Stock assessment

Skates

(Rajidae)

Andreas Winter

Natural Resources

Fisheries

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Index

Summary

1. In 2016, skate catch by skate-licensed trawlers was reported at 2125.6 tonnes, out of a total skate catch (all fisheries) of 6189.4 tonnes. The total skate catch in 2015 was the second-lowest since 2009, but correspondingly skate-license effort was the lowest since the 1990s.
2. Stock assessment of the multi-species skate assemblage was calculated with a Schaefer production model. The model was optimized on CPUE indices of Korean and Spanish target trawl catches north of 51°S, with penalty functions for survey biomass estimates calculated in 2010 and 2013, carrying capacity ≥ initial biomass, and current biomass > maximum sustainable yield.
3. The Schaefer production model estimated skate biomass north of 51°S in 2015 at 40,631 tonnes (95% confidence interval 33,800 to 82,716 tonnes) and maximum sustainable yield at 6,726 tonnes (95% confidence interval 5,937 to 47,879 tonnes).
4. Among the six predominant skate species, individual species CPUE time series showed increasing smoothed trends for *Bathyraja brachyurops* and *Zearaja chilensis*. CPUE time series were not significantly changing for *Bathyraja albomaculata*, *Bathyraja multispinis* and *Bathyraja scaphiops*. The CPUE smoothed trend for *Bathyraja griseocauda* was decreasing through 2016.

Introduction

Skate catches (Rajiformes) have been reported in Falkland Islands waters since 1987. Skate catches were low until the stocks were commercially recognized by a Korean trawl fleet in the early 1990s (Wakeford et al. 2005), but rapidly increased >5000 tonnes year^{-1}. Given the strong targeted effort, skate trawling was licensed separately from other trawl fisheries starting in 1994 (Wakeford et al. 2005). Two skate fishing regions were identified: north and south of the Falkland Islands, and the southern region soon showed signs of decreasing catch (Agnew et al. 2000; Wakeford et al. 2005). As a conservation measure, directed fishing for skates was prohibited south of 51°S in 1996 (Agnew et al. 1999).

Directed fishing for skates in the north has continued annually. In 2016, skate catch by skate-licensed trawlers was 2125.6 tonnes (Table 1), taken in 31 grid units north of 51 ºS (Figure 1). Of these 31 grid units, 55.3% of skate catch as well as 55.3% of skate-license effort were taken in 8 consecutive grid units along the 200 m isobath (XFAJ, XGAJ, XGAK, XHAK, XHAL, XJAM, XJAN, XKAN) (Figure 1). Skate bycatch by other commercial bottom trawls (licensed for finfish or Falkland calamari) was 3718.7 tonnes, taken in 139 grid units around the Falkland Islands. Of these 139 grid units, 28 were among the 31 grid units that had also been fished with skate license; and these accounted for 38.0% of the skate catch by other commercial bottom trawls. Of the total skate bycatch by other commercial bottom trawls, 43.4% was taken by vessels that had also held skate licenses during the year, while representing 21.2% of the effort. Additionally 28.7 tonnes of skate in 2016 were taken as bycatch under longline (L) license, and 1.0 tonnes under surimi (S) license. No skate bycatch was taken under *Illex* (B) license. Total experimental (E license) catch of skate in 2016 was 5.6 tonnes.

FIFD observers sampled skates on 20 fishing vessels in 2016, over a total of 256 sample stations. Sixteen skate species were identified, representing most of the known species in Falkland Islands waters (Arkhipkin et al. 2012). By specimen numbers, 26.5% of skate samples were *Bathyraja brachyurops*, 21.4% *Zearaja chilensis*, 20.8% *Bathyraja albomaculata*, 11.9% *Bathyraja griseocauda*, 4.8% *Amblyraja doellojuradoi*, 4.8% *Bathyraja* *macloviana*, 4.3% *Bathyraja scaphiops*, 1.9% *Bathyraja cousseauae*, 1.7% *Bathyraja multispinis*, 0.8% *Psammobatis* spp., 0.4% *Dipturus argentinensus*, 0.2% *Amblyraja cf. georgiana*, 0.2% *Bathyraja magellanica*, 0.1% *Bathyraja papilionifera*, 0.1% *Bathyraja meridionalis*, 0.1% *Dipturus trachydermus*.

Stock assessment for license allocation was again based on the multi-species skate complex, as species are not identified in vessel catch reports (Agnew et al. 2000, Wakeford et al. 2005, Winter et al. 2015). However, annual CPUE trends are reported for six major species of interest (Winter et al. 2015).

