

Shag interactions with commercial rock lobster pot and trap fishing methods in the Chatham Islands



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Abstract

Crayfish/ rock lobster is an integral part of Chatham Island life. It also forms an important part of the economy of the Islands and nationally rock lobster is an important seafood export earner.

Three species of shag breed in the Chatham Islands, two of which Chatham Island Shag and Pitt Island shag are endemic. The populations of both these species have suffered significant declines in the past 15 years. Accidental bycatch of shags has been reported from the Chatham Islands rock lobster fishery, but there has been no qualitative research into the issue.

Internationally studies of seabird interactions (including shags) in pot and trap fisheries are limited, with shag interactions reported from the Chatham Islands, New Zealand, Australia, North and South America, and few studies have quantified the level of shag bycatch.

Outside of New Zealand there have been no mitigation measures developed for seabird interactions with commercial pot and trap fisheries, including shag/ cormorant interactions. This is probably as a result of the low levels of shag interactions reported. The CRA6 Industry Association has been operating a seabird interaction code of practice since the issue of shag interactions was drawn to their attention in 2010. This appears to be the first such mitigation practice developed for pot and trap fishing in relation to seabird interactions.

Between the 1979/80 – 2009/10 fishing season the annual number of pot lifts has remained relatively stable with an average of 285,300 pot lifts per season (range 163,500 – 428,000), although the number of boats has declined from around 48 to 34.

Interviews were carried out with 22 past and present fishermen to determine shag interactions with commercial rock lobster pot fishing in the Chatham Islands. Nine of these fishermen reported catching between 1-5 Pitt Island shag during their entire fishing career.

Fishermen reported a total of 20 captures of Pitt Island shag, captures were widely distributed throughout the Chatham Islands although more bycatch was reported from Area 942 than other areas.

All reported bycatch occurred at least 5 years ago, and most over 10 years ago. Generally fishermen could not recall precise dates of shag interactions, but related the bycatch to pot and bait type, commenting that they changed baiting methodology 10-15 years ago.

Although fishermen could not remember the precise date of shag captures all reported that their bycatch occurring when pots were set close to shore in shallow water. This occurs each January and February when fishing gear is moved in shallow to follow the annual movement of rock lobster.

Fishermen who reported bycatch reported that shag captures occurred when they were using hanging baits and they thought shags were attracted to the bait, or small fish attracted to that bait when pots were first lowered into the water. These fishermen reported that since they moved to using snifters (bait holders) they had not caught shags.

Fishermen noted that at the time of their shag interaction they were using a different pot design than they do presently. The pots had a larger neck and were covered with large mesh, it was considered that the larger neck and mesh size of old pots provided more opportunity for shags to enter pots, either through the neck or even through the mesh. Modern pots have a narrower neck and smaller mesh size.

There was a high level of awareness of shags and shag interactions amongst CRA6 fishermen. This is probably as a result of debate about the relative significance of this issue, and a proposed observer programme.

All fishermen strongly felt that pot fishing was not the cause of shag population declines, and that the rock lobster industry was being singled out. It was felt that all possible threats to shags should be studied to determine the reason for population declines. This included disturbance from stock, impacts of introduced predators, and the impacts of increasing black-backed gull populations. Fishermen also commented that as little is known about the ecology of shags in the Chatham's it is impossible to determine the cause of population declines.

Introduction

Rock lobster, or kōura, is an integral part of the Chatham Islands. It has always been an important food for Moriori who traditionally caught them by hand or in baited supplejack pots that were lowered around coastal reefs. This tradition continued to be followed after Pakeha and Māori colonisation of the Chatham Islands and today rock lobster remained an important local food source (King 1989).

Large volumes of rock lobster were caught and exported from the Chatham's during the "rock lobster boom" in the mid to late 1960s. When international exports started in 1965, high overseas prices encouraged many fishermen to go rock lobster fishing. During this time steel-frame and wire-mesh cages replaced traditional supplejack pots. The "rock lobster boom" peaked in 1968 when 150 vessels landed 5,958 tonnes. Catches decline from 1969 and by the 1970's rock lobster were no longer in abundance (Dana 2003).

In 1990 the Quota Management System was applied to the rock lobster industry. The CRA6 area Total Allowable Commercial Catch (TACC) was originally over 500 tonnes but decreased in 1998 to 380 tonnes, the asset value of rock lobster within CRA6 has increased to \$60 million in 2003 (http://www3.stats.govt.nz/environment/Fish_Species_Resource_Rock_Lobster.pdf downloaded 3/5/2012). From 2001-2010 between 32-36 fishing vessels have been operating in the Chatham Islands (Starr 2011). Nationally rock lobster is an important marine resource, with rock lobster being the third biggest seafood export earner. In 2004 rock lobster exports earned nearly \$100 million (http://www3.stats.govt.nz/environment/Fish_Species_Resource_Rock_Lobster.pdf downloaded 3/5/2012).

Three species of shag breed in the Chatham Islands (Bell and Bell 2000), two of which are endemic species that have declining populations. The following species occur in the Chatham Islands -

Black shag *Phalacrocorax carbo novaehollandiae*

A widespread cosmopolitan species which breeds throughout eastern North America, Greenland, Iceland, Europe, Asia, Africa and Australasia. Six sub-species recognised, of which *P.c. novaehollandiae* occurs in Australia, New Guinea, New Zealand and the Chatham Islands (Heather and Robertson 1996). Occurs in both marine and freshwater habitats including inland lakes and rivers (Marchant and Higgins 1990). In the Chatham Islands black shag colonies are only found on main Chatham Island, with nests in small scattered colonies in trees, scrubs and flax on river and lake margins (Bell and Bell 2000). Their breeding biology is well known. The breeding season is quite variable, with most eggs are laid between June and October. Each pair lays 2-5 eggs, with eggs laid two days apart. Eggs hatch after 27-31 days of incubation and chicks fledge after 7 weeks and fed by parents for a further 7-10 weeks. Some young breed at 2 years old, but most start when 3 years old.

