

Occurrence of prey species identified from remains in regurgitated
pellets collected from king shags in 2019 and 2020
Progress Report



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Chris Lalas¹ and Rob Schuckard²

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¹PO Box 31 Portobello, Dunedin 9048, New Zealand.

²PO Box 98 Rai Valley 7145, New Zealand

ABSTRACT

This report encompasses the first component of a project to deduce diet of king shags from analysis of prey remains from 225 regurgitated pellets collected in Marlborough Sounds during 2019 and 2020. Here we quantified the frequency of occurrence of prey taxa for a future comparison with the outcome of DNA analysis on the same pellets by Andrew Jeffs and Aimee van der Reis (Institute of Marine Science, School of Biological Sciences, University of Auckland). The second component of our project will encompass more thorough analyses of diet that quantify number, mass, length and daily intake of prey species

This study represents the second published investigation of king shag diet from analysis of prey remains in pellets. We increased the biodiversity of prey from the first study in 1991 and 1992 with 10 taxa (two crustaceans and eight fishes) from 22 pellets at one site to this study with 27 taxa (two crustaceans, 2 cephalopods and 23 fishes) from 215 pellets at seven sites. The basic understanding of foraging and diet remains unchanged—king shags target bottom-dwelling fishes and flatfishes, particularly witch (*Arnoglossus scapha*), predominate.

Frequencies of occurrence deduced from prey remains analysis and DNA analysis provide a simple qualitative assessment of king shag diet through the presence/absence of taxa in pellets. Prey remains analysis of pellets can provide a quantitative estimate for daily intake as a total biomass of prey items. The equivalent in DNA analysis is more qualitative: relative read abundance, an assessment of the strength of DNA signatures, generates estimates for proportion of total biomass. Comparisons between results from these two analyses could facilitate calculation of indices to transform relative read abundances into real masses.

The key issue for future projects on king shag diet is to decide on the purpose and desired outcome of research and then select the appropriate methods and analyses before samples are collected.

INTRODUCTION

New Zealand king shags (king shags, *Leucocarbo carunculatus*) are designated as Nationally Endangered under the New Zealand Threat Classification System (Robertson *et al.* 2017) because they have a small range and very small population. Their distribution is restricted to the sea and small islands bounded within a 55 km by 35 km rectangle within Marlborough Sounds at the northern tip of South Island, New Zealand (Schuckard *et al.* 2018) (Figure 1). This equates to an at least 75% contraction of their more widespread prehistoric distribution that extended to the southern North Island and the northeastern tip of South Island (Rawlence *et al.* 2017). Records stretching back to 1773 indicate that king shags have not been more widespread or more numerous through the historical past and the present population is considered stable (BirdLife International 2020). Monitoring of the species is ongoing with censuses in 2020 producing estimates of 815 individuals in February prior to the breeding season (Bell *et al.* 2020), followed by 277 nests at nine colonies in May (Schuckard & Frost 2020) (Figure 1). King shags are exclusively marine foragers and fly an average of 6–10 km (maximum 24 km) from colonies or roosts (Schuckard 1994, 2006) to forage alone in depths of 20–60 m (Brown 2001).

Shags (Phalacrocoracidae) typically regurgitate daily a pellet containing prey remains that can provide a quantitative assessment of diet composition and daily intake—among the variety of methods to investigate diet, pellets provide the most comprehensive information for the lowest sampling effort and least disturbance (Seefelt & Gillingham 2006, Barrett *et al.* 2007, Oehm *et al.* 2016). However, pellet analysis suffers from biases due to the underestimation of prey that are digested completely and overestimation of prey with resilient remains. These biases potentially can be overcome by analysis of the DNA digested prey, a relatively new technique first applied in 2005 (Barrett *et al.* 2007). However, in common with analysis of prey remains, frequency of occurrence deduced from DNA analysis overestimates the importance of prey species taken frequently but only in small amounts (Deagle *et al.* 2019). This bias is rectified in prey remains analyses by assessing composition of the diet from masses (estimated original masses) of prey species. The equivalent to prey species mass in DNA analysis is relative read abundance, an assessment of the relative strength of species-specific DNA signatures (Deagle *et al.* 2019).