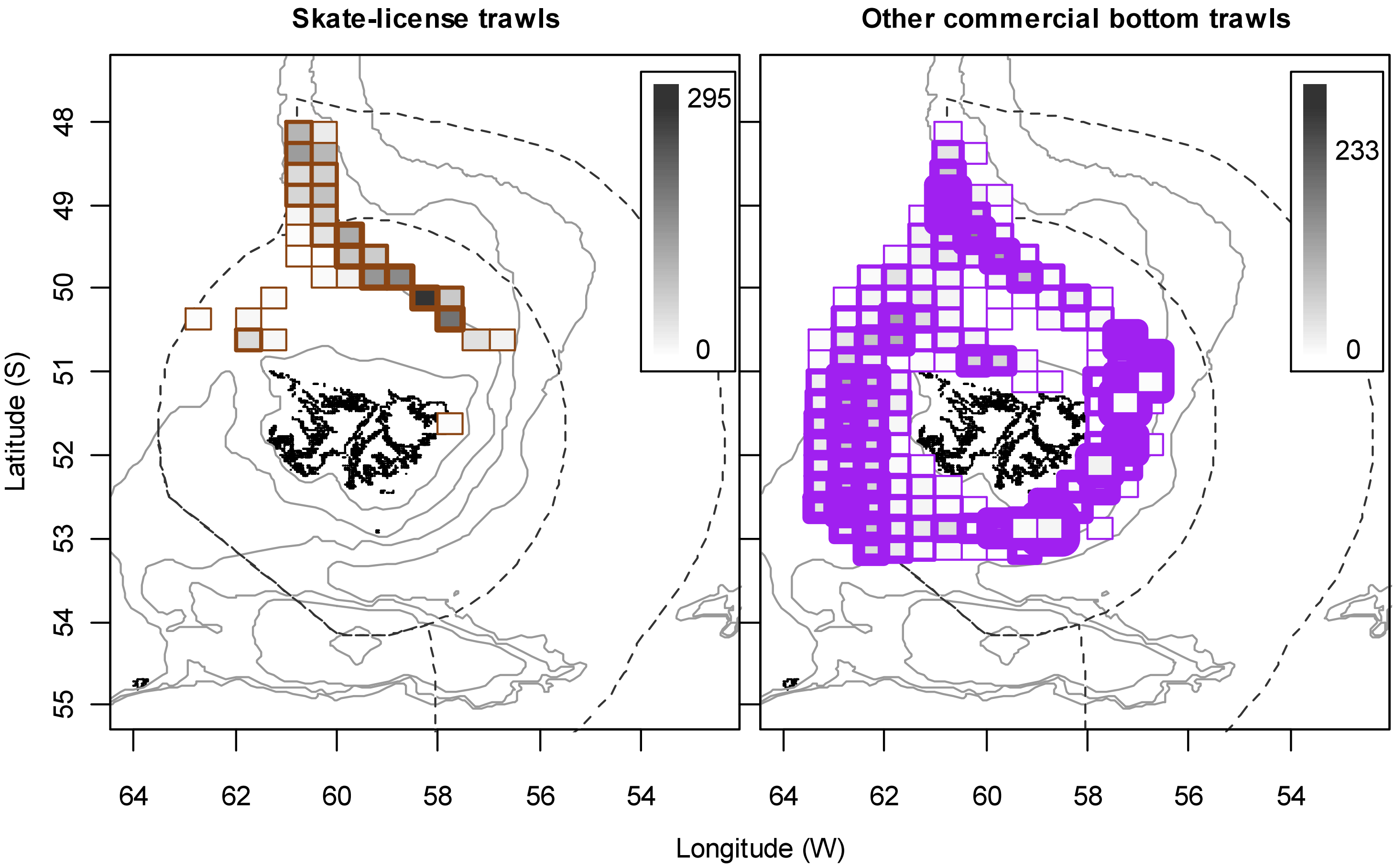


Figure 1. Distribution of skate catches by grid under skate license (left) and other bottom-trawl licenses (right) in 2016. Thickness of grid lines is proportional to the number of vessel-days (1 to 14 for skate license, left; 1 to 298 for other bottom-trawl licenses, right). Gray-scale is proportional to the skate catch biomass (maximum 295.5 tonnes in one grid unit for skate license, left; maximum of 233.3 tonnes for other bottom-trawl licenses, right).

Methods

The skate stock assessment calculated last year (Winter, 2016) was updated with the most recent year's catch and effort report data. All skate catches from all years are entered according to the revised conversion factors (Winter and Pompert 2014). The current skate stock assessment was calculated as a Schaefer production model (Schaefer 1954), expressed as a difference equation:

$$B_{t+1} = B_t + rB_t\left(1 - \frac{B_t}{K}\right) - C_t$$

where B_t and C_t are the stock biomass and catch in year t; r is the intrinsic population growth rate and K is the carrying capacity. The Schaefer production model was optimized on time series indices of standardized CPUE. Since last year (Winter 2016), the Schaefer production model has been optimized on an objective function comprising the negative log-likelihood functions of both Korean and Spanish skate-license CPUE trawl indices north of 51°S:

$$L\{\mathrm{CPUE}_{Korea\ N}, \mathrm{CPUE}_{Spain\ N} \mid \text{parameters}\} =$$

$$L\{\mathrm{CPUE}_{Korea\ N} \mid K, B_1, r, q_{Korea\ N}\} + L\{\mathrm{CPUE}_{Spain\ N} \mid K, B_1, r, q_{Spain\ N}\}$$

where

$$L\{\mathrm{CPUE}_{Korea\ N} \mid K, B_1, r, q_{Korea\ N}\} =$$

$$n\left(\log(\sigma_{Korea\ N}) + \frac{\log(2\pi)}{2}\right) + \frac{\sum_t\left(\log(B_t) - \log(\mathrm{CPUE}_{Korea\ N\ t} / q_{Korea\ N})\right)^2}{2\sigma^2_{Korea\ N}}$$

Equivalently, substitute *Spain N* for *Korea N*; notation following Hilborn and Mangel (1997) [7.11]; n is the length of time series t observations, q is the catchability coefficient of the CPUE index expressed as kg of skate catch per trawl hour, and σ is the standard deviation between $\log(B_t)$ and $\log(\mathrm{CPUE}_t / q_t)$:

$$\sigma_{Korea\ N} = \sqrt{\left(\log(B_t) - \log(\mathrm{CPUE}_{Korea\ N\ t} / q_{Korea\ N})\right)^2}$$

$\mathrm{CPUE}_{Korea\ N}$ and $\mathrm{CPUE}_{Spain\ N}$ were standardized for latitude, longitude, month and depth using generalized additive models (GAM) with a log link function. Annual skate catch and effort data from 1989 through 2015 were included. Skate licenses have been implemented since 1994 (Wakeford et al. 2005), and a probabilistic algorithm (FIFD 2013) was used to infer which Korean trawls were actually targeting skates in the years 1989 to 1993, before the issuance of skate licenses. The two earliest years 1987 and 1988 were not included because catch reporting did not yet distinguish trawls from jigging or longline. The same probabilistic assignment of 1989 to 1993 Korean skate target trawls as previously (FIFD 2015, Winter 2016) was applied to the current assessment. The probabilistic algorithm was not calculated to infer Spanish trawls targeting skates in 1989 to 1993, because in the following years 1994 to 1996, which are used as the template, only 12 days of skate license trawling were taken by a single Spanish vessel (during 1995).