Chatham Island shag *Leucocarbo onslowi*

A marine shag endemic to the Chatham Islands and surrounding waters (Marchant and Higgins 1990), with a restricted number of breeding colonies distributed on Chatham I, Pitt I, Rabbit I, North East Reef and the Star keys (Bell and Bell 2000). Breeds in discrete colonies of 5-300 pairs on exposed coastal headlands and rocky islets (Heather and Robertson 1996). The breeding biology is poorly known; with laying extending from August to December, but there is some variation both between and within colonies (Heather and Robertson 1996). Between 1-4 eggs are laid, but there is no data on incubation periods, nestling period, growth of young and breeding success. Since 1997 the populations has declined from 842 breeding pairs (Bell and Bell 2000), to 355pairs in 2011 (Debski *et. al.* 2012).



Chatham Island shag on nest at Cape Fournier colony, November 2011.

Pitt Island shag *Stictocarbo featherstoni*

A marine shag endemic to the Chatham Islands and surround waters (Marchant and Higgins 1990), with a widespread breeding distribution through the island group. Colonies are found on Chatham I, Pitt I, South East I, Mangere I, Little Mangere I, Rabbit I, The Castle, Murumuru Rocks, Star keys, Forty Fours, and the Sisters (Bell and Bell 2000). Breeds in small scattered colonies of between 5-20 pairs on coastal cliffs and rocky islets (Heather and Robertson 1996). The breeding biology is poorly known; breeding is said to extend from August to December with laying starting in August and all chicks fledging by December (Marchant and Higgins 1990). Although laying has been known to continue to as late as December (Heather and Robertson 1996). Between 1-4 eggs are laid, but there is no data on incubation periods, nestling period, growth of young and breeding success. The breeding population has decline from 729 pairs in 1997 (Bell and Bell 2000) to an estimated 434 pairs in 2011 (Debski *et. al.* 2012).



Pitt Island shag incubating at a colony at Waitangi West, November 2011.

Accidental bycatch of shags has been reported from the Chatham Islands rock lobster fishery (Bell and Bell 2000), but there has been no detailed research into the issue. Using interviews with past and present fishermen this report investigates shag interactions with commercial rock lobster pot fishing in the Chatham Islands.

Method

This study was based on an interview survey of fishermen and retired fishermen from the Chatham Islands. Fishermen were questioned on their experience of shag interactions with pot fishing for rock lobster.

A questionnaire was developed with input from the Department of Conservation Marine Conservation Services Section and the CRA6 Industry Association (see Appendix 1 for a copy of the questionnaire). The draft survey was circulated to members of the CRA6 Industry Association and feedback was that no shags had been captured in the past five years. This advice influenced further survey design, especially around collection of historical data on shag interactions.

Surveys were carried out by face to face interviews with fisherman, where questions were presented to fishermen in an informal discussion, rather than a formal interview. Generally during the course of a discussion the topics included in the questionnaire were brought up and discussed. The CRA 6 Industry Association co-ordinated a meeting with some of its members to promote participation in the study. A small number of telephone interviews were undertaken after this meeting to follow up or clarify information discussed during the meeting.

Fishermen's responses were recorded by the interviewer in note form. Information on shag interactions were entered into a GIS linked database, recording shag species, location, pot type, baiting method, pot depth, and date. As fishermen could not recall specific dates of shag interactions data on date was altered during the survey to record approximate dates. Fishermen were asked to estimate when bycatch occurred during the clumped time periods; <5 years ago, 5-10 years ago, or >10 years ago.

Global review of shag interactions with commercial pot fishing

A literature review has shown that studies of seabird interactions (including shags) in pot and trap fisheries are limited. Research is strongly biased towards gill netting, long lining and trawl fisheries; a reflection that these methods are the most significant causes of seabird bycatch. Shag interactions in pot and trap fishing are reported from the Chatham Islands (Bell and Bell 2000), New Zealand (Sim and Powlesland 1995), Australia (Hobday *et. al.* 2008), North and South America (Matthews *et. al.* 2005, Shester *et. al.* 2008).

There has been no shag bycatch reported in the New Zealand commercial rock lobster fishery via official, mandatory, reporting mechanisms. Sim and Powlesland (1995) reported a banded black shag drowned in a rock lobster pot on the Wairarapa coast during 1976-89, but do not confirm if this was a commercial or recreational pot. Some bycatch of endangered Mediterranean shag *Phalacrocorax aristotelis desmarestii* has been reported from the crustacean fishery in the Mediterranean Sea area, but more significant bycatch was recorded in gill netting and long lining fisheries (Malet 2009).

Few studies have quantified the level of shag bycatch. Low levels of shag interactions are reported from the South Australian rock lobster fishery. During an observer programme one dead cormorant was found in a pot during 45,604 observed pot lifts between the 2004/05 and 2007/08 fishing seasons (Hobday *et. al.* 2008). In the Florida (USA) spiny lobster fishery 5 dead cormorants were found during 21,309 observed pot lifts during the 1993/94 fishing season (Matthews *et. al.* 2005). The highest level of shag interaction reported is from the Baja spiny lobster fishery, where 36 cormorants (*Phalacrocorax pelagicus*) were reported during 4940 observed pot lifts (Shester *et. al.* 2008).