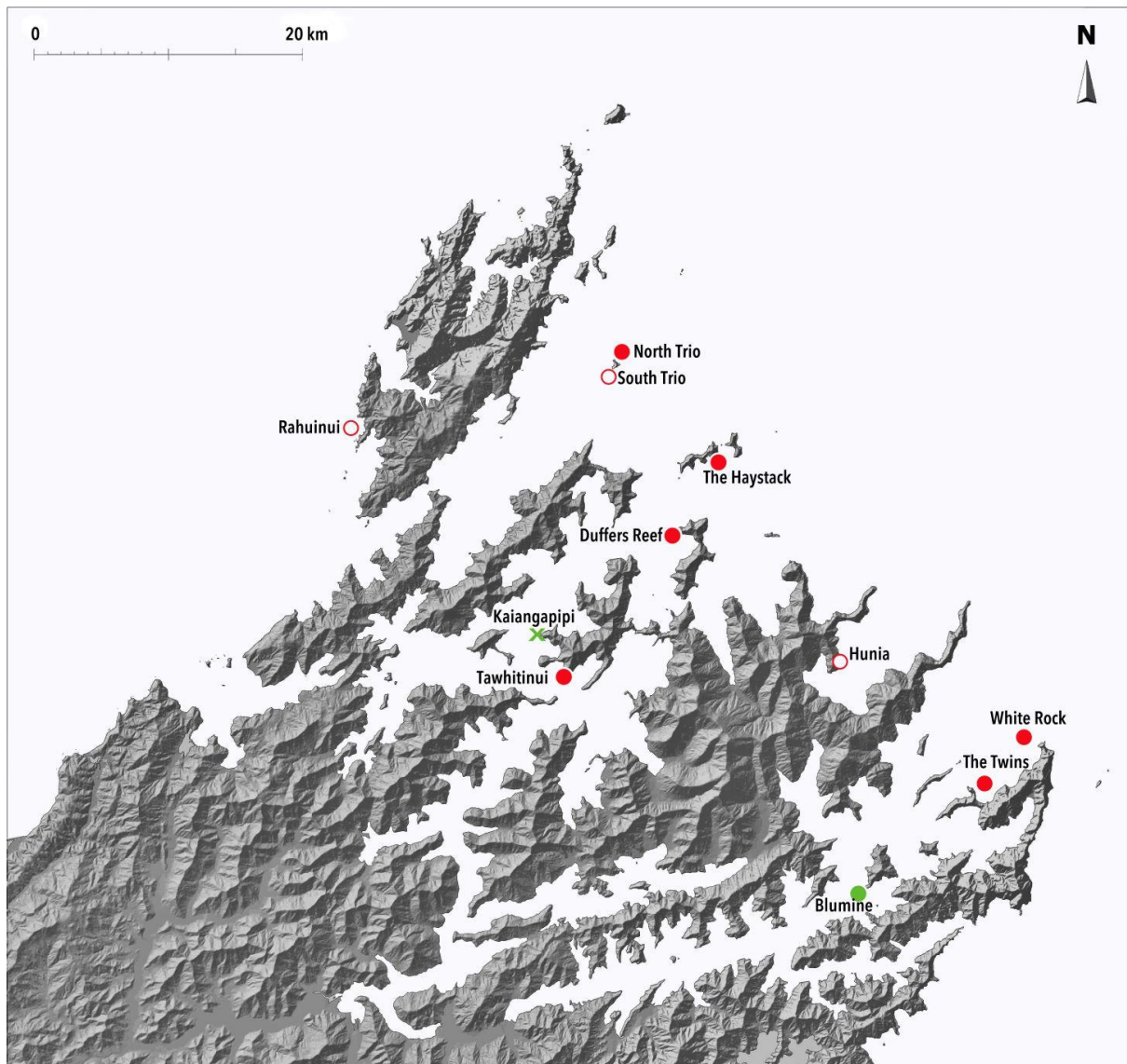


Figure 1: Map of Marlborough Sounds showing the nine breeding colonies (red circles) and one major roost site (green circle) of New Zealand king shags in 2019 and 2020. Pellets were collected at six colonies (solid red circles) and the one major roost site. The depicted roost site (Blumine) was the only site to average ≥ 10 individuals in a survey on 21 February 2020 by Bell *et al.* (2020) that was not recorded as a breeding colony in 2019 and/or 2020 by Schuckard & Frost (2020). Lalas & Brown (1998) collected pellets at Te Kaiangapipi (green cross), a currently unoccupied roost site.

The purpose of this report is to present frequency of occurrence of remains of prey species in king shag pellets for comparison with DNA analysis of the same pellets. The outcome of this comparison will compare efficacies of these two analyses and highlight similarities, differences and anomalies. Prey remains analysis of pellets can provide a quantitative estimate for daily intake as a total biomass of prey items. The equivalent in DNA analysis is more qualitative: relative read abundance, an assessment of the strength of DNA signatures, generates estimates for proportion of total biomass. Comparisons between results from these two analyses could facilitate calculation of indices to transform relative read abundances into real masses. This outcome is an unexpected bonus that could make a major contribution to the methodology for quantification of DNA analysis. In particular, pellets with only one taxon identified among prey remains could provide the clearest outcomes.

The only previous assessment of the diet of King Shags has been for birds based at Te Kaiangapihi, a roost site within Pelorus Sound (Figure 1). Here prey remains found in 22 pellets collected in 1991 and 1992 contained 10 taxa, all bottom-dwelling species dominated by witch (*Arnoglossus scapha*), a flatfish (Lalas & Brown 1998). Our present study encompasses over 10 times the number of pellets from seven sites and will lead to insight into spatial differences in diet of king shags.

METHODS

Source and analyses of pellets

King shag regurgitated pellets were collected by Mike Bell (Wildlife Management International Ltd) and Dan Palmer (Department of Conservation) from seven sites during monitoring of the species in Marlborough Sounds. Each site was sampled on one or two occasions from March 2019 to March 2020. Pellets were individually coded, stored in alcohol and sent to Andrew Jeffs and Aimee van der Reis (Institute of Marine Science, School of Biological Sciences, University of Auckland) who undertook DNA analyses. Partially sorted pellets stored in alcohol were then forwarded to us (Lalas & Schuckard) with the contents of each pellet subdivided into 2–4 pottles. We sorted and analysed prey remains found in pellets in October 2020. Details for the location and date of collection of each pellet is given in Appendix 2.