Biomass in the first year of the fishery ($B_1 = B_{1989}$) was optimized as a free parameter in the Schaefer production model. B_1 is sometimes assumed to equal the carrying capacity K (Punt 1990, Hilborn and Mangel 1997, Maunder 2001), and this assumption has also been employed for the Falkland Islands skate fishery (Agnew et al. 2000). However, skate catches in Falkland Islands waters have been taken since before 1989 (FIG 1989), and K and B_1 were optimized separately along with r, $q_{Korea\ N}$, and $q_{Spain\ N}$.

Four penalty terms were added to the Schaefer production model to stabilize the optimization. The first two penalty terms related to skate biomass estimates from FIFD skate surveys conducted in 2010 (Arkhipkin et al. 2010) and 2013 (Pompert et al. 2014). In either survey the 26 grid units were occupied that represented the historic concentration of the skate target fishery (Payá et al. 2008). Because the actual commercial fishery can shift around in any year, the inference was made that the proportion of total commercial skate catch taken in the top 26 grids (not necessarily the exact same ones) should reflect the ratio of survey area biomass to total biomass north of 51 ºS (Laptikhovsky et al. 2011). Survey area biomasses in 2010 and 2013 were estimated from swept-area samples with variability distributions calculated by bootstrap re-sampling (Arkhipkin et al. 2010, Pompert et al. 2014). Proportions of total commercial skate catch taken in the top 26 grids in 2010 and 2013 likewise had variability distributions calculated by bootstrap re-sampling. Combining the two variability distributions, composite estimates of total skate biomass had 95% confidence limits of:

2010	17,832.7 to 50,198.3 tonnes
2013	14,494.1 to 82,840.4 tonnes

The penalty function was implemented as the log squared difference:

$$P\{B_{survey\ 2010}, B_{2010} |\ K, B_1, r, q_{Korea\ N}\} = \emptyset \frac{\left(\log\left(B_{survey\ 2010\ min\ /\ max\ 95\%}\right) - \log(B_{2010})\right)^2}{2\sigma^2_{Korea\ N}}$$

where $\emptyset = 0$ if the B_{2010} iteration of the optimization was within the 95% confidence limits of the 2010 survey estimate, and $\emptyset = 1$ if the B_{2010} iteration was outside the 95% confidence limits of the 2010 survey estimate. (Again, equivalently substitute *Spain N* for *Korea N*, and / or survey 2013 for survey 2010). The third penalty term was for $K \geq B_1$ (Prager 1994), and the fourth penalty term was for $B_{2015} \geq$ maximum sustainable yield (MSY). The third and fourth penalty terms were likewise calculated as log squared differences and triggered by multipliers $\emptyset = 0$ or 1 according to whether the condition was met.

The Schaefer production model was optimized in R programming code with a Nelder-Mead algorithm, on both Korean and Spanish CPUE indices and the four penalty functions. The larger number of Korean data automatically gave greater weight to the Korean index. To estimate parameter variability the model was run though a Markov Chain Monte Carlo (MCMC) with 5×10^6 iterations of which the first 20,000 were discarded as burn-in, and every tenth iteration was retained to mitigate autocorrelation. The set of 498,000 retained MCMC iterations was used to generate 95% confidence intervals for each of the optimization parameters K, B_1, r, $q_{Korea\ N}$ and $q_{Spain\ N}$, and for MSY calculated as (Hilborn and Walters 1992):

$$MSY = \frac{rK}{4}.$$

The assessment of total skate biomass can potentially mask changes in assemblage composition, with species more vulnerable to fishing pressure replaced by more resilient species (Dulvy et al. 2000, Ruocco et al. 2012). Agnew et al. (2000), Wakeford et al. (2005), and Winter et al. (2015) examined species composition trends in the Falkland Islands skate fishery. For the current stock assessment, CPUE time-series trends were updated and examined for the six species of interest described in Winter et al. (2015): *B. albomaculata*, *B. brachyurops*, *Z. chilensis*, *B. griseocauda*, *B. multispinis* and *B. scaphiops*.

