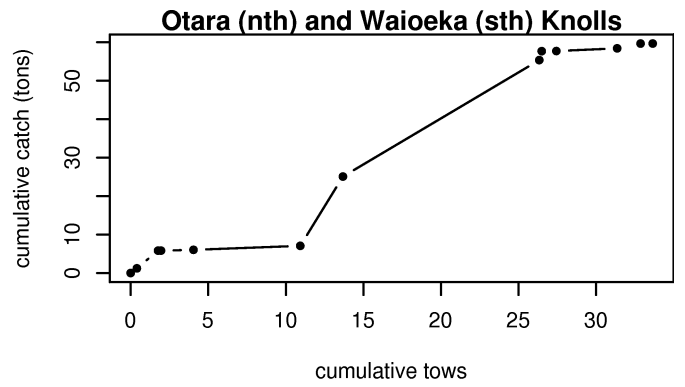
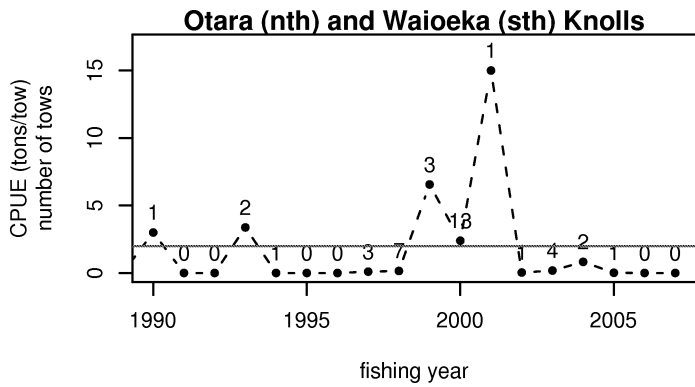
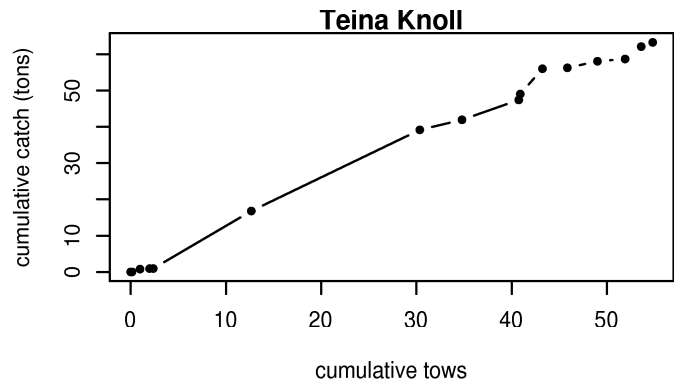
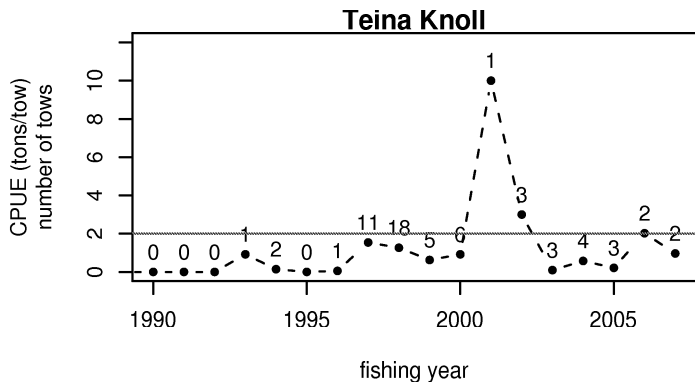
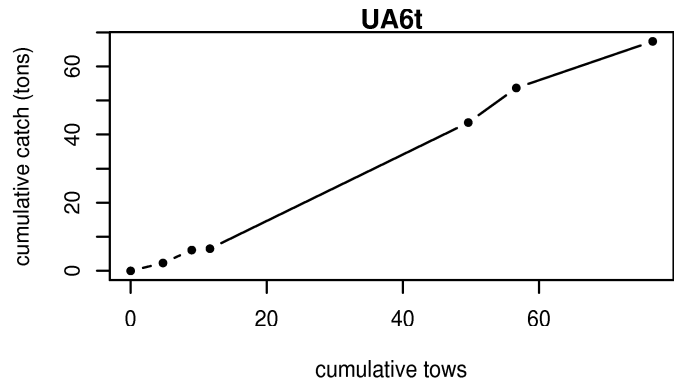
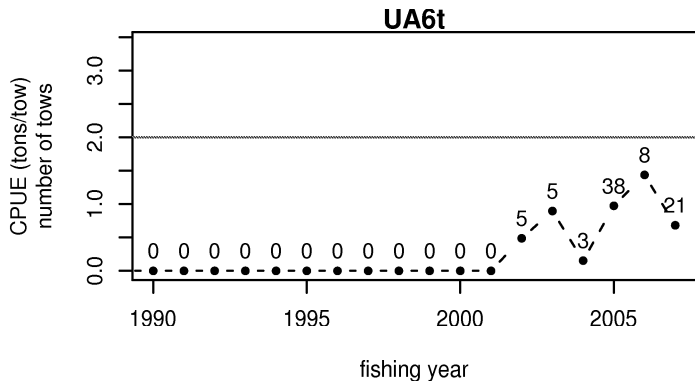
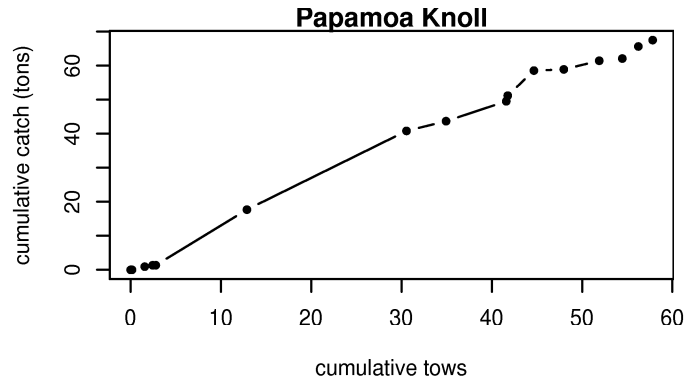
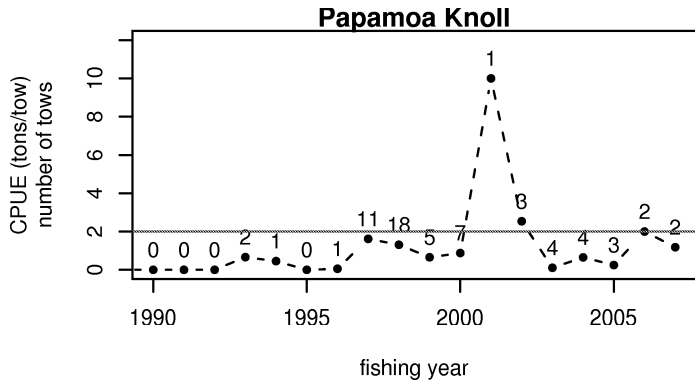
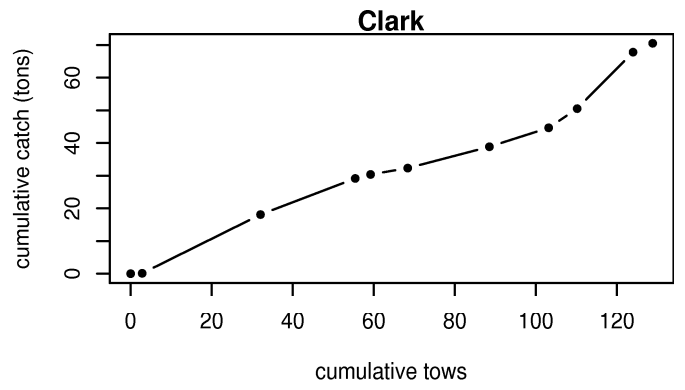