Identification of prey species from prey remains

We teased apart pellets in water and retained all diagnostic prey remains identified from a comprehensive reference collection held by Chris Lalas. Diagnostic remains differ among taxa: jaws from polychaete worms; pieces of exoskeleton (especially claws and carapaces; often decalcified) from crustaceans; beaks from cephalopods; tunic (gelatinous tube) from salps; mouthparts from hagfish and lampreys; teeth, body thorns, dorsal spine sheaths and (cartilaginous) vertebrae from sharks and rays; and otoliths (sagittal otoliths), jaws and other dentition, caudal vertebrae and some other species-specific bones for teleost fishes. Otoliths for all the genera and most of the teleosts we encountered are illustrated in Schwarzhans (1984, 1999); Smale *et al.* (1995); or Furlani *et al.* (2007). Jaws and some other fish bones we encountered are illustrated in Leach (1997). For the taxonomy and nomenclature (common and scientific names) of New Zealand fishes we follow Roberts *et al.* (2015).

Analyses of prey remains in taxa

We restricted quantified analysis of prey remains in pellets to the occurrence (presence or absence) of each prey taxon. Our precision of presentation of taxon reflected our assessment of reliability in identification of remains: typically to species, but to genus and on occasion family in cases where multiple closely-related species occur at Marlborough Sounds. We quantified frequency of occurrence for each prey taxon as the number (FOO) and proportion (%FOO) of pellets for each site that contained that taxon. We did not attempt to differentiate between primary prey items (items caught by king shags) and secondary prey items (items originating from the digestive tract of primary prey items).

Here we present results for frequency of occurrence for each site and for totals from all seven sites. Accurate identification of remains required careful inspection of each sample. Consequently, we capitalised on this effort by estimating the minimum number of prey items per taxon. For fishes we typically did this by halving the number of otoliths. These data were entered into spreadsheets and used to indicate occurrence in pellets (Appendix 2).

Fate of prey remains

We dried all diagnostic prey remains and retained them for future further analysis. Each pellet was allocated an A4 ziplock bag containing handwritten details on A4 paper and remains retained in labelled, species-specific, small ziplock bags.

RESULTS

Number of pellets analysed

Analyses were derived from a total of 225 king shag pellets collected from seven colonies during 2019 and 2020 (Table 1). We analysed 215 (96%) of the total 225 pellets. The other 10 pellets were not analysed for a number of reasons and another seven pellets contained anomalies; details about these 17 pellets are presented in Appendix 1. Both types of diet analyses—prey remains and DNA—were performed on 184 (82%) of the total pellets, and represent a large sample size for future comparisons between outcomes of the two methods. These are huge sample sizes relative to the size of the species total population, equivalent to one pellet for every four individuals (where $215/815 = 26\%$ and $184/815 = 23\%$), and near 10-fold the sample size of 22 pellets in the previous analysis of king shag diet by Lalas & Brown (1998).

A problem with alcohol denaturing otoliths

We encountered two problems attributable to storage of otoliths in alcohol. First, otoliths were dehydrated. Otoliths typically became opaque and lost their internal detail meaning that the internal growth rings and earlier shape of otoliths were often difficult to see. This loss of clarity could compromise the accuracy of species identification, especially for eroded otoliths. Second, otoliths were difficult to clean because grime often adhered to the surface – this could mask the surface and compromise judgements of the degree of erosion of otoliths (important when deriving estimates for prey size) and sometimes species identifications.

Table 1: Summary of results for the number of king shag pellets collected from seven sites in 2019 and 2020, and for their contents deduced from analysis of prey remains. Three sites were in Queen Charlotte Sound (Charlotte), three in Pelorus Sound (Pelorus) and one in Admiralty Bay (Admiralty). Sites are depicted in Figure 1. Number of nests are from Schuckard & Frost (2020) and number of individuals from Bell *et al.* (2020).

Criterion	Total	White Rocks	The Twins	Blumine	The Haystack	Duffers Reef	Tawhitiui	North Trio
Features of sites in 2020 (see Figure 1):								
Location	-	Charlotte	Charlotte	Charlotte	Pelorus	Pelorus	Pelorus	Admiralty
Number of nests (% total 277)	213 (77%)	24 (9%)	13 (5%)	0 (0%)	20 (7%)	83 (30%)	29 (10%)	44 (16%)
Number of individuals (% total 815)	564 (69%)	46 (6%)	43 (5%)	55 (7%)	16 (2%)	207(25%)	78 (10%)	119 (15%)
Number of pellets:								
Collected	225	23	24	28	10	51	42	47
Analysed for prey remains	215	22	22	28	10	46	42	45
Analysed for DNA	189	23	24	28	10	37	33	34
Analysed for DNA & remains	184	22	22	28	10	36	33	33
Mean (range) per pellet:								
Number of prey taxa	3.2 (1-9)	2.8 (1-9)	3.1 (1-7)	2.5 (1-6)	3.4 (1-7)	3.5 (1-7)	3.6 (1-6)	3.0 (1-7)
Minimum number of prey items	19 (2-114)	15 (4-36)	19 (4-64)	15 (4-48)	17 (5-66)	18 (3-69)	25 (2-114)	20 (5-57)
Pellets with particular taxa								
FOO% (proportion of pellets):								
Contain witch (<i>Arnoglossus scapha</i>)	77%	95%	68%	93%	50%	70%	69%	84%
Contain flatfishes (Pleuronectiformes)	86%	95%	82%	93%	60%	80%	88%	89%
Contain only flatfishes	20%	14%	18%	43%	10%	11%	12%	29%
Do not contain any flatfishes	14%	5%	18%	7%	40%	20%	12%	11%
Pellets with only one taxon								
FOO (number of pellets):								
Witch (<i>Arnoglossus scapha</i>)	20	3	2	5	0	1	3	6
Leatherjacket (<i>Meuschenia scaber</i>)	4	0	2	0	1	0	0	1
Red gurnard (<i>Cheilodichthys kumu</i>)	1	0	0	0	0	0	0	1
Wrasse (Labridae)	1	0	0	0	0	1	0	0
Total with only one taxon	26	3	4	5	1	2	3	8