Skate CPUE were calculated from all trawl stations under skate license (or inferred to be skate-targeting prior to 1994; FIFD 2013), north of 51°S, that had observer reports of catch by species. CPUE trends were calculated according to methods slightly simplified from Winter et al. (2015), with CPUE per station standardized for latitude, longitude, month, depth and nation (Korea or Spain), and the inter-annual trends smoothed using locally-weighted regression (LOESS). Standardizations were calculated with generalized additive models (GAM), and because of the frequent occurrence of zero CPUE for species in various observer reports, a zero-inflated approach was used of fitting GAMs separately to positive (non-zero) CPUEs, with lognormal error distribution, and to the probability of occurrence (presence/absence) of positive CPUEs, with binomial error distribution (Pennington 1983). LOESS were calculated with degree = 1, span = 0.666, and weighted in proportion to the duration of each trawl station. Variability of the trends was estimated by randomly resampling with replacement the yearly stations and recalculating the LOESS for each resample. Resampling was iterated 5000× for each species. In several (particularly early) years, some stations recorded various amounts of both identified skate species and the unidentified code 'RAY'. For these stations the unidentified RAY was then assigned to the identified species as the lesser of either the proportion of identified species among themselves or the ratio of each identified species to the unidentified RAY. The latter option was mainly to prevent large amounts of unidentified RAY being assigned to single identified species at a station. For variability estimation, stations with both identified skate species and RAY were additionally randomized at each iteration by setting the proportional assignment for an identified species to a random uniform draw between zero and 2× the ratio of the identified species to the unidentified RAY (up to a maximum of the total amount of unidentified RAY). Stations that reported only RAY and no identified skate species were excluded altogether as it would be incorrect to record these as having zero catch of any one skate species. 95% confidence intervals (2.5% to 97.5%; Buckland 1984) were calculated from the 5000 random iterations weighted in proportion to each iteration's correlation between its standardized and unstandardized CPUE, with the weight factor capped at the standardized / unstandardized correlation of the empirical (i.e., original non-randomized) data. CPUE trends were evaluated against the criterion that statistically significant change would be indicated by a horizontal line intersecting the lower and upper 95% confidence intervals (Swartzman et al. 1992).

Due to findings of catch misreporting since last year (Mercopress 2016), a test was calculated to examine whether skate-license catch reports in the presence of a FIFD observer gave equivalent catch rates to catch reports without an observer. Skate-license catch reports were classified as either observed or not-observed according to whether an observer station was recorded on that vessel on that day. Per year, and separately for Korean and Spanish vessels, CPUE were compared between the sets of observed vs. not-observed skate-license catch reports using two-sample Wilcoxon tests. P-values of Wilcoxon tests were Bonferroni-corrected for the number of parallel comparisons.

Results

Skate catch north of 51°S was 4213.4 tonnes in 2016, the lowest since 2008. In particular, skate target catch was the lowest since 1998 (Table 1), but skate non-target catch north was also the lowest since 2009 (Table 1). In contrast, total skate catch in 2016 (6189.4 t) was around the median of the past 12 years (Figure 2), evincing that (non-target) catch south of 51°S was the highest since 2011 and second-highest since 1992. The proportion of target skate catch vs. total skate catch (north and south) was 34.4% in 2016, the second-lowest of the past 12 years (after 2011). The Korean target trawl standardized CPUE in 2016 was again the highest on record, whereas the Spanish target trawl standardized CPUE was approximately median for the past 12 years (Figure 2, Table 1).

Table 1. For the fishery north of 51ºS latitude*, yearly total skate catches under target license (F/R), yearly total skate catches under other licenses, and standardized skate CPUE index of Korean and Spanish target trawls. Skate target and non-target licenses were not discriminated before 1994.

Year	Catch (tonnes)		CPUE (t/hr)	
	target	non-target	Korean target trawl	Spanish target trawl
1989	812.92		0.32	-
1990	787.03		0.45	-
1991	5806.63		0.37	-
1992	3314.25		0.25	-
1993	5465.51		0.27	-
1994	2186.32	1932.34	0.33	-
1995	3623.42	862.35	0.29	0.10
1996	1927.08	791.01	0.22	-
1997	1976.42	593.86	0.32	-
1998	226.63	396.65	0.41	-
1999	3467.83	417.58	0.36	-
2000	2511.36	549.27	0.31	-
2001	3406.68	542.06	0.38	-
2002	2194.42	495.94	0.41	-
2003	3137.54	479.57	0.41	-
2004	3881.38	473.34	0.41	-
2005	4396.01	594.41	0.49	-
2006	2711.47	1229.93	0.48	-
2007	3527.83	1300.19	0.60	0.37
2008	2280.21	1067.41	0.52	0.33
2009	2932.08	1916.39	0.57	0.46
2010	2725.08	2040.46	0.61	0.38
2011	2572.93	2781.54	0.53	0.29
2012	3094.04	2377.99	0.70	0.34
2013	2223.73	2478.56	0.56	0.34
2014	2953.40	2128.40	0.61	0.73
2015	2365.28	3187.47	0.69	0.31
2016	2125.59	2087.81	0.75	0.35

* Skate-license fishing is restricted to north of 51ºS latitude since 1996. Target catches before 1996, and non-target catches before and since 1996 listed in the table are thus not total catches of skate.

Production model fit parameters for total skate biomass north of 51 °S are summarized in Table 2 together with their 95% confidence intervals from the MCMC. A similar outcome as in previous assessments was obtained: very wide bounding of the carrying capacity K and heavily right-skewed biomass estimates. The optimized estimate of skate biomass for 2016 was 40,631 tonnes, and the maximum sustainable yield 6,726 tonnes.

Table 2. Optimized Schaefer production model parameters obtained with the combination of Korean and Spanish target trawl CPUE indices, plus resulting estimates of year 2016 biomass north of 51 °S latitude and MSY. 95% confidence intervals from MCMC iteration of the production model.