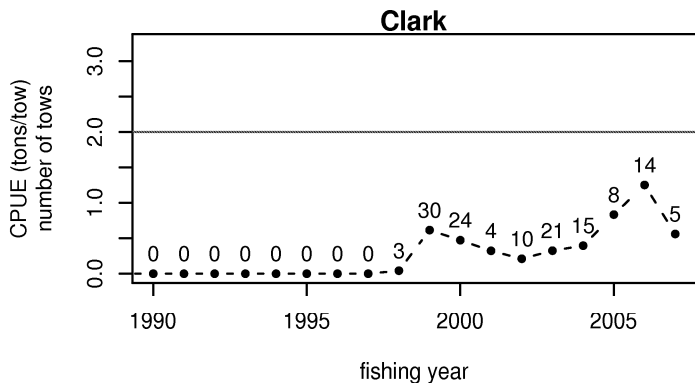
Birdflue

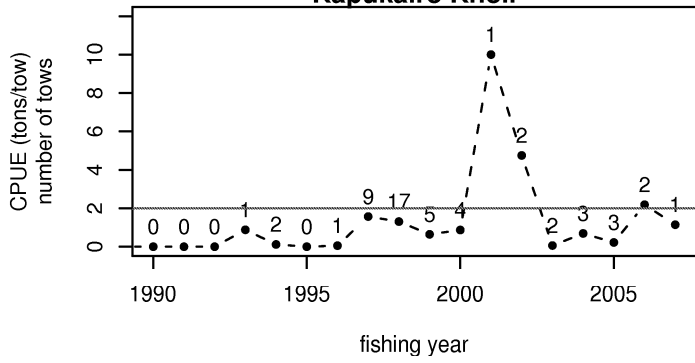
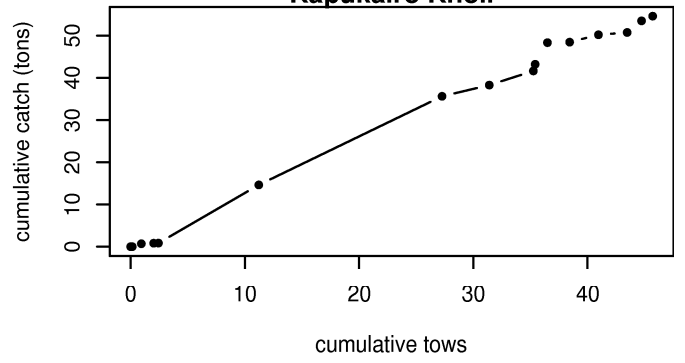
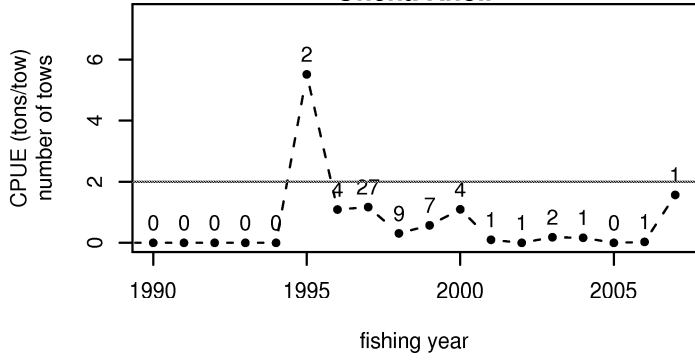
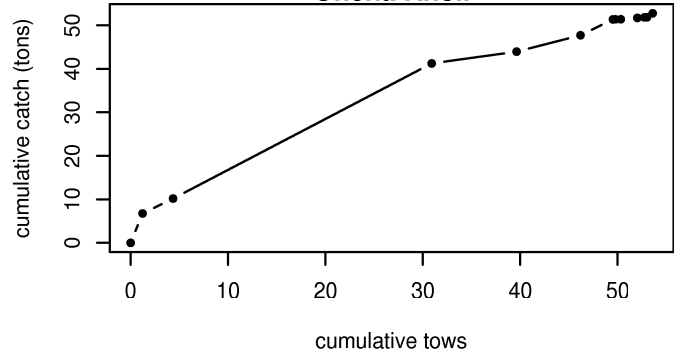
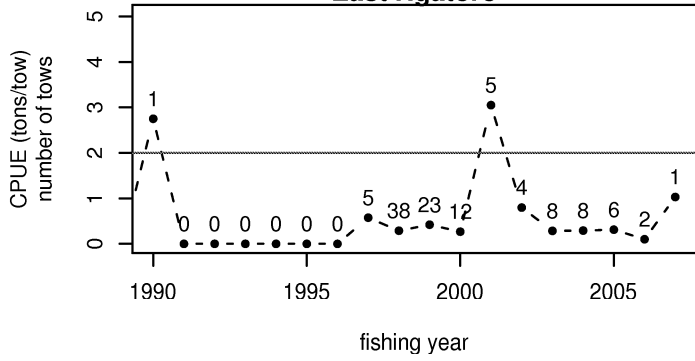
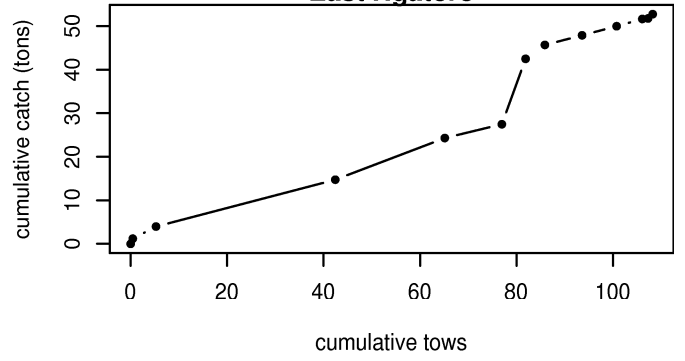
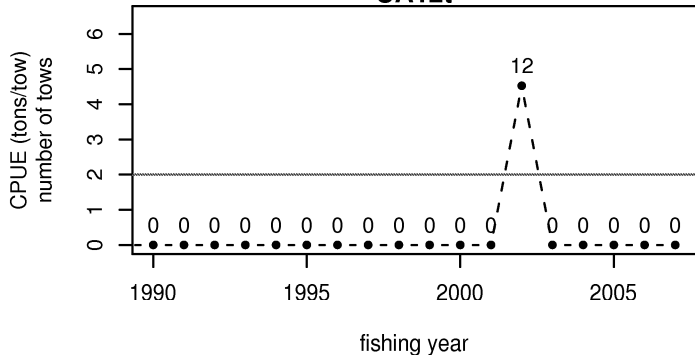