We need to emphasise that analysis of compromised otoliths had two detrimental impacts on this project. First, the duration required to deduce frequency of occurrence by about a third from an average of about one hour to about 1 h 20 min. Second, the reliability of some species identifications was compromised.

Prey taxa represented in prey remains

Analysis of prey remains from 215 pellets generated averages of 3.2 (range 1–9) prey taxa and a minimum 19 (range 2–114) prey items per pellet (Table 1). Here we further consider the frequency of occurrence of prey taxa. Minima for number of prey items per taxon are presented in Appendix 2 for each pellet.

Witch, a lefteye flounder (Bothidae), was the most frequently-encountered prey species; recorded in 77% of the total 215 pellets, with a range of 50–95% among the seven sites (Table 1). Following witch in frequency were three genera of southern righteye flounders (Rhombosoleidae): lemon sole (*Pelotretis*), sole (*Peltorhamphus*) and flounder (*Rhombosolea*). The predominance of flatfishes is exemplified by the paucity of pellets that did not contain any flatfishes: no flatfish were found in only 14% of the total 215 pellets, with a range of 5–40% among the seven sites (Table 1). A total of 27 taxa (two crustaceans, 2 cephalopods and 23 fishes) were recorded from the 215 pellets (Table 2). Other than flatfishes, five taxa can be regarded as important prey (recorded in $\geq 10\%$ of the 215 pellets): jock stewart (*Heliocolenus percoides*), red gurnard (*Chelidonichthys kumu*), opalfish (*Hemerocoetes* cf. *monopterygius*), triplefin (Tripterygiidae) and leatherjacket (*Meuschenia scaber*) (Table 2).

Twenty-six (12%) of the 215 pellets contained only one taxon: 20 with only witch; four with only leatherjacket; and one each with only red gurnard or wrasse (Labridae) (Table 1).

For wrasse, the entry “*Notolabrus & Pseudolabrus* 4 spp” in Table 2 represented 29 fish of which 16 were tentatively identified to species: two spotty (*N. celidotus*), seven girdled wrasse (*N. cinctus*), one banded wrasse (*N. fucicola*) and six scarlet wrasse (*P. miles*).

Table 2: Frequency of occurrence of prey taxa deduced from analysis of prey remains found in king shag pellets collected from seven sites in 2019 and 2020. Results for occurrence of each taxon are presented in two formats: first, occurrence as the number (FOO) and proportion (%FOO) of the total 215 pellets; and second, occurrence as the number of sites (1–7) and the range in %FOO among sites.

Prey taxon recorded from prey remains (taxonomic listing)		Total 7 sites		Range among sites	
		FOO	%FOO	Number	%FOO
Witch	<i>Arnoglossus scapha</i>	166	77.2%	7	50–95%
Opalfish	<i>Hemerocoetes cf. monopterygius</i>	82	38.1%	7	10–64%
Lemon sole	<i>Pelotretis flavilatus</i>	60	27.9%	6	0–41%
Triplefin	Tripterygiidae spp.	55	25.6%	7	5–41%
Leatherjacket	<i>Meuschenia scaber</i>	54	25.1%	6	0–35%
Jock stewart	<i>Helicolenus percoides</i>	47	21.9%	7	7–36%
Flounder	<i>Rhombosolea</i> 1-3 spp.	47	21.9%	6	0–38%
Sole	<i>Peltorhamphus</i> 1-3 spp.	45	20.9%	7	10–28%
Red gurnard	<i>Chelidonichthys kumu</i>	37	17.2%	7	10–32%
Wrasses	<i>Notolabrus</i> & <i>Pseudolabrus</i> 4 spp.	20	9.3%	6	0–19%
Midget octopus	<i>Octopus cf. huttoni</i>	12	5.6%	6	0–30%
cf. Red cod	<i>Pseudophycis</i> 1-3 spp.	12	5.6%	6	0–20%
Red swimming crab	<i>Nectocarcinus antarcticus</i>	8	3.7%	5	0–10%
Butterfly perch	<i>Caesioperca lepidoptera</i>	8	3.7%	6	0–11%
Red scorpionfish	<i>Scorpaena papillosa</i>	7	3.3%	3	0–40%
Blue cod	<i>Parapercis colias</i>	5	2.3%	3	0–10%
Pillbox crab	cf. <i>Halicarcinus</i> sp.	4	1.9%	3	0–5%
cf. Twosaddle rattail	cf. <i>Coelorinchus biclinozonalis</i>	2	0.9%	2	0–5%
Arrow squid	<i>Nototodarus gouldi</i>	1	0.5%	1	0–5%
Silver conger	<i>Gnathophis habenatus</i>	1	0.5%	1	0–4%
Ling	<i>Genypterus blacodes</i>	1	0.5%	1	0–2%
Rock cod	<i>Lotella rhacina</i>	1	0.5%	1	0–2%
Dwarf cod	<i>Notophycis marginata</i>	1	0.5%	1	0–2%
Common roughy	<i>Paratrachichthys trailli</i>	1	0.5%	1	0–5%
Greenbone	<i>Odax pullus</i>	1	0.5%	1	0–5%
Stargazer	Leptoscopidae sp.	1	0.5%	1	0–2%