Parameter	CPUE target trawl indices	
	optimum	95% conf. int.
K	99,283	80,927 - 1,198,900
B_{1989}	13,780	11,934 - 28,797
r	0.271	0.133 - 0.303
q_{Korea}	1.71 e^{-5}	0.88 e^{-5} - 1.99 e^{-5}
q_{Spain}	1.05 e^{-5}	0.53 e^{-5} - 1.32 e^{-5}
B_{2016}	40,631	33,800 - 82,716
MSY	6,726	5,937 - 47,879

The time series of skate species catch data extended from 1993 to 2016, with data absent in years 1998, 1999, 2005 and 2008 (Table 3). A total of 986 skate fishery observer stations were available over that time period. *B. brachyurops* (RBR) and *Z. chilensis* (RFL) continued the increasing CPUE trends that had been noted in Winter et al. (2015), albeit with higher variability in recent years (Figure 3). *B. albomaculata* (RAL) showed some increase since the start of the time series in 1993, but in contrast to previous assessments (Winter et al. 2015, Winter 2016), the revised and updated evaluation of the trend was not significant. The two less abundant species *B. multispinis* (RMU) and *B. scaphiops* (RSC) had CPUE time series that were not significantly changing. The CPUE time series of most concern was presented by *B. griseocauda* (RGR). With data up to 2013, Winter et al. (2015) found that the previous significant decline of *B. griseocauda* (Agnew et al. 2000, Wakeford et al. 2005) had reversed, while Winter (2016), with two further years' data, found that the declining trend had stabilized to a lower level. The current evaluation suggests that *B. griseocauda* CPUE has resumed declining after several years' high variability (Figure 3). However, this LOESS trend needs to be regarded with caution. Average values of both standardized and unstandardized *B. griseocauda* CPUE have actually been increasing again since 2014 (Figure 3), and compared to the other skates, *B. griseocauda* showed a weak correlation between standardized and unstandardized CPUE; indicative that more precise examination of changes in spatial and temporal distributions would be warranted for this species.

A total of 8467 skate-license catch reports are in the FIFD database from 1992 to 2016. Of these catch reports, 503 (between 0 and 38 per year) were matched to 1021 of the 1138[a] skate-license observer stations over that period. Twenty-eight within-year comparisons

[a] This is more than the 986 observer stations used for species CPUE trends, above, because some stations reported only code RAY, which could not be used for species trends, but could be used for overall CPUE comparison.

were available; 20 for Korean vessels and 8 for Spanish vessels. The corrected P-value threshold for statistical significance was thus set at 0.05 / 28 = 0.0018. By this threshold, 8 annual fishery comparisons had statistically significant average CPUE differences, all Korean. In 1997, 2000, 2001, 2003, 2004, 2012 and 2015 CPUE were significantly higher on not-observed catch reports, and in 2013 CPUE were significantly higher on observed catch reports (Figure 4). The result gives some evidence that vessels may adjust their catch performance, or catch reporting, in the presence of observers, but as observers accompany continuous periods of entire fishing trips (albeit relatively infrequently), the issue is difficult to evaluate precisely.