Some pot and trap fisheries report no shag interactions. Zollett (2009) found no seabird bycatch in pot and trap fisheries in US east coast commercial fisheries, but did report some by-catch of marine mammals and sea turtles (entanglement in pot lines).

Outside of New Zealand there have been no mitigation measures developed for seabird interactions with commercial pot and trap fisheries, including shag/ cormorant interactions. This is probably as a result of the low levels of shag interactions reported.

CRA6 Industry Association has been operating a seabird interaction code of practise since the issue of shag interactions was drawn to their attention in 2010 (Daryl Sykes Pers. Comm.). This appears to be the first such mitigation practise developed for pot and trap fishing in relation to seabird interactions.

CRA 6 INDUSTRY CODE OF PRACTICE: SEABIRD INTERACTIONS

- Don't set pots alongside nesting sites; don't set pots in the vicinity of mating birds.
- Don't set pots when shags are sitting on the surface close to the boat.
- Don't use tied baits.
- Where possible use frozen baits if setting pots in vicinity of shag colonies.
- Watch pots carefully as they are set; be prepared to recover a pot if you see a bird dive after it.
- Release the bird after re-setting the pot.
- Last resort – use cover panels on pot necks which release after one/two hour soak time. Timed release units or even candy sticks could be deployed to activate the cover panels. (Based on the certainty that only way a shag can enter a pot is to dive through the neck)
- Use mandatory non-fish by-catch reporting forms if any fishing-related seabird mortalities are experienced.

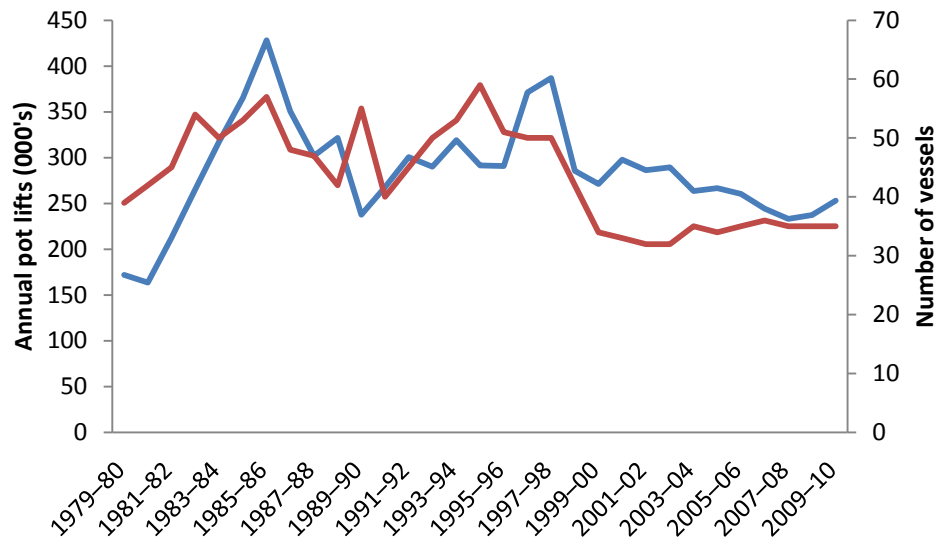
Results

A total of 22 fishermen and/or retired fishermen were interviewed. Ten fishermen were interviewed in a CRA6 Industry Association organised meeting, the remaining 12 fisherman were interviewed individually, either face to face (nine fishermen), or by telephone (3 fishermen).

Fishing effort

Determining fishing effort is important in quantifying bycatch risk. Data on fishing effort from CRA6 has been collected by the Ministry of Fisheries and was summarised by Starr (2011). Since 1979 the number of boats fishing in the Chatham's has declined. From the 1979-80 fishing season to the 1998-1999 season an average of 48 vessels (range 39-59) were operating in the Chatham's (Figure 1). However since the 1999-2000 season this average fell to 34 vessels and has since remained at this level (range 32-36). However over the same time period (1979-80 to 2009-10 season) the annual number of pot lifts has remained relatively stable (Figure 1), with an average of 285,300 pot lifts per season (range 163,500 – 428,000) (Starr 2011). So although there are fewer boats now working in the Chatham Islands, they are working the same amount of gear.

Figure 1. Annual number of pot lifts (blue line) and number of rock lobster vessels (brown line) in CRA6; 1979-80 season to 2009-10 season (data from Starr 2011).



CRA6 is divided into four statistical reporting areas (Figure 2).

- 940 – North east
- 941 – North west
- 942 – South east
- 943 – South west

Fishing effort in these four areas is not even, from the 1989-80 fishing season to the 2009-10 season a total of 8,843,600 pot lifts have occurred in CRA6. More pot lifts (35%) occur in statistical area 942 than in any of the other areas (Figure 3). This area includes the south eastern coast of Main Chatham around from Owenga, Pitt and the surrounding offshore islands. Northern areas 940 and 941 have 26 and 27% of pot lifts, whilst area 943 only has 12% of pot lifts (Figure 3).

The distribution of fishing effort has remained relatively constant between 1979-80 and 2009-10 (Figure 4). Although there is some yearly variation, the annual number of pot lifts from each statistical area has been relatively stable and reflects the twenty year average. More fishing occurs in area 942, equal effort is occurring in 940 and 941, with the least effort in area 943.

Figure 2. Map of boundaries of the statistical reporting areas from CRA6.