We did not record any gelatinous organisms (salps or jellyfish), polychaete worms or cartilaginous fishes. We did record two non-prey crustacean taxa likely to appear in DNA analyses: parasitic isopods (Cymothoidae, 6 pellets) and hermit crabs (Paguridae, 18 pellets). We also recorded trace remains of molluscs that are unlikely to appear in DNA, gastropod and bivalve shells (typically broken pieces), gastropod opercula; and chiton valves.

Fishes underrepresented in prey remains

Tiny otoliths (< 1 mm) are unlikely to survive digestion and appear as prey remains in pellets. Fish will be underrepresented in pellets if they not only have tiny otoliths but also lack resilient diagnostic bones and teeth. Two families of fishes fulfil these criteria as potential prey of king shags: pipefishes and seahorses (Syngnathidae); and tommyfishes (Creediidae), a close relative of opalfishes (Percophidae). In contrast, another two families have tiny otoliths but resilient diagnostic bones and so are likely to be represented realistically in pellets: bellowsfishes (Macroramphosidae) have a resilient dorsal spine (none recorded in pellets); and leatherjackets (Monacanthidae) have a resilient dorsal spine and resilient enamel teeth (regularly recorded in pellets).

DISCUSSION

This is the second published investigation of king shag diet from analysis of prey remains in pellets. We increased the number of reported prey taxa from 10 (two crustaceans and eight fishes) from 22 pellets (Lalas & Brown 1998) to 26 (two crustaceans, 2 cephalopods and 22 fishes) from 215 pellets.

We confined output to the frequency of occurrence of prey taxa because the allocated time and funding of our contracts were grossly inadequate. For methods we have given the example that the use of alcohol to ensure high quality samples for DNA analysis unfortunately downgraded their quality for analysis of prey remains—this problem could have been resolved at the planning stage of the project. Potential outcomes of prey remain analysis and DNA analysis are compared in Table 3.

Table 3: Expected outcomes of king shag diet studies derived from regurgitated pellets: comparison between prey remains analysis and prey DNA analysis.

Outcome	Prey remains analysis	DNA analysis
Definitive differentiation between primary and secondary prey	No	No
Detection of prey species that lack robust remains	Inconsistent	Yes
Number of prey species per pellet	Yes	Yes
Number of prey items per pellet & proportion of diet by number	Yes	No
Lengths of prey items	Yes	No
Biomass of prey items	Yes	No
Proportion of diet by biomass of prey species per pellet	Yes	RRA
Total biomass of all prey per pellet = daily intake	Yes	Not yet

Biomass = original mass of prey.

RRA = relative read abundance, an indicator of the relative importance of species.

RECOMMENDATIONS

Recommendations for the remainder of this project

1. The next step for frequency of occurrence of prey taxa is to compare outcomes between prey remains analysis and DNA analysis for the same ≈ 180 pellets. Here our data in Appendix 2 is available as an Excel Workbook.
2. We need to establish expectations and prioritise outcomes that can be accomplished with the second half of our contract.
3. We are particularly keen to fully analyse (following Table 3) the 26 pellets that contained only one prey taxon. This would facilitate calculations to quantify relative read abundances into real masses and broaden the applicability of DNA analysis as a tool to deduce diet.

Recommendations for future diet projects

1. The key issue for future projects on king shag diet is to decide on the purpose and desired outcome of research and then select the appropriate analyses before samples are collected (Table 3).
2. Statistical advice is critical to deduce the minimum valid number of pellets required to satisfy intended diet analyses; e.g., the extreme range in the present project was for North Trio with 45 pellets (too many pellets) collected on 29 November 2019 and six pellets (too few pellets) collected on 11 March 2020 (Appendix 2).
3. The timing and sites of pellet collections need to be selected to satisfy intentions; e.g., collections must be six months apart for a study to detect seasonal differences from two samples.
4. Any future work involving DNA analysis and prey remains analysis on the same pellets must resolve the problem of degradation of otoliths stored in alcohol.