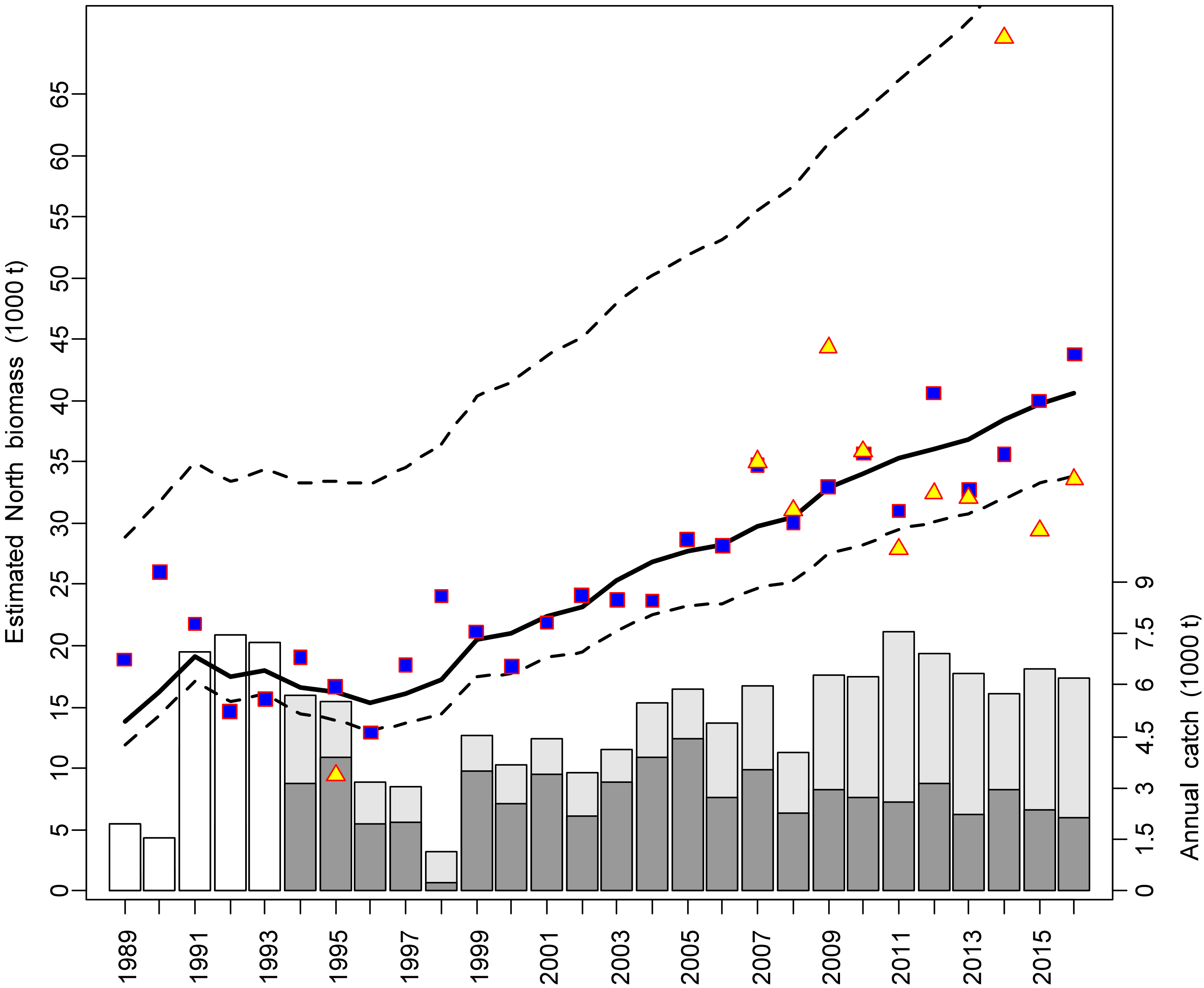
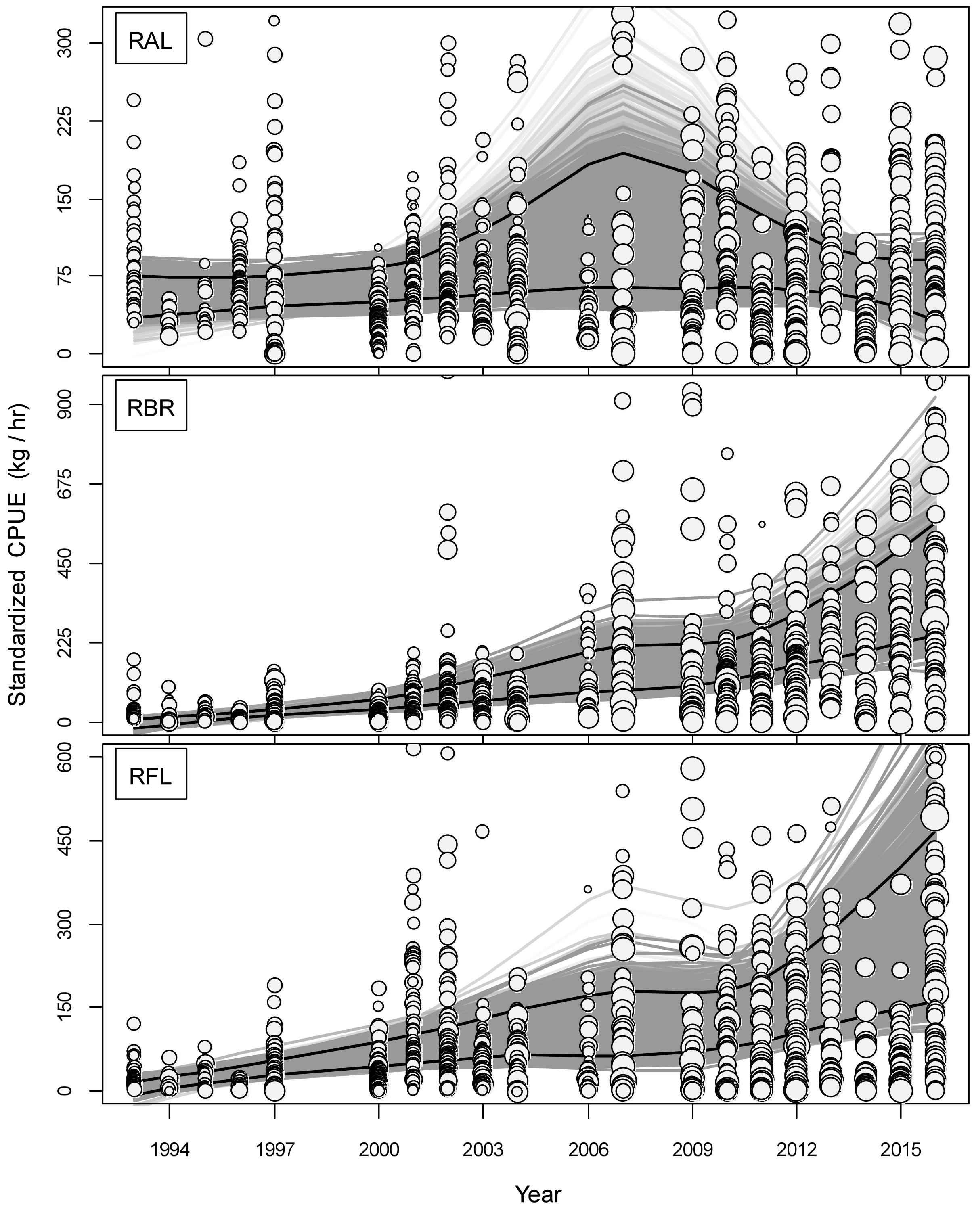


Figure 2. F/R-licensed skate catches (dark grey bars), non-target-licensed skate catches (light grey bars), indiscriminate license catches (white bars), estimated biomass of the northern skate stock ± 95% confidence intervals (black lines), and CPUE indices the biomass time series was optimized on: Korean target trawls (blue squares) and Spanish target trawls (yellow triangles). The figure is formatted for comparison with Figure 3A in Wakeford et al. (2005).