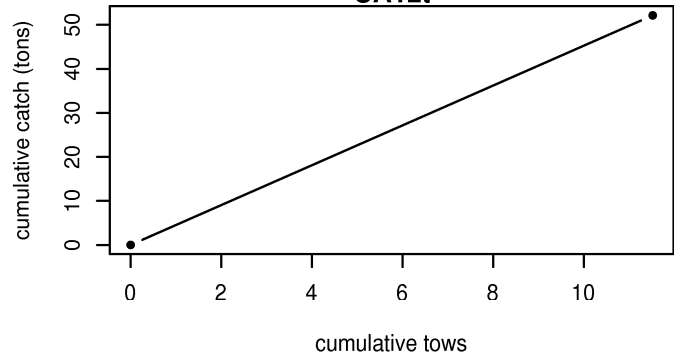
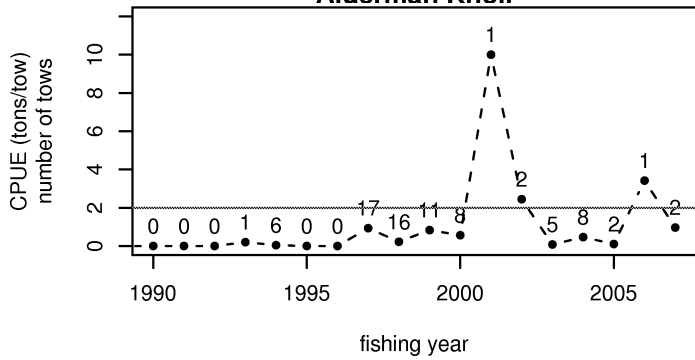
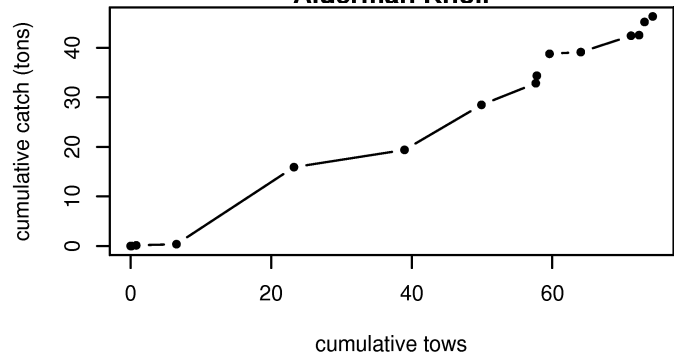


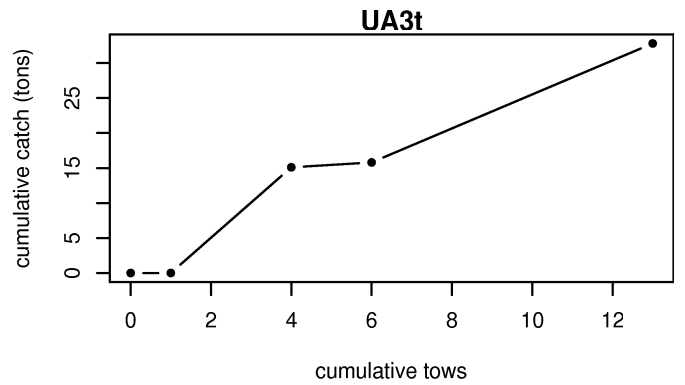
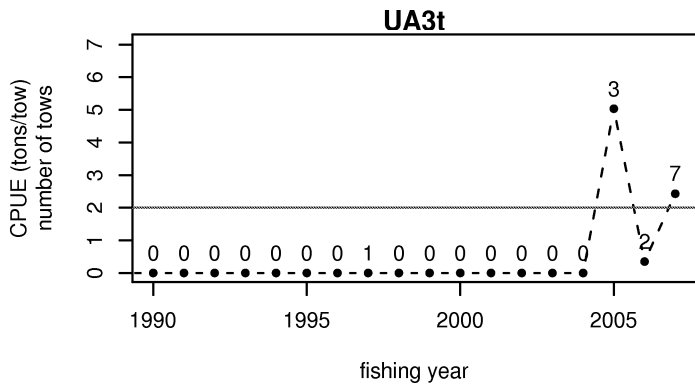
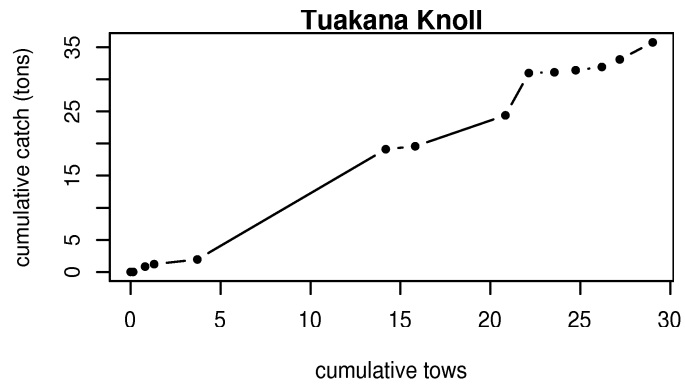
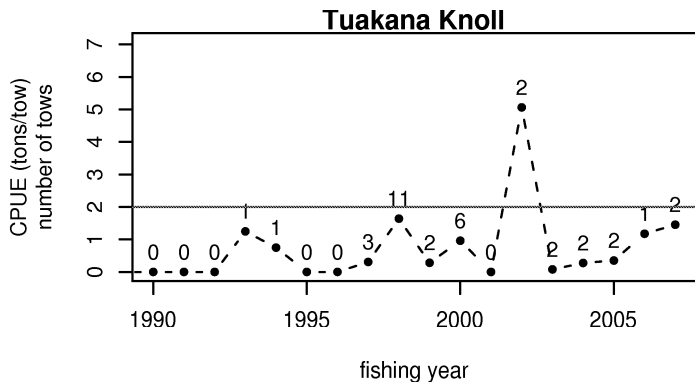
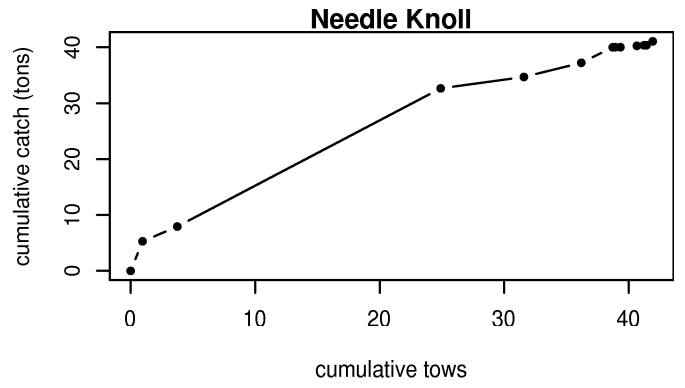
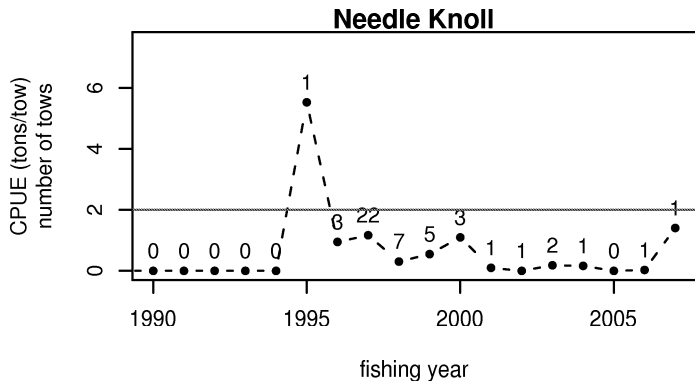