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APPENDIX 1

Notes for pellets we regarded as anomalous

Pellet code	Colony	Date collected	Fate of pellet (included or excluded)	Notes
WR03	White Rocks	11-Mar-19	excluded	Obviously incomplete: only 1 otolith; but minimum 3 fish ex bones
TT18	The Twins	20-Mar-20	excluded	No pottles. Jeffs note: "No hard parts were separated from the pellet"
TT23	The Twins	20-Mar-20	excluded	Obviously incomplete: only 2 otoliths; fish bones and eye lenses more numerous
DR06	Duffers Reef	26-Nov-19	included but suspect	Jeffs note: "No hard parts were separated from the pellet"
DR08	Duffers Reef	26-Nov-19	excluded	Jeffs note: "Does not exist"
DR15	Duffers Reef	26-Nov-19	included seems OK	Jeffs note: "No hard parts were separated from the pellet"
DR28	Duffers Reef	26-Nov-19	included seems OK	Jeffs note: "No hard parts were separated from the pellet"
Burp ball 3	Duffers Reef	24-Aug-19	excluded	Plant material; no prey remains
Burp ball 5	Duffers Reef	24-Aug-19	excluded	Not a pellet; remains of 1 fish; includes articulated bones & flesh
Burp ball 6	Duffers Reef	24-Aug-19	excluded	Obviously incomplete: 12 eye lenses = min. 6 fish but otoliths = 3 fish
Burp ball 7	Duffers Reef	24-Aug-19	excluded	Plant material; no prey remains
TN02	North Trio	26-Nov-19	included but suspect	No otolith pottle for this sample = none or lost?
TN14	North Trio	26-Nov-19	excluded	Contents of pottles confused = appear mixed with TN15
TN15	North Trio	26-Nov-19	excluded	Contents of pottles confused = appear mixed with TN14
TN19	North Trio	26-Nov-19	included seems OK	Jeffs note: "No hard parts were separated from the pellet"
TN32	North Trio	26-Nov-19	included seems OK	Jeffs note: "Only feathers"
TN45	North Trio	11-Mar-20	included but suspect	No otolith pottle for this sample = none or lost?

APPENDIX 2

Frequency of occurrence and minimum number of prey items per taxon for prey identified from prey remains in king shag pellets collected at seven breeding colonies in 2019 and in 2020.

Sequence of contents

White Rocks	Appendix pages 3–5
The Twins	Appendix pages 6–8
Blumine	Appendix pages 9–11
The Haystack	Appendix pages 12–13
Duffers Reef	Appendix pages 14–18
Tawhitinui	Appendix pages 19–22
North Trio	Appendix pages 23–27

**King shag
Prey number
and occurrence**

pellet code total = 23
DNA analysis done total = 23
Prey remains analysis done total = 22
DNA & Remains done total = 22

WR

White Rocks

Total minimum number of items = 321
Total number of pellets analysed = 22

	WR01	WR02	WR03	WR04	WR05
Pellet code	yes	yes	yes	yes	yes
DNA analysis done?	yes	yes	no	yes	yes
Jeffs & van der Reis notes	WR	WR	WR	WR	WR
Lalas & Schuckard notes	11-Mar-19	11-Mar-19	11-Mar-19	11-Mar-19	11-Mar-19
VALID prey remains analysis done?	2	2	1	2	2
Date pellet collected	11-Mar-19	11-Mar-19	11-Mar-19	11-Mar-19	11-Mar-19
DNA+Remains=yes=2	16	11		4	22
Minimum number prey items	2	2		2	3
Number prey taxa					

Occurrence of taxon in pellets
% total Number
of all pellets of pellets

*if 1 species enter species code

Not prey species

Parasitic isopod	4	5%	4
Hermit crab	4	5%	4
Definite or likely prey species			
Pill-box crab	0	0.0%	0
cf. <i>Hallicarcinus</i> sp. or spp.			
Red swimming crab	0	0.0%	0
<i>Nectocarcinus antarcticus</i>			
Arrow squid	1	0.3%	1
<i>Nototodarus gouldi</i>			
Midget octopus	0	0.0%	0
<i>Octopus cf. huttoni</i>			
Silver conger	0	0.0%	0
<i>Gnathophis habenatus</i>			
Sandfish	0	0.0%	0
<i>Gonorynchus forsteri</i>			
Ling	0	0.0%	0
<i>Genypterus blacodes</i>			
cf. Twosaddle rattail	1	0.3%	1
<i>Coelorrinchus biclinozonalis</i>			
Rock cod	0	0.0%	0
<i>Lotella thacina</i>			
Dwarf cod	0	0.0%	0
<i>Notophycis marginata</i>			
cf. Red cod	0	0.0%	0
<i>Pseudophycis</i> 1-3 spp.			
Common roughy	3	0.9%	1
<i>Paratrachichthys trailli</i>			
Jock stewart	18	5.6%	8
<i>Helicolenus percoides</i>			
Red scorpionfish	0	0.0%	0
<i>Scorpaena papillosa</i>			
Red gurnard	27	8.4%	7
<i>Chelidonichthys kumu</i>			
Butterfly perch	3	0.9%	1
<i>Caesioperca lepidoptera</i>			
Greenbone	1	0.3%	1
<i>Odax pullus</i>			
Wrasse	2	0.6%	2
<i>Notolabrus & Pseudolabrus</i> 4 spp.			
Blue cod	0	0.0%	0
<i>Parapercis colias</i>			
Opalfish	38	11.8%	4
<i>Hemerocoetes cf. monopterygius</i>			
Stargazer	0	0.0%	0
<i>Leptoscoptidae</i> sp.			
Triplefin	1	0.3%	1
<i>Tripterygiidae</i> spp.			
Witch	199	62.0%	21
<i>Arnoglossus scapha</i>			
Lemon sole	2	0.6%	2
<i>Pelotretis flavilatus</i>			
Sole	16	5.0%	5
<i>Peltothamphus</i> 1-3 spp.			
Flounder	1	0.3%	1
<i>Rhombosolea</i> 1-3 spp.			
Leatherjacket	8	2.5%	5
<i>Meuschenia scaber</i>			