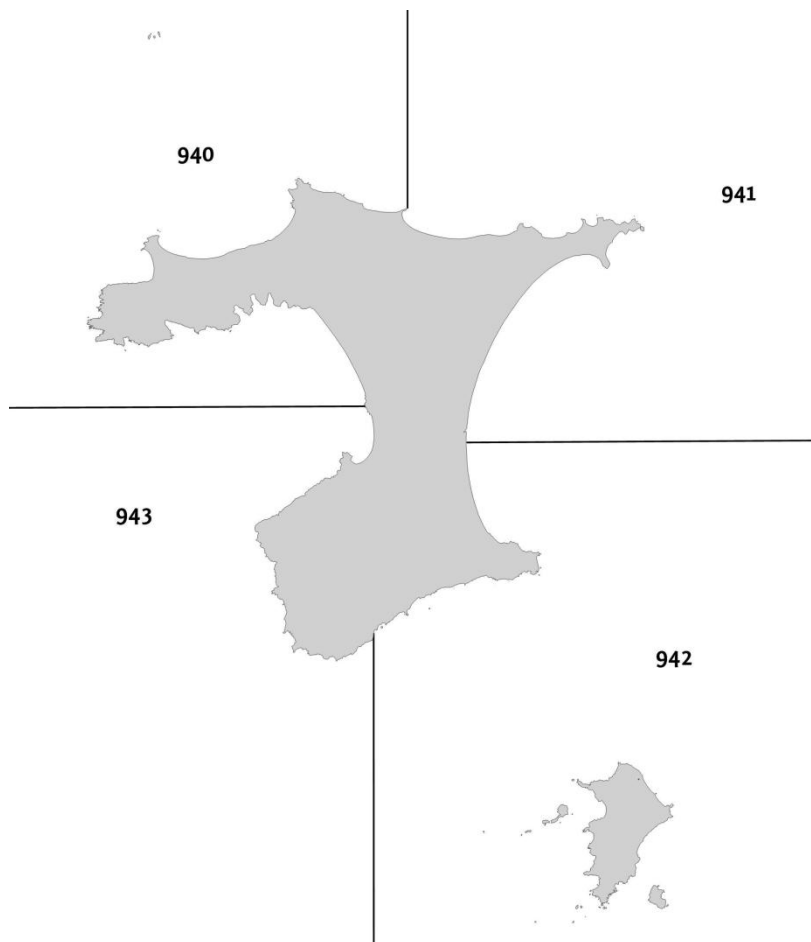


Figure 3. Percentage of pot lifts per statistical area in CRA6; 1979-80 season to 2009-10 season.

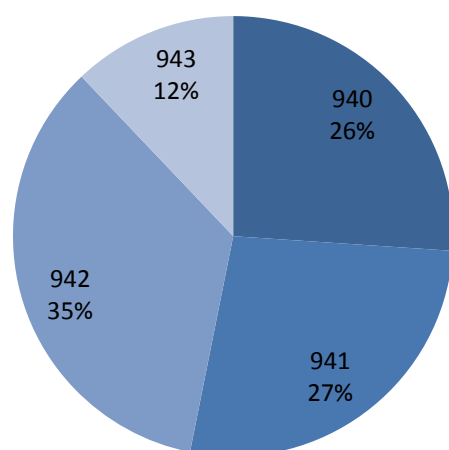
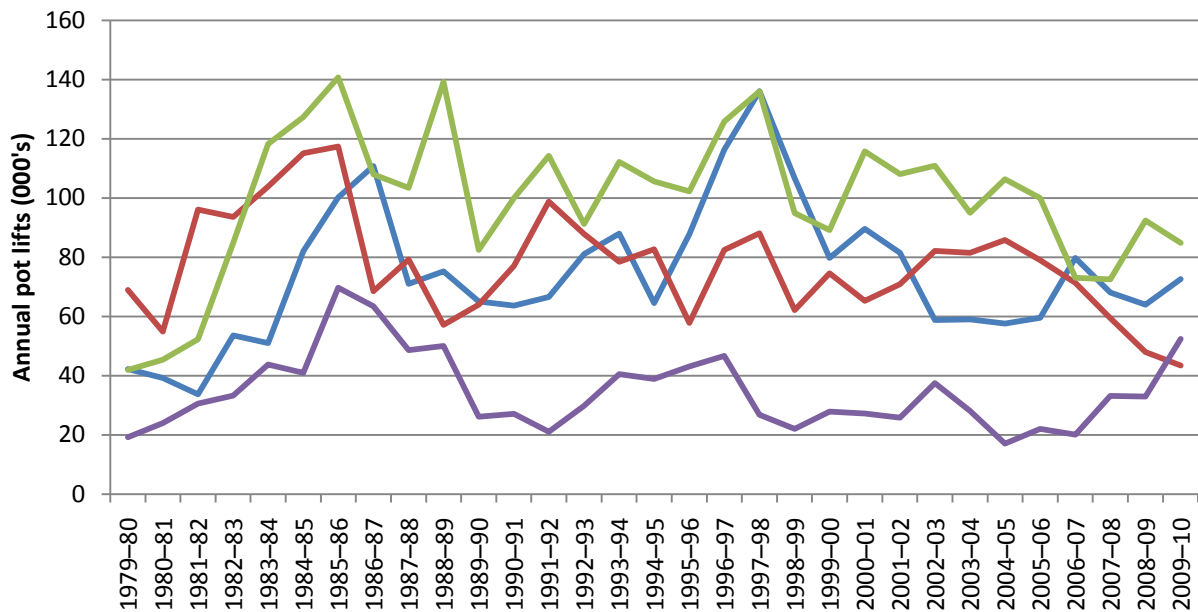


Figure 4. Annual number of pot lifts per statistical area from CRA6; Area 940 blue line, Area 941 brown line, Area 942 green line, Area 943 purple line.