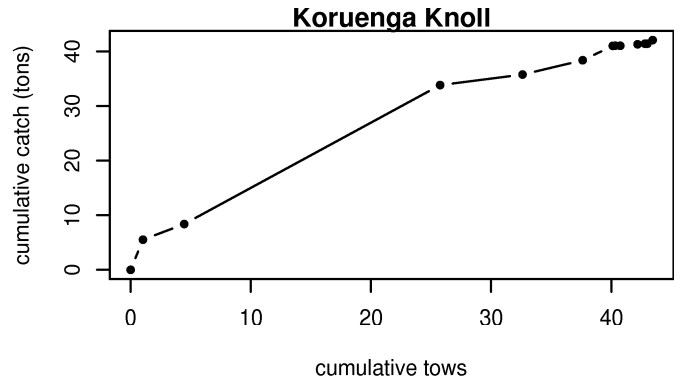
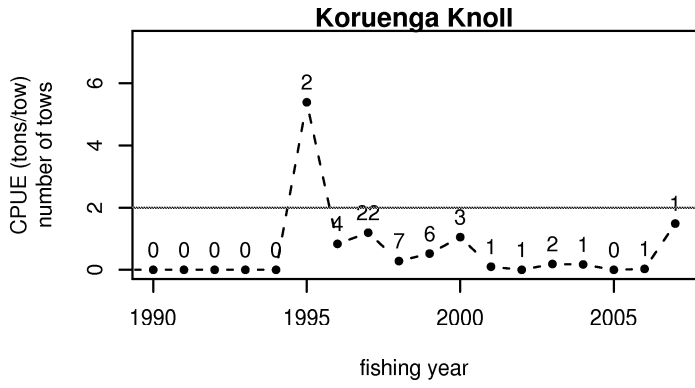
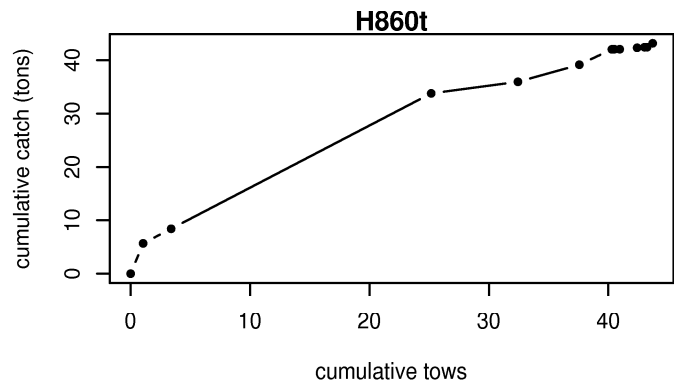
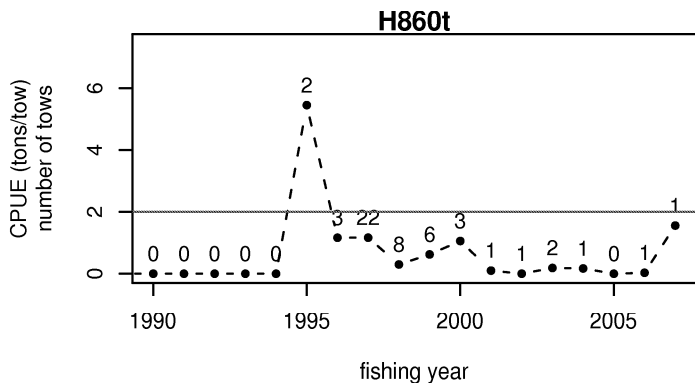




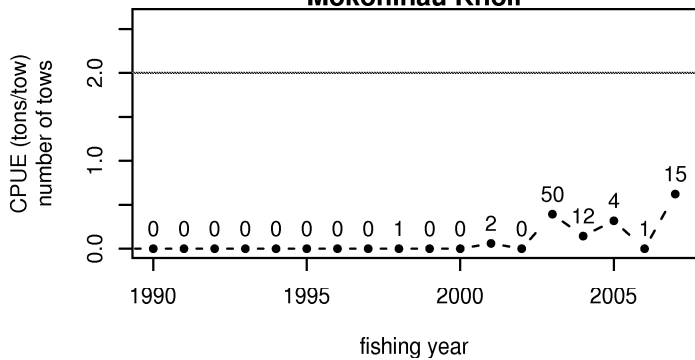




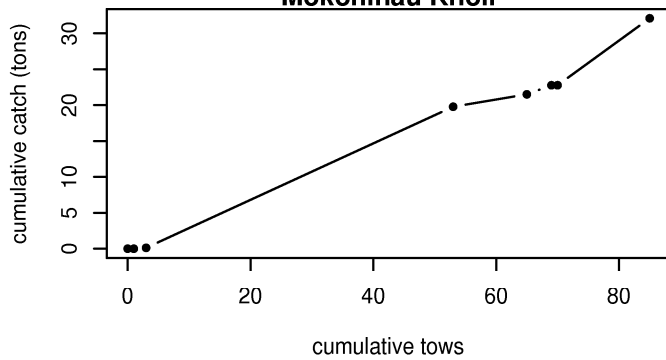
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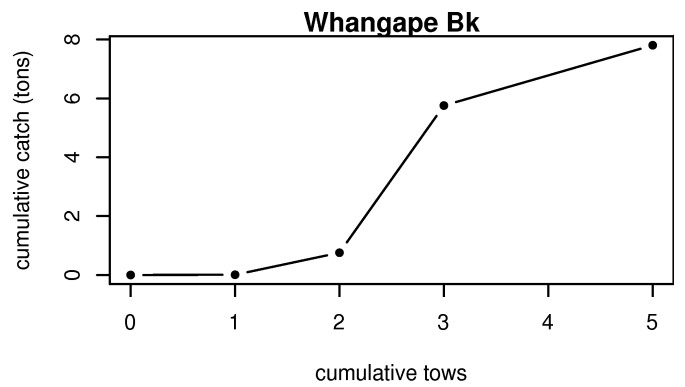
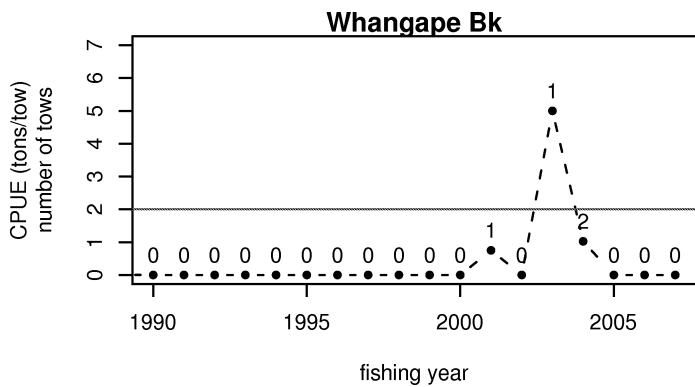