King shag Prey number and occurrence	Pellet code DNA analysis done? Jeffs & van der Reis notes Lalas & Schuckard notes	WR18 yes	WR19 yes	WR20 yes	WR21 yes	WR22 yes	WR23 yes
WR	VALID prey remains analysis done? Colony	yes WR	yes WR	yes WR	yes WR	yes WR	yes WR
White Rocks	Date pellet collected	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20
	DNA+Remains=yes=2	2	2	2	2	2	2
	Minimum number prey items	8	6	23	13	15	18
	Number prey taxa	3	3	3	2	3	9
	If 1 species enter species code						1 chiton
Not prey species							
Parasitic isopod							
Hermit crab							
Definite or likely prey species							
Pill-box crab	cf. <i>Halicarinus</i> sp. or spp.						
Red swimming crab	<i>Nectocarcinus antarcticus</i>						
Arrow squid	<i>Nototodarus gouldi</i>						
Midget octopus	<i>Octopus cf. huttoni</i>						
Silver conger	<i>Gnathophis habenatus</i>						
Sandfish	<i>Gonorynchus forsteri</i>						
Ling	<i>Genypterus blacodes</i>						
cf. Twosaddle rattail	cf. <i>Coelorinchus biclinozonalis</i>		1				
Rock cod	<i>Lotella rhacina</i>						
Dwarf cod	<i>Notophycis marginata</i>						
cf. Red cod	<i>Pseudophycis</i> 1-3 spp.						
Common roughy	<i>Paratrachichthys trailli</i>						
Jock stewart	<i>Helicolenus percoides</i>	4			1	2	2
Red scorpionfish	<i>Scorpaena papillosa</i>						
Red gurnard	<i>Chelidonichthys kumu</i>			2			2
Butterfly perch	<i>Caesioperca lepidoptera</i>						3
Greenbone	<i>Odax pullus</i>						1
Wrasse	<i>Notolabrus & Pseudolabrus</i> 4 spp.						
Blue cod	<i>Paraperca colias</i>						2
Opalfish	<i>Hemerocoetes cf. monopterygius</i>						
Stargazer	<i>Leptoscopidae</i> sp.						
Triplefin	<i>Tripterygiidae</i> spp.						1
Witch	<i>Arnoglossus scapha</i>	2	2	19	12	9	5
Lemon sole	<i>Pelotretis flavilatus</i>						
Sole	<i>Peltorhamphus</i> 1-3 spp.			2		4	1
Flounder	<i>Rhombosolea</i> 1-3 spp.						
Leatherjacket	<i>Meuschenia scaber</i>	2	3				1

**King shag
Prey number
and occurrence**

pellet code total = 24
DNA analysis done total = 24
Prey remains analysis done total = 22
DNA & Remains done total = 22

Total minimum number
of items = 421

Total number of pellets
analysed = 22

TT	TT01	TT02	TT03	TT04	TT05
	yes	yes	yes	yes	yes
	TT	TT	TT	TT	TT
	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20
	2	2	2	2	2
	21	24	20	13	26
	1	5	4	2	3

VALID prey remains analysis done?

Colonies

Date pellet collected

DNA+Remains=yes=2

Minimum number prey items

Number prey taxa

If 1 species enter species code

WIT

Minimum number of items per taxon	Occurrence of taxon in pellets
Number per pellet	% total of all pellets

Not prey species

Parasitic isopod

Hermit crab

Definite or likely prey species

Pill-box crab cf. *Halicarinus* sp. or spp.

Red swimming crab *Nectocarcinus antarcticus*

Arrow squid *Nototodarus gouldi*

Midget octopus *Octopus cf. huttoni*

Silver conger *Gnathophis habenatus*

Sandfish *Gonorynchus forsteri*

Ling *Genypterus blacodes*

cf. Twosaddle rattail cf. *Coelirinchus biclimozonalis*

Rock cod *Lotella rhacina*

Dwarf cod *Notophycis marginata*

cf. Red cod *Pseudophycis* 1-3 spp.

Common roughy *Paratrachichthys trailii*

Jock steward *Helicolenus percoides*

Red scorpionfish *Scorpaena papillosa*

Red gurnard *Chelidonichthys kumu*

Butterfly perch *Caesioperca lepidoptera*

Greenbone *Odax pullus*

Wrasse *Notolabrus & Pseudolabrus* 4 spp.

Blue cod *Paraperca coltas*

Opalfish *Hemerocoetes cf. monopterygius*

Stargazer *Leptoscopidae* sp.

Triplefin *Tripterygiidae* spp.

Witch *Arnoglossus scapha*

Lemon sole *Pelotretis flavilatus*

Sole *Peltorhamphus* 1-3 spp.

Flounder *Rhombosolea* 1-3 spp.

Leatherjacket *Meuschenia scaber*

0	0%	0
4	5%	4
1	0.2%	1
2	0.5%	2
0	0.0%	0
9	2.1%	1
0	0.0%	0
1	0.2%	1
0	0.0%	0
0	0.0%	0
0	0.0%	0
0	0.0%	0
0	0.0%	0
1	0.2%	1
0	0.0%	0
15	3.6%	4
1	0.2%	1
20	4.8%	6
2	0.5%	1
0	0.0%	0
37	8.8%	8
0	0.0%	0
2	0.5%	2
1	0.2%	1
0	0.0%	0
109	25.9%	9
185	43.9%	15
14	3.3%	7
3	0.7%	3
0	0.0%	0
18	4.3%	23%