Survey coverage

A total of 22 fishermen or retired fishermen were interviewed. The fishermen surveyed fished from Waitangi (4 fishermen), Port Hutt (4 fishermen), Kaingaroa (4 fishermen), Owenga (7 fishermen) and Pitt Island (3 fishermen). These fishermen had gear covering the entire fishing area in Chatham Island waters, and reflect the pot lift effort recorded by Starr (2011).

Shag interactions with commercial pot fishing methods

A total of nine fishermen (40%) acknowledged catching shags in rock lobster pots, all of these interactions involved a dead shag being recovered in a rock lobster pot when it was retrieved. Fisherman interviewed had either never caught a shag in pots, or had caught a small number of shags (1-5 shags) during their entire fishing career. Fishermen reported low levels of bycatch during their career, with fishermen reporting catching either 1 shag (2 fishermen), 2 shags (5 fishermen), 3 shags (1 fisherman) or 5 shags (1 fisherman). The fisherman who did report shag bycatch did have a good recollection of the event, especially in relation to the species caught, pot location, pot depth, pot type, baiting method and time of year.

All reported bycatch involved Pitt Island shag. There were no reports of Chatham Island shag being caught in pots.

A total of 20 captures of Pitt Island shag were reported, captures were widely distributed throughout the Chatham Islands although several hot spots show up (Figure 5a and 5b). More shag bycatch was reported from Area 942 than other areas, and in particular the southern end of Pitt Island were five captures were reported. Likewise in Area 940 there was three reported captures in Ocean Bay (Figure 5a, 5b and Table 1).

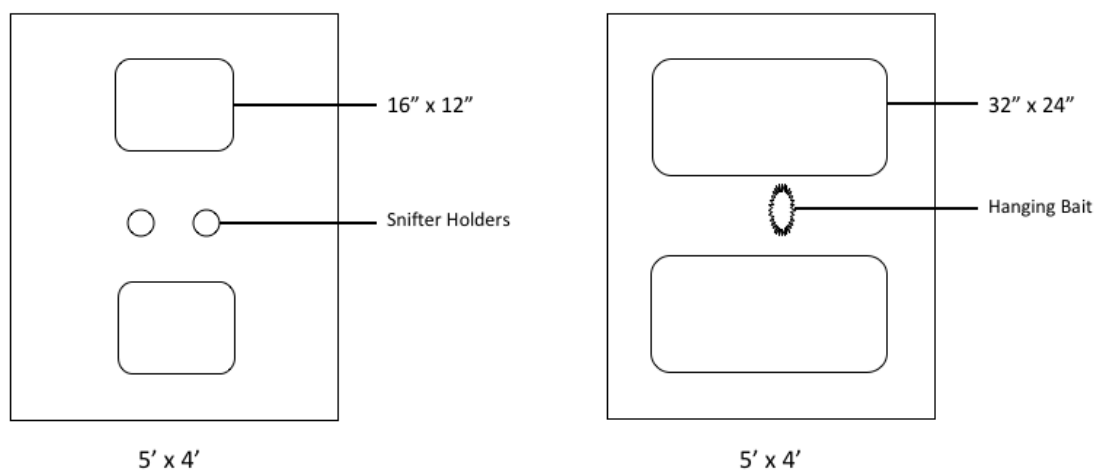
Figure 5a. Distribution of Pitt Island shag bycatch in the Chatham Island – Main Chatham.



System (QMS) in 1990/91 rock lobster pots used in the Chatham's were 6' x 5', 5' x 5', or 5' x 4' wide and 18 inches deep, each pot had two necks which took up approximately two thirds of the top of pot and pots were covered with large mesh (Figure 6). After the implementation of the QMS the CRA6 TACC took two reductions before 1998; following on from these fishermen changed pot design and baiting methodology to ensure pots were fishing more efficiently. Pot size remained the same with pots being between 5' x 4' to 3' x 3' and 20"-22" deep, but neck size reduced dramatically to 16' x 12' wide, snifter holding frames were welded between the two necks and pots are covered in netting with a small mesh size (Figure6).

It was felt that the larger neck design and larger mesh size of pots provided more opportunity for shags to enter pots through the neck. It was also felt that shags could potentially have entered pots through the larger mesh, but then become stuck and drowned inside pots. The smaller neck widths and mesh size now prevents shags from entering pots.

Figure 6. Changes in pot design used in the Chatham Islands; left - modern pot design, right old pot design.



Fishermen awareness of shag interactions with commercial pot fishing methods

All fishermen interviewed strongly felt that pot fishing is not an issue for shags in the Chatham Islands; this view was held by both fishermen that did reported bycatch and by those that didn't. It was acknowledged that historically some bycatch of shags was occurring, but that this was very limited. All fishermen felt that the present pot design and baiting method – with all bait contained in snifters - has completely eliminated shag bycatch. This pot design and baiting strategy first started in the Chatham's in about 1990 and increased after TACC reductions in 1998. Initially a few fisherman began using narrower necked pots and snifters, and over time as damaged and lost pots were replaced all fisherman shifted to this fishing method. It has been at least five years since every fisherman has been baiting with snifters. All fishermen in the Chatham Islands are now using snifters, but occasional do hang larger bait when typical bait is not available (e.g. several fisherman noted that at times they use groper heads which are too large to place in snifters so these are hang in pots).