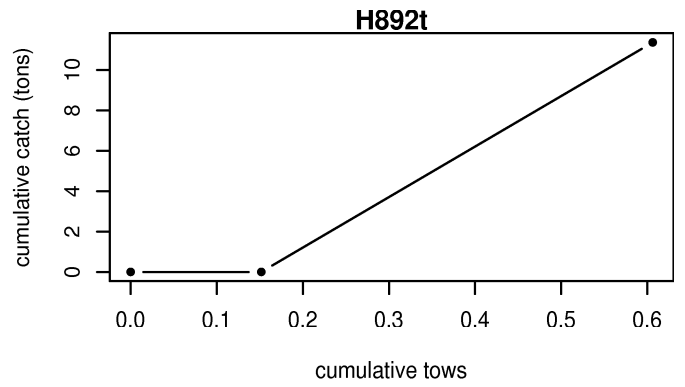
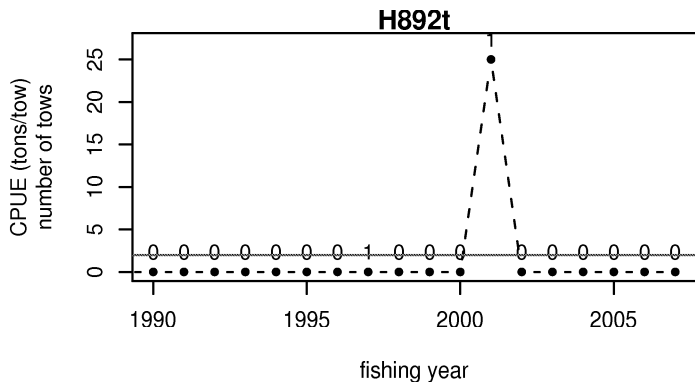
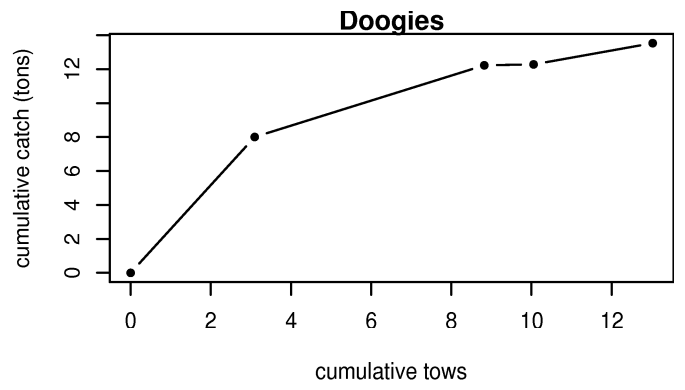
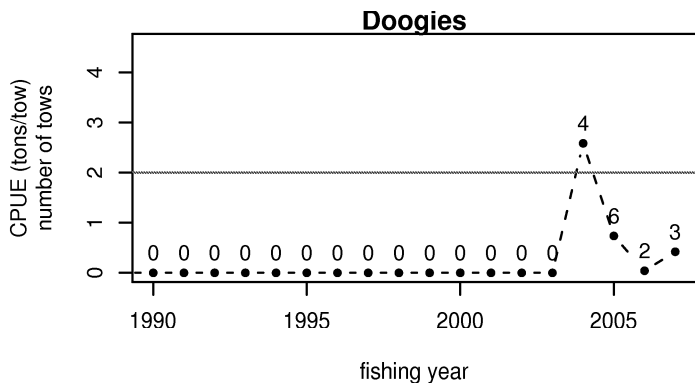
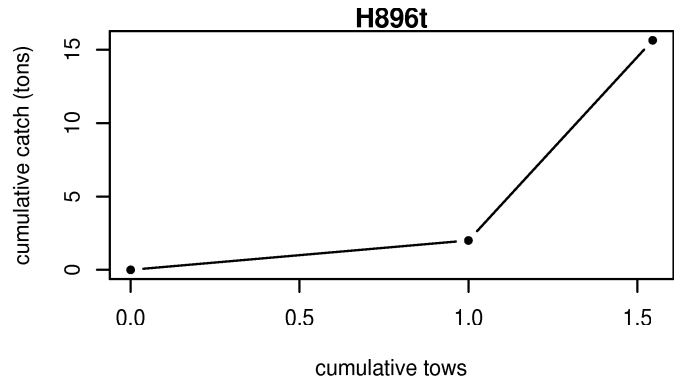
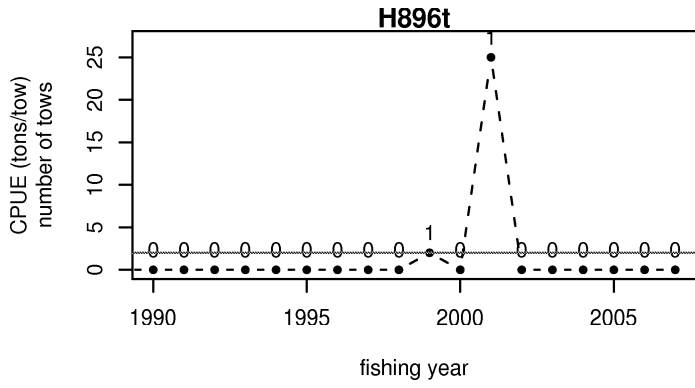
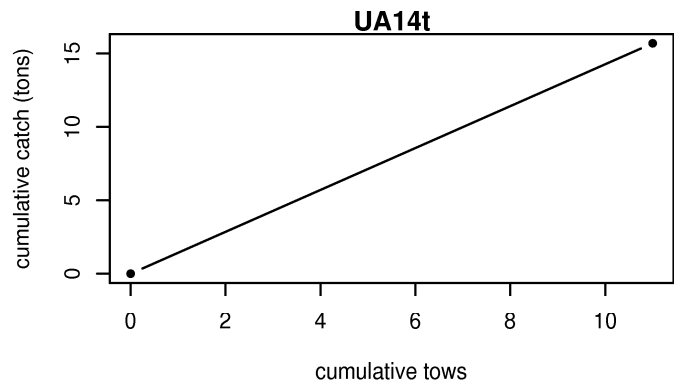
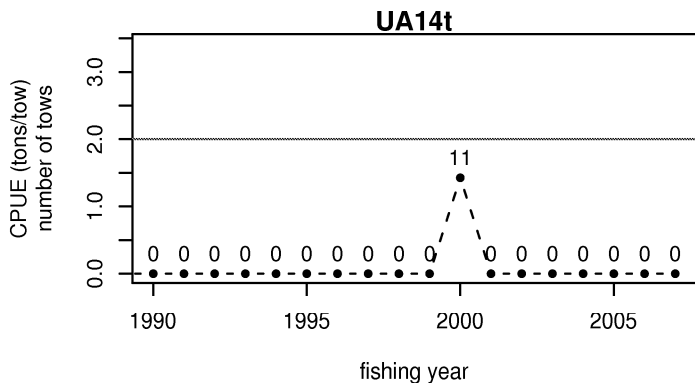


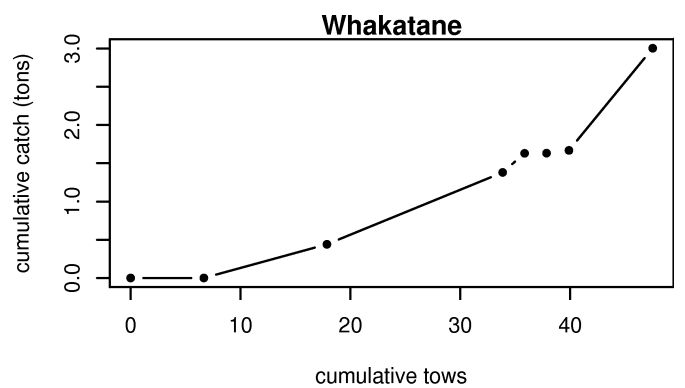