RAL
RBR
RFL
Standardized CPUE (kg / hr)
Year
0
75
150
225
300
0
225
450
675
900
0
150
300
450
600
1994
1997
2000
2003
2006
2009
2012
2015

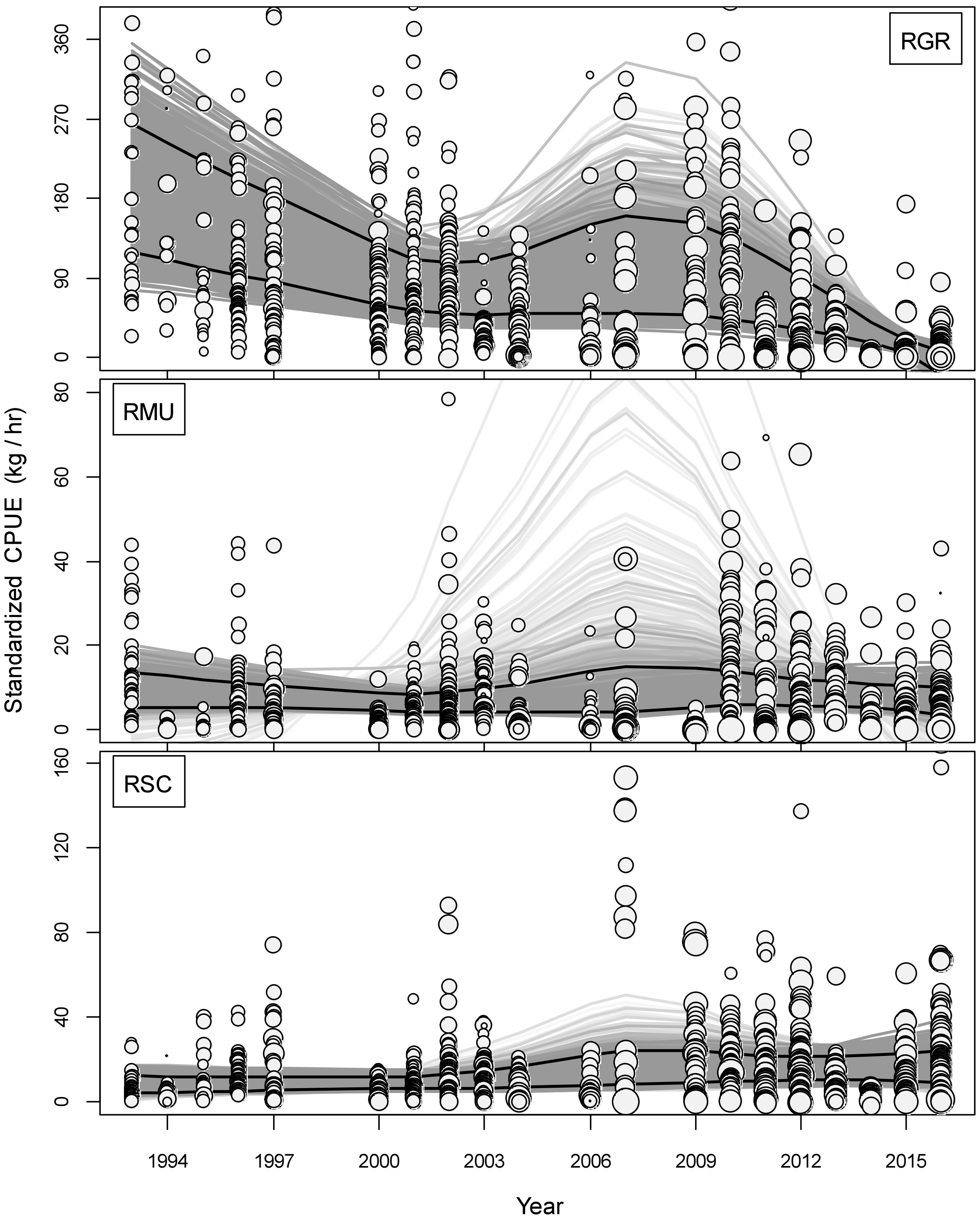


Figure 3. Standardized CPUE by species estimated from observer trawl stations in the skate-license fishery, 1993 to 2016. Upper limit of each plot truncated at 95% of the data for visibility. Symbols are sized proportional to the duration of each trawl station. Grey lines: 5000 randomized iterations of the LOESS smooth through the time series; colour-scaled to the correlation between standardized and unstandardized CPUEs of each iteration. Black lines: weighted 95% confidence intervals of the randomized iterations.

Table 3. LOESS smooth values of standardized CPUE (kg hr^{-1}) per year per species from observer catch data; N = number of observer-sampled stations. LOESS smooth values correspond to the mid-range between 95% confidence intervals on Figure 3. Note that standardization (with residual error added back) can result in negative values. These were not corrected, to maintain the relative changes of the inter-annual trends.

Year	N	RAL	RBR	RFL	RGR	RMU	RSC
1989	0	-	-	-	-	-	-
1990	0	-	-	-	-	-	-
1991	0	-	-	-	-	-	-
1992	0	-	-	-	-	-	-
1993	35	55.5	-1.3	4.3	178.6	8.4	7.0
1994	11	56.5	5.5	13.1	165.8	8.1	7.1
1995	19	57.2	11.9	22.1	152.5	7.7	7.2
1996	53	58.8	19.2	31.0	139.8	7.3	7.3
1997	60	60.4	26.5	39.6	127.1	7.0	7.5
1998	0	-	-	-	-	-	-
1999	0	-	-	-	-	-	-
2000	76	67.0	50.1	63.4	89.1	6.0	8.1
2001	72	69.9	59.2	71.6	78.4	5.7	8.2
2002	69	76.7	73.0	79.7	75.2	5.6	8.8
2003	54	83.4	86.0	87.6	74.3	5.7	9.4
2004	57	91.2	99.5	94.1	77.2	5.8	10.2
2005	0	-	-	-	-	-	-
2006	29	107.9	127.9	100.6	86.2	6.1	12.5
2007	35	111.9	138.1	103.1	89.0	6.5	13.5
2008	0	-	-	-	-	-	-
2009	50	104.3	148.5	106.8	84.4	8.0	14.5
2010	57	97.0	162.3	115.5	76.4	8.4	14.5
2011	55	91.6	188.4	132.1	65.3	8.3	14.5
2012	70	85.6	220.4	155.6	53.5	8.2	14.7
2013	33	79.1	254.2	180.1	40.3	7.8	15.0
2014	29	72.6	290.1	205.8	26.4	7.4	15.2
2015	43	66.3	328.1	232.8	11.5	6.9	15.4
2016	79	60.7	367.7	261.1	-3.0	6.4	15.6