All of the fishermen interviewed and the CRA6 Industry Association are aware of the shag bycatch issue. All fishermen brought up concerns that an observer programme had been proposed, and it is this issue which has probably led to widespread awareness of shag interactions. The only proposal to

collect shag-potting interaction data that was formally developed, and consulted upon in 2011, as part of the Conservation Services Programme, did not specify that an observer programme be implemented. Following consultation the approved project was focussed on using interviews and existing literature only (this project INT2011-02).

Several fishermen stated that it is important for themselves as fishermen, and the rock lobster industry to avoid negative impacts of their fishing operation. These fishermen commented about the Chatham's unique birdlife and that they consider themselves conservationists. They commented that their support of Department of Conservation work on off-shore islands (i.e. transporting staff to these islands) is testament to this.

The CRA6 Industry Association has developed a Seabird Interaction Code of Practise to help mitigate shag interactions when this issue was brought to their attention. This has been circulated to all fishermen within CRA6. There has been no review of this Code of Practise to assess adequacy, and it does not appear to include any mechanism for auditing and reporting on its effectiveness.

All fishermen and especially those which did not report bycatch, were surprised that shag interactions were being linked to shag population declines. They felt that the low level of bycatch reported during these interviews (1 or 2 shags throughout a 20-30 year fishing career) could not be responsible for the population declines reported. Fishermen strongly felt that the fishing industry was being targeted, and that other causes of population decline were not being investigated (see "Other issues" below for further details).

Fishermen awareness of shags in the Chatham Islands

All fisherman interviewed were aware of both Chatham Island and Pitt Island shags, and that they are endemic to the Chatham Islands. However there was little awareness about the present state of their populations, and the population trends. Fisherman commented that they had heard rumours that populations were in decline, but did not know any facts around how significant these declines were.

Several fishermen commented that they felt shag numbers were not in decline, and that they were seeing as many shags as previously. When the census methods and results were explained all fishermen acknowledged that it is likely that populations are decline, although some fisherman continued to question the accuracy of the census. Again during discussion on population declines all fishermen commented that they did not consider that pot fishing is the reason behind this decline.

Other issues raised by Fishermen

All fishermen interviewed raised concerns that they believed proposals had been developed to place observers on rock lobster fishing boats. It is likely that these concerns alone were responsible for the widespread knowledge of the bycatch issue within CRA6. Fishermen felt that observer coverage was unnecessary (that with present pot design and baiting methodology there is no bycatch) and that costs would be recovered from the fishermen, who estimate these costs to be approximately \$1000/day.

Fishermen also commented that the industry has been paying Conservation Services Levies for years, and that as far as they knew, none of this money had been spent within the Chatham Islands, and especially on shag research. Conservation Services are in fact levied on a project by project basis to recover costs from applicable stocks as determined by Cost Recovery Rules. The only projects related to shags in the Chatham Islands and their interaction with commercial rock lobster pot fishing that have been conducted as part of the Conservation Services Programme have been 100% Crown funded (including this project). No Conservation Services Levies have been applied to rock lobster

stocks. Levies applied to other commercial stocks have been used to recover costs of projects related to those fisheries.

All fishermen strongly felt that pot fishing was not the cause of shag population declines, and that the rock lobster industry was being singled out. It was felt that all possible threats to shags should be studied prior to progressing into an observer programme. All fisherman interviewed thought that there are more significant threats to shags operating than pot interactions; these include-

- Lack of habitat security

Fishermen interviewed highlighted that few shag colonies are found on protected land - either within Department of Conservation reserves or private conservation covenants (there is a significant number of private conservation covenants on the Chatham Islands). It was felt that this lack of security for colonies could be contributing to the decline in shag numbers as both domestic and feral stock had access to colonies and could potentially be negatively impacting on breeding productivity.

In addition it was also highlighted that colonies on off shore islands are not necessarily secure – the decline of Chatham Island shag numbers on The Star Keys was used as an example, a predator free island were an increasing seal population is displacing shags and has caused the colony to shift several times over the past 20 years. However give that Pitt Island shag numbers have also declined on the Star Keys, where colonies are on steep cliffs inaccessible to seals, suggests that reasons for population declines are actually at sea.

- Predation from introduced pests

All fisherman interviewed felt that predation by introduced predators (cats, possums, rats and weka) is likely to be negatively impacting on shag numbers. Although predation from introduced predators is likely to be having an effect on shag numbers, it is not likely to be completely responsible for the recorded population declines as these have also occurred on predator free off-shore islands.

- Predation from black-backed gulls

Several fishermen brought up the fact that numbers of black-backed gulls have significantly increased in the Chatham's over the last 10-15 years. Primarily as a result of poor rubbish and fish offal disposal. These fishermen felt that gulls are a significant predator of shags, and that the increase in the gull population has coincided with declines in shag populations. One farmer reported observing black-backed gulls predating Pitt Island shag nests on the south coast of Main Chatham. Waste management is a Council function and fishermen felt that Council should be managing this issue better.

All fishermen interviewed commented on the fact that little is known about the breeding biology, at sea distribution and feeding ecology of both Chatham and Pitt Island shags. It was overwhelmingly felt that until a complete study was done on these species it is impossible to determine the reasons behind population declines. Fishermen felt that blame was being attached to the rock lobster industry without investigating other possible causes.