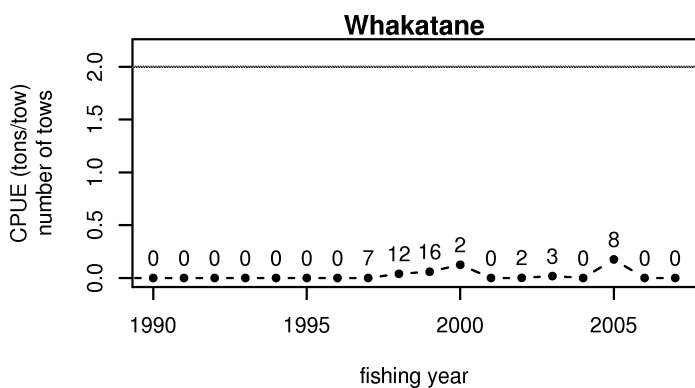
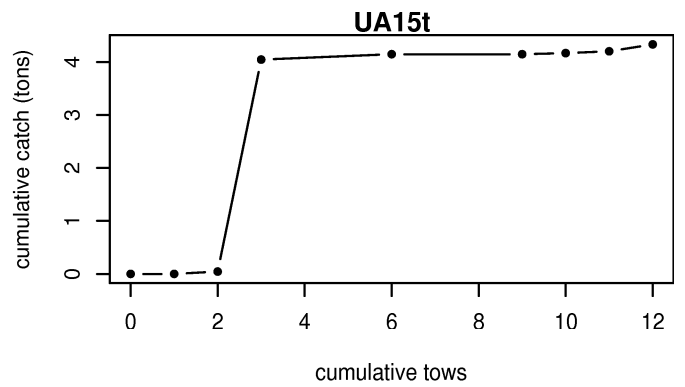
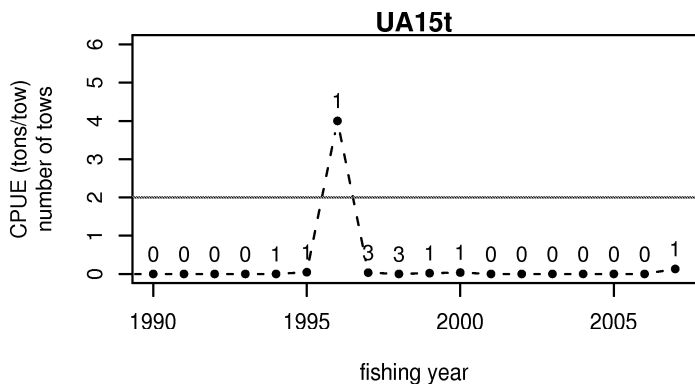
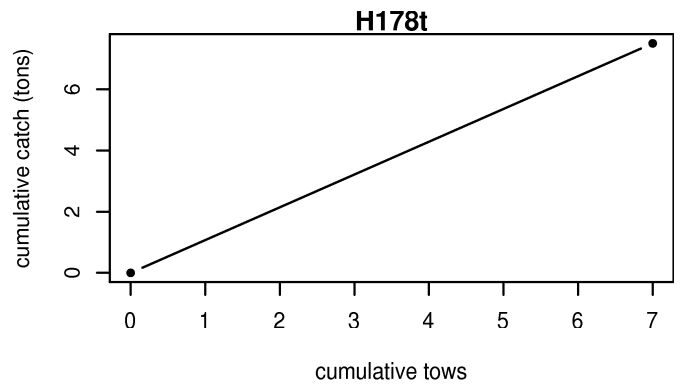
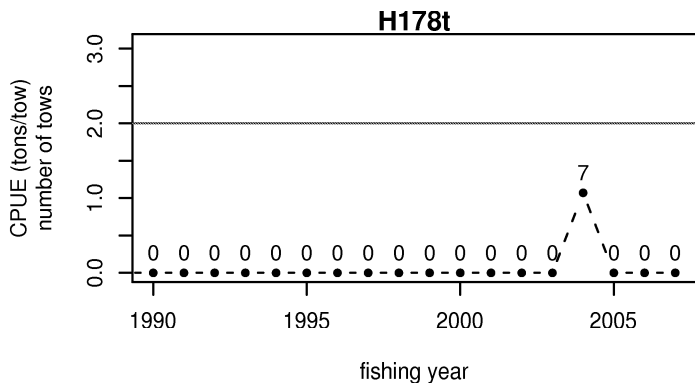
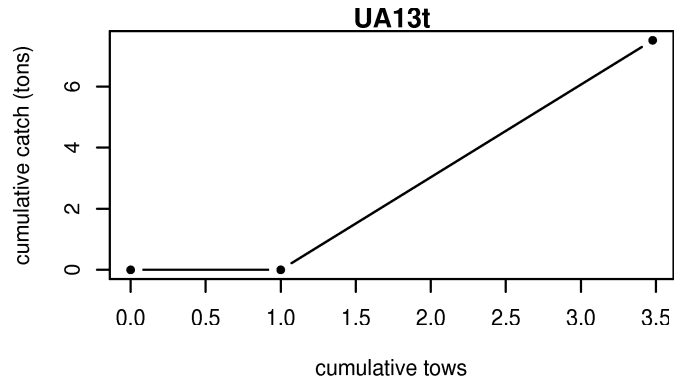
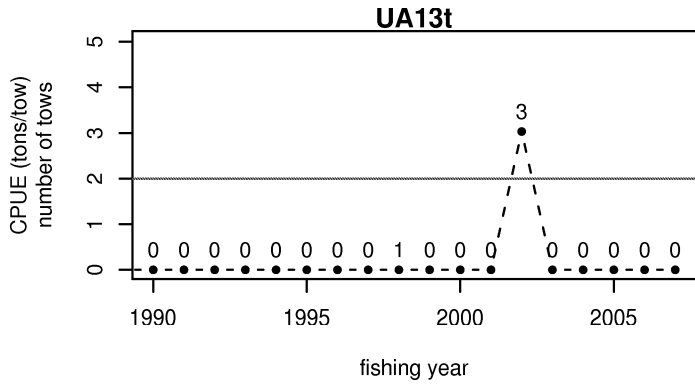
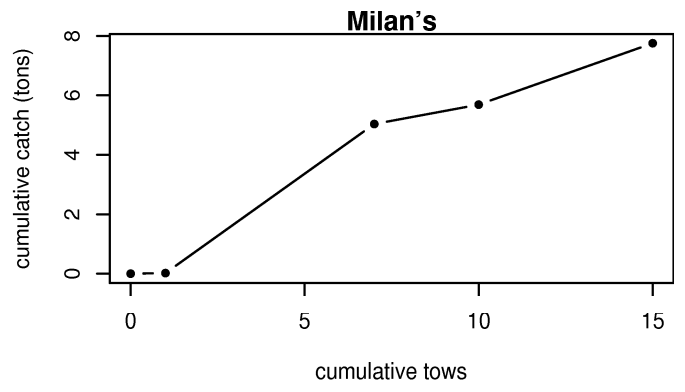