Conclusions

Total skate CPUE in the commercial skate-target fishery continued to show an increasing trend in 2015, ongoing since 1996 (Figure 2). The resulting lack of contrast in the time series obtained an imprecise optimization of the Schaefer production model, particularly for carrying capacity K (Table 2). Carrying capacity may be especially unstable in a production model as cumulative changes in reproductive parameters, juvenile and adult survival, growth, and predator and prey interactions contribute to fluctuations in carrying capacity over time (Quinn 2003). However, the optimum model parameters and MSY estimate of this assessment were generally similar to previous years' estimates (Winter 2016); indicative that total skate biomass in the Falkland Islands zone appears stable. The ratio of catchability coefficients between Spanish and Korean vessels from joint model optimization (Table 2:

1.05 / 1.71 = 0.614) was similar to the estimate of 0.600 made after the 2013 skate survey (Pompert et al. 2014).

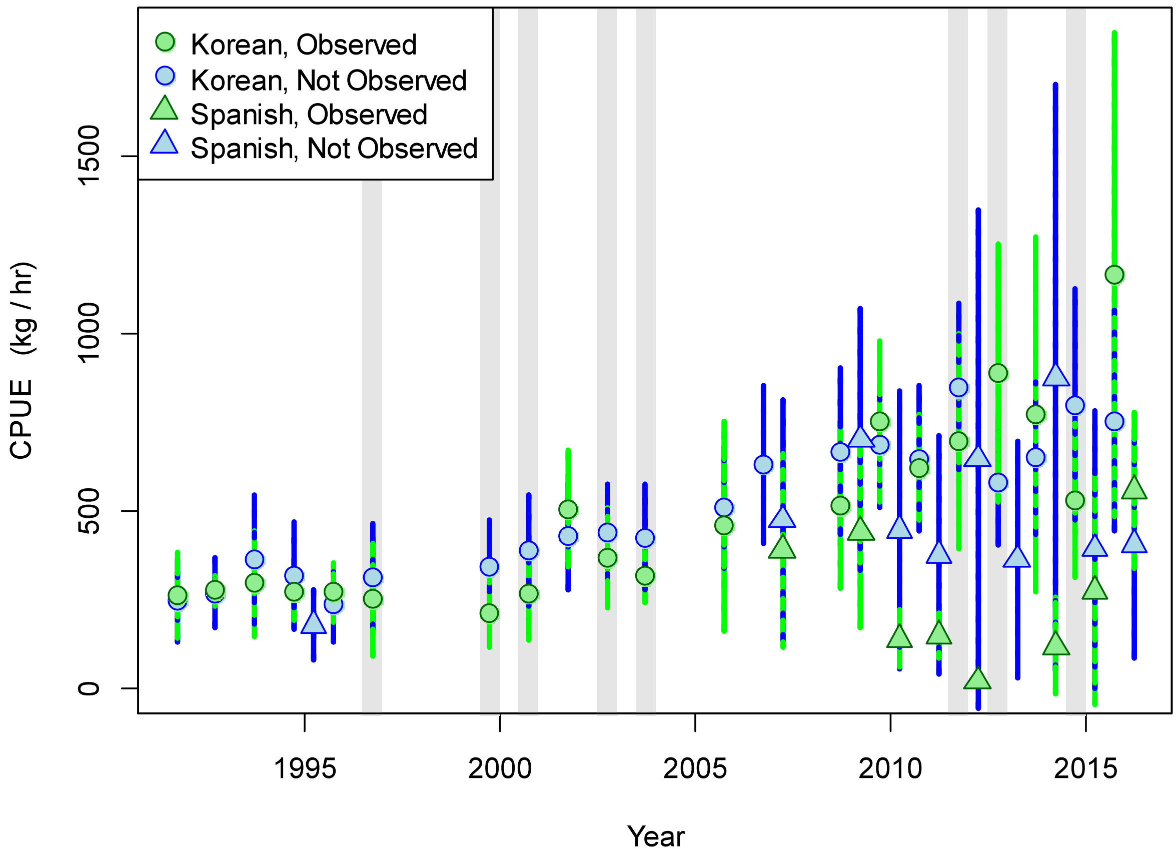


Figure 4. Mean CPUE per year among skate-license catch reports that were observed vs. not-observed, ± 1 standard deviation. Grey under-shading: significantly different CPUE comparisons; two-sample Wilcoxon test.

Use of combined CPUE indices for assessment of the multi-species skate assemblage (Wakeford et al. 2005) remains a potential source of error. Maunder et al. (2006) and Kleiber and Maunder (2008) have noted that CPUE is not proportional to community abundance if q (catchability coefficient) is not similar for all species being combined. The species with the highest catchability may contribute a greater proportion to the combined CPUE, and represent the population that is most depleted. Given this issue, for the current skate assessment the examination of individual species' commercial CPUE trends was reprised from Winter et al. (2015), with one year's older data (1993) and three years' more recent data (2014-2016). CPUE trends are level for *B. albomaculata*, *B. multispinis* and *B. scaphiops*. CPUE trends are continuing to increase for *B. brachyurops* and *Z. chilensis*. The CPUE trend of *B. griseocauda* is now showing a significant decrease over the past 2-3 years. As *B. griseocauda* is classified as endangered (McCormack et al. 2007), further study of this species in Falkland Islands waters is advisable.

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