Shag population trends in the Chatham Islands

The population trend of both Chatham Island shag and Pitt Island shag are well known as there has been three complete censuses of breeding pairs in 1997, 2003 and 2011 (Bell and Bell 2000; Bester and Charteris 2005; Debski *et. al.* 2012). These censuses have used similar methodology, with counters covering as much as possible of the potential breeding habitat in the Chatham Islands. Observers covered all of the rocky coastline on foot, zodiac or fishing boat, stopping at each colony

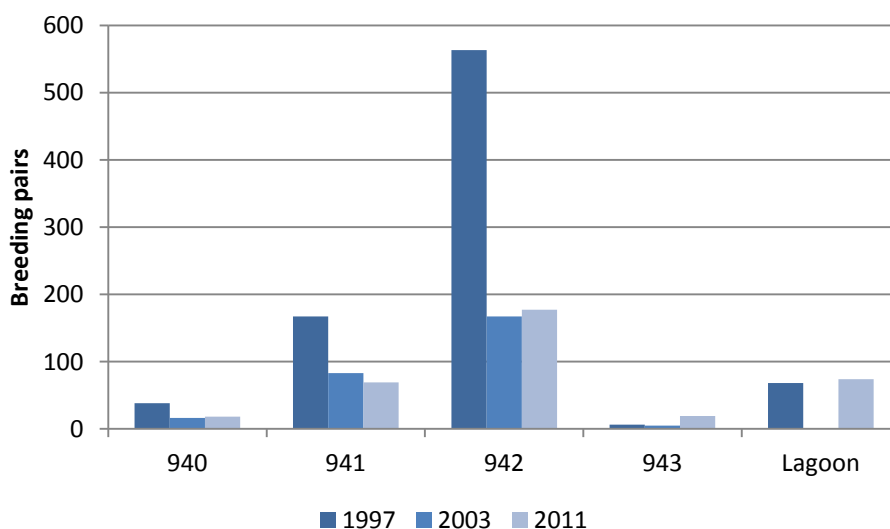
to count the number of occupied nests to get a count of the adult breeding population (see Bell and Bell (2000) for full methodology).

A comparison between censuses is the most robust for Pitt Island shag. The census methodology is similar, with the only difference being coverage. During the 2003 and 2011 census the albatross islands - The sisters, Forty Fours and Pyramid - were not counted, or not counted in good conditions. As such for evaluation of population trends in this report these islands have been excluded.

A comparison of Chatham Island shag censuses is more problematic as the timing of breeding both within and between colonies is known to be variable (Marchant and Higgins 1990). This was accounted for in the original 1997 count, with counts carried out over several months, and maximum counts used for each colony to determine population size. The 2003 counts only used single counts at each colony and this likely to have impacted on the results. The 2011 census used multiple counts at two colonies, making it more comparable to the 1997 census. No Chatham Island shag breed on the albatross islands so coverage was identical during all surveys and no areas need to be excluded for evaluation of population trends.

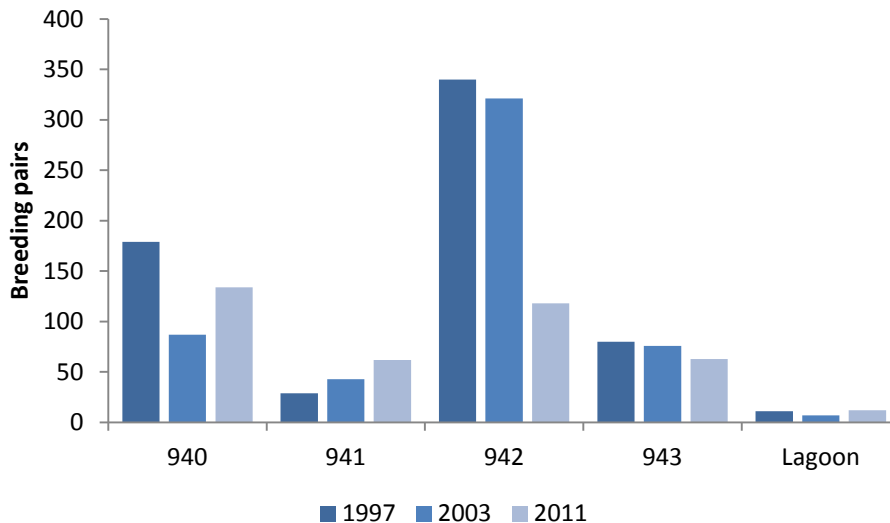
In 1997 the total breeding population of Chatham Island shag was 842 pairs (Bell and Bell 2000). Only 271 breeding pairs were recorded in 2003 (Bester and Charteris 2005). In 2011 a total of 355 pairs were recorded (Figure 7). It is likely that due to the variability of breeding that the 2003 census underestimated the total breeding population, particularly as no breeding was recorded in Te Whanga Lagoon. Breeding in Te Whanga lagoon is usually earlier than other colonies, and the 2003 survey was carried out from Late October – January, it is probable that breeding had already finished at this colony prior to the survey. The 2011 census incorporates earlier counts at Te Whanga Lagoon, and a later count at Cape Fournier is also more comparable to the 1997 survey. Despite the slight variation in survey timing in relation to breeding, it is beyond doubt that the Chatham Island shag population is in serious decline. The population has declined in all but one of the CRA6 statistical areas, and has been stable within Te Whanga Lagoon (Figure 7). The major decline in Area 942 (south east area) is primarily due to a significant decline in the colony at the Star Keys (339 pairs in 1997, 81 in 2003 and 88 in 2011), this colony alone accounts for 65% of the population decline from Area 942.

Figure 7. The number of breeding pairs of Chatham Island shag from statistical areas from CRA6 and Te Whanga Lagoon; 1997, 2003 and 2011.