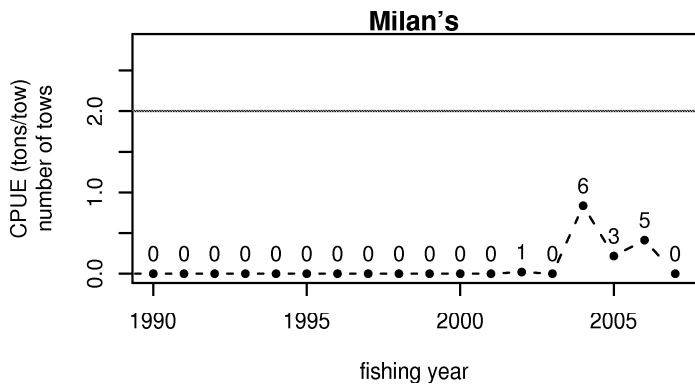
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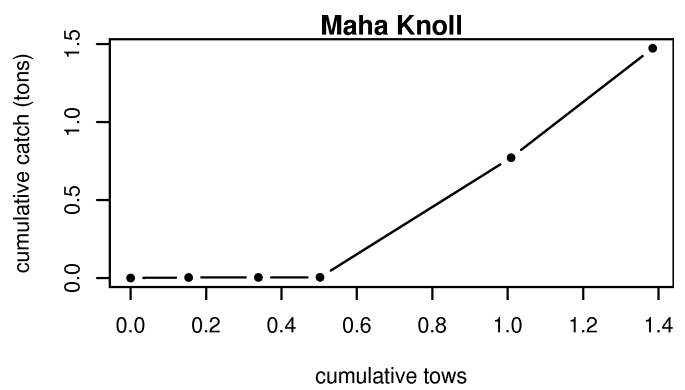
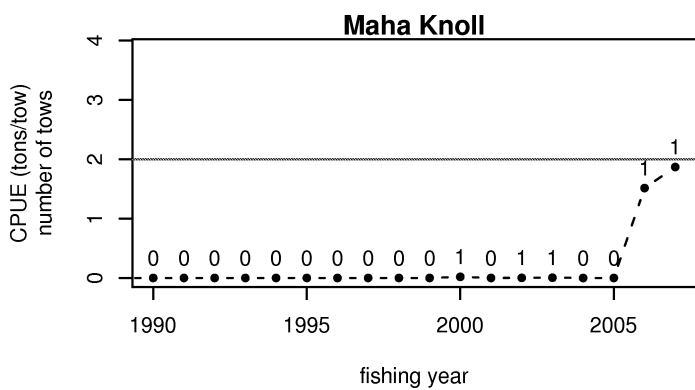
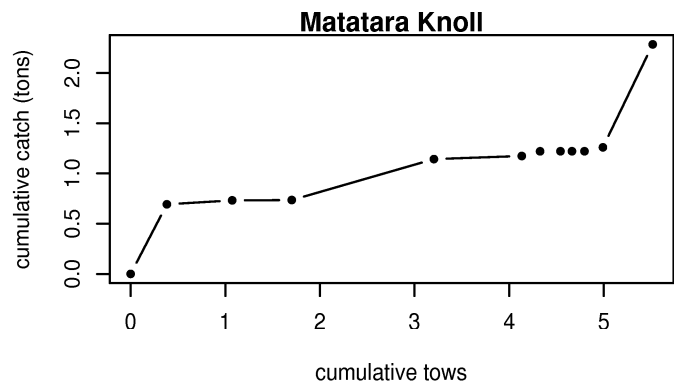
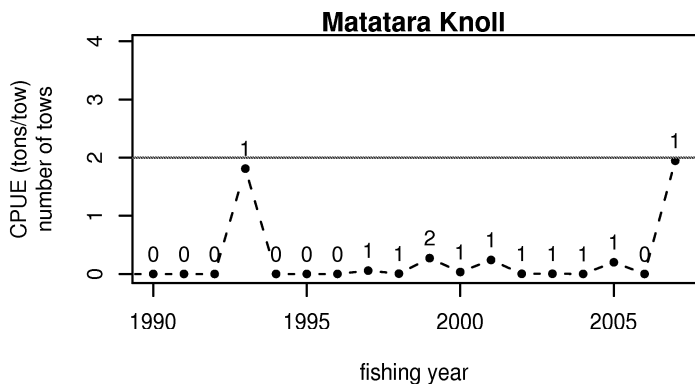
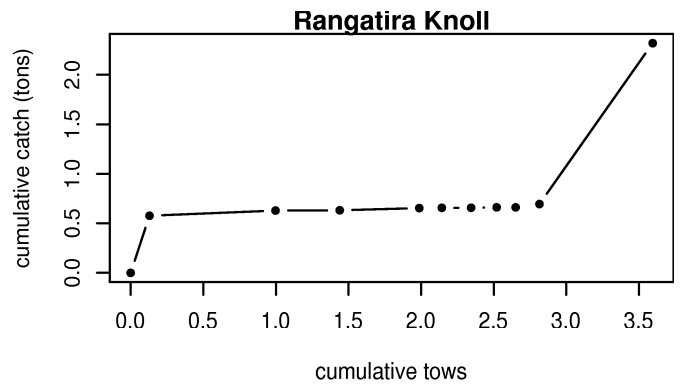
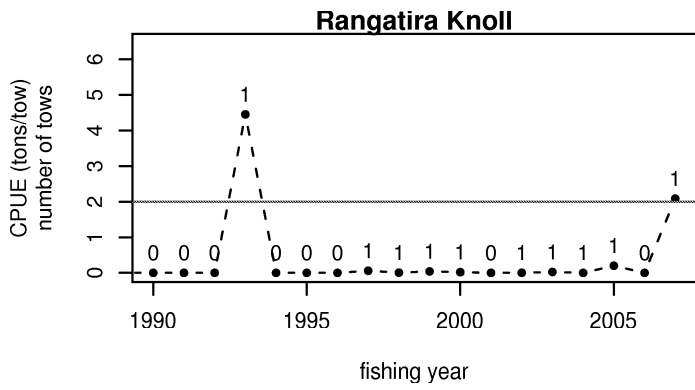
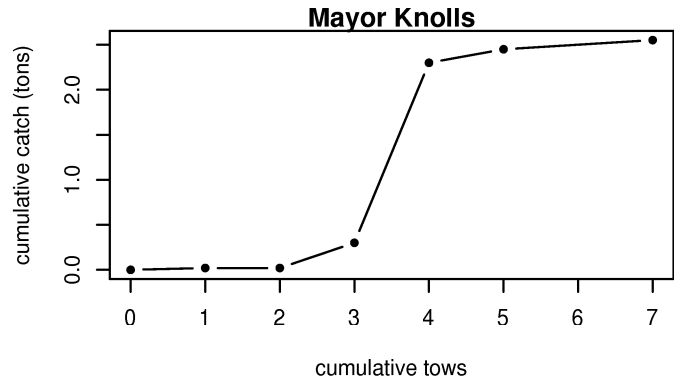