The breeding population of Pitt Island shags in the Chatham Islands in 1997 was 729 breeding pairs, with a total of 639 pairs when excluding the albatross islands (Bell and Bell 2000). In the same area in 2003 a total of 534 breeding pairs were recorded (Bester and Charteris 2005), and in 2011 only 389 pairs (Bell pers. obs. Figure 8). The breeding population has declined by nearly 40% over 15 years with 88% of that decline occurring in Area 942 (Figure 8).

Figure 8. The number of breeding pairs of Pitt Island shag from statistical areas from CRA6 (excluding the albatross islands) and Te Whanga Lagoon; 1997, 2003 and 2011.



Discussion

Without doubt both Chatham Island shag and Pitt island shag numbers have declined significantly over the past 15 years. Recent surveys suggest that the Chatham Island shag population has declined by about 58%, whilst the Pitt Island shag population has declined by around 40%. Such significant population declines are likely to see the threat status of these species increase to Critically Endangered.

Low levels of bycatch of Pitt Island shag have now been reported to have occurred historically within the CRA6 fishery, with most bycatch reported from over 10 years ago. This is consistent with Bell and Bell (2000) who first reported shag bycatch during 1997/98.

As fishermen could not remember precise dates, it is difficult to use the information reported here to determine precise levels of bycatch. In this study fishermen reported no bycatch in the past 5 years (2007/08 to 2011/12 fishing season), only 2 shag captures between 5-10 years ago (2001/02 to 2006/07 fishing season) and 18 shags caught more than 10 years ago (prior to 2000/01 season). Based on these reported levels, with a fishing career spanning 20-30 years, up to 2 shags per year were caught in CRA6 prior to the 2000/01 season. Average pot lifts between the 1990/91 and 2000/01 fishing seasons were 301,000 pot lifts; suggesting a possible interaction rate of 1 capture per 150,000 pot lifts. This is considerable lower than bycatch rates of 1 capture per 45,000 pot lifts in the South Australian rock lobster fishery (Hobday *et. al.* 2008); 1 capture per 4,250 pot lifts in the Florida spiny lobster fishery (Matthews *et. al.* 2005) and 1 capture per 137 pot lifts reported from the Baja spiny lobster fishery (Shester *et. al.* 2008).

Changes in pot design (smaller pot neck with a smaller mesh size) and baiting methodology (all bait contained within snifters) has been reported by fishermen to have eliminated bycatch over the past 5- 10 years. These changes were driven by catch efficiency of pots rather than seabird mitigation, but have also solved the bycatch problem. Zero bycatch of seabirds in pot and trap fishing is possible and was reported by Zollett (2009), who recorded no seabird bycatch from pot and trap fisheries in US east coast commercial fisheries.

The CRA6 Industry Association has developed a Seabird Interaction Code of Practise which has been circulated around the CRA6 fishermen. Globally this is the first mitigation measures for seabirds in any pot or trap fishery. Internationally mitigation measures for pot and trap fisheries had been developed for marine mammals and sea turtles, but never for seabirds. Although positive to see the industry taking a led, there has been no review of the adequacy of the CRA6 Code of Practise and there appears to be no mechanism for auditing or reporting.

The CRA6 Code of Practise in parts fails to incorporate aspects of shag biology. Pot setting distances from colonies are not specified, and although a lack of research on shag foraging range hampers determining buffer zones the large number of colonies would see large stretches of coastline being excluded from fishing. This measure would be unrealistic to fisherman and evidence suggests that it is not being followed presently. In addition during January and February when pots are set in close, Pitt island shags have finished breeding, so buffers around colonies would not add further protection to birds.

At present all shag bycatch must be reported in mandatory catch reporting mechanisms, however the CRA6 Code of Practise has no reporting pathway to ensure that non-lethal interactions are reported. Therefore there is no way to assess the adequacy of the code, review mitigation practises and update the code.

Significantly this study has identified that pot design and bating methods can significantly reduce shag interactions, and these need to be included in the CRA6 Code of Practise. The use of narrow necked pots and baiting in snifters has eliminated bycatch of shags and it is important to ensure that these fishing methods are continued to be used in the Chatham's.

Fisherman strongly considered that pot fishing is unlikely to be having an impact on shag populations in the Chatham Islands. There has been no recorded bycatch of Chatham Island shags and the historical levels of bycatch reported are unlikely to have been impacting on Pitt Island shag populations. However, the populations of both Chatham Island and Pitt Island shag have decline significantly. Without further study interpreting the causes of population declines is difficult.

Recommendations

1. That CRA6 fishermen continue to use pots with a narrow neck, small mesh size and only bait rock lobster pots with bait contained within snifters.
2. That the CRA6 Seabird Interaction Code of Practise is reviewed and updated. This should include adding information on pot design and baiting methods to reduce shag interactions, and incorporate information on shag biology to assist the development of the code.
3. That a "shag fact sheet" is produced for the CRA6 area and distributed to CRA6 fishermen and quota owners. This should include information on the status of both Chatham Island and Pitt Island shag, the Seabird Interaction Code of Practise and guidelines on pot design (see

above). This fact sheet should be produced with input from the CRA6 Industry Association and Department of Conservation.

4. An in-depth research project into the breeding ecology of Chatham Island and Pitt Island shag should be initiated. This research project should be aimed at determining the cause of population decline in these species and mitigating against these.
5. An in-depth research project into the foraging behaviour and range of Chatham Island and Pitt Island shag should be initiated. This research project should be aimed at determining the cause of population decline in these species and mitigating against these.

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