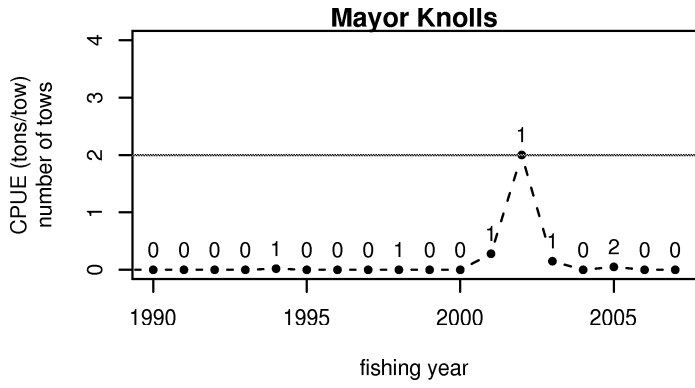
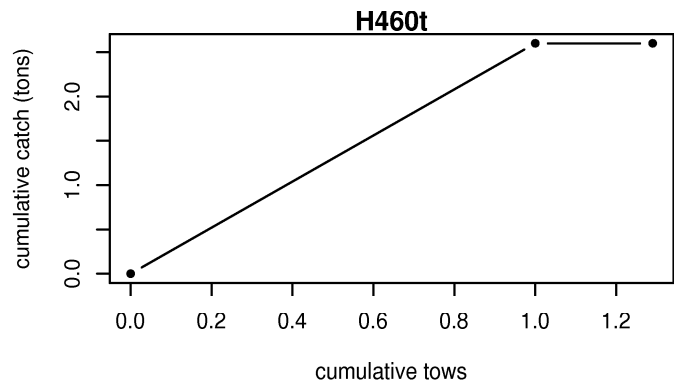
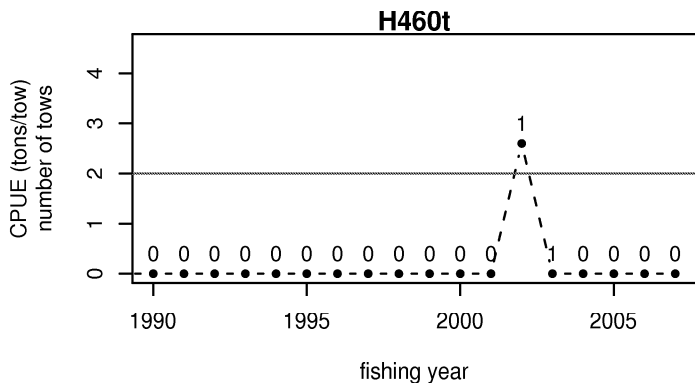


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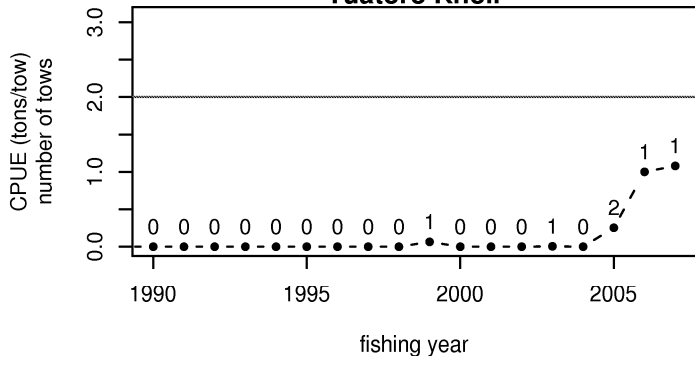




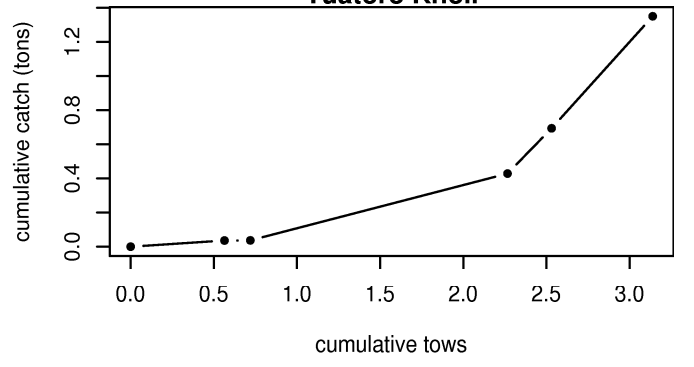




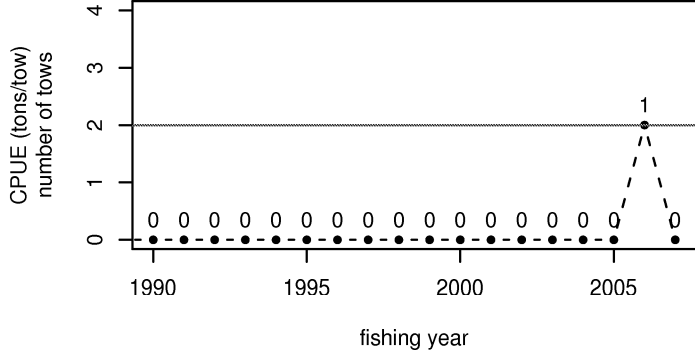
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