King shag pellet analysis 2020 draft report

Lalas and Schuckard

King shag Prey number and occurrence	Pellet code DNA analysis done? Jeffs & van der Reis notes Lalas & Schuckard notes	TT06 yes	TT07 yes	TT08 yes	TT09 yes	TT10 yes	TT11 yes	TT12 yes	TT13 yes	TT14 yes	TT15 yes	TT16 yes	TT17 yes
TT	VALID prey remains analysis done? Colony	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT
The Twins	Date pellet collected	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20
	DNA+Remains=yes=2	2	2	2	2	2	2	2	2	2	2	2	2
	Minimum number prey items	6	30	49	17	10	19	19	11	9	17	64	19
	Number prey taxa	1	5	3	3	3	3	1	7	2	3	7	3
	If 1 species enter species code	LEA						WIT					
Not prey species													
Parasitic isopod													
Hermit crab									4				
Definite or likely prey species													
Pill-box crab	cf. <i>Halicarcinus</i> sp. or spp.												9
Red swimming crab	<i>Nectocarcinus antarcticus</i>								1				
Arrow squid	<i>Nototodarus gouldi</i>												
Midget octopus	<i>Octopus</i> cf. <i>huttoni</i>												
Silver conger	<i>Gnathophis habenatus</i>												
Sandfish	<i>Gonorynchus forsteri</i>												
Ling	<i>Genypterus blacodes</i>												
cf. Twosaddle rattail	cf. <i>Coelorinchus biclinozonalis</i>												
Rock cod	<i>Lotella thacina</i>												
Dwarf cod	<i>Notophycis marginata</i>												
cf. Red cod	<i>Pseudophycis</i> 1-3 spp.												
Common roughy	<i>Paratrachichthys trailli</i>												1
Jock stewart	<i>Heliocolenus percooides</i>												
Red scorpionfish	<i>Scorpaena papillosa</i>								1				
Red gurnard	<i>Chelidonichthys kumu</i>								1				
Butterfly perch	<i>Caesioperca lepidoptera</i>												
Greenbone	<i>Odax pullus</i>												
Wrasse	<i>Notolabrus</i> & <i>Pseudolabrus</i> 4 spp.												
Blue cod	<i>Paraperca coltas</i>												
Opalfish	<i>Hemerocoetes</i> cf. <i>monopterygius</i>								1				2
Stargazer	<i>Leptoscopidae</i> sp.												
Tripletfin	<i>Tripterygiidae</i> spp.												
Witch	<i>Arnoglossus scapha</i>												
Lemon sole	<i>Pelotretis flavilatus</i>								5	7	14		5
Sole	<i>Peltothamphus</i> 1-3 spp.								1	2			12
Flounder	<i>Rhombosolea</i> 1-3 spp.												
Leatherjacket	<i>Meuschenia scaber</i>												
		6							1				2

King shag Prey number and occurrence	Pellet code	TT18	TT19	TT20	TT21	TT22	TT23	TT24
	DNA analysis done? Jeffs & van der Reis notes no hard parts Lalas & Schuckard notes	yes	yes	yes	yes	yes	yes	yes
TT	VALID prey remains analysis done? Colony	no	yes	yes	yes	yes	no	yes
The Twins	Date pellet collected	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20
	DNA+Remains=yes=2	1	2	2	2	2	1	2
	Minimum number prey items	14	14	14	8	4	7	7
	Number prey taxa	5	2	2	1	3	1	1

obviously incomplete

If 1 species enter species code

LEA

Not prey species

Parasitic isopod								
Hermit crab								
Definite or likely prey species								
Pill-box crab	cf. <i>Haliscarinus</i> sp. or spp.	1						
Red swimming crab	<i>Nectocarcinus antarcticus</i>	1						
Arrow squid	<i>Nototodarus gouldi</i>							
Midget octopus	<i>Octopus cf. huttoni</i>							
Silver conger	<i>Gnathophis habenatus</i>							
Sandfish	<i>Gonorynchus forsteri</i>							
Ling	<i>Genypterus blacodes</i>							
cf. Twosaddle rattail	cf. <i>Coelorinchus biclinozonalis</i>							
Rock cod	<i>Lotella thacina</i>							
Dwarf cod	<i>Notophycis marginata</i>							
cf. Red cod	<i>Pseudophycis</i> 1-3 spp.							
Common roughy	<i>Paratrachichthys trailli</i>							
Jock stewart	<i>Helicolenus percoides</i>	6						7
Red scorpionfish	<i>Scorpaena papillosa</i>							
Red gurnard	<i>Chelidonichthys kumu</i>							
Butterfly perch	<i>Caesioperca lepidoptera</i>					2		
Greenbone	<i>Odax pullus</i>							
Wrasse	<i>Notolabrus</i> & <i>Pseudolabrus</i> 4 spp.					1		
Blue cod	<i>Paraperais colias</i>							
Opalfish	<i>Hemerocoetes cf. monopterygius</i>	2						
Stargazer	<i>Leptoscopidae</i> sp.							
Triplefin	<i>Tripterygiidae</i> spp.		1					
Witch	<i>Arnoglossus scapha</i>	4		13				
Lemon sole	<i>Pelotretis flavilatus</i>							
Sole	<i>Peltothamphus</i> 1-3 spp.							
Flounder	<i>Rhombosolea</i> 1-3 spp.							
Leatherjacket	<i>Meuschenia scaber</i>				8			1

King shag
Prey number
and occurrence

pellet code total = 28
DNA analysis done total = 28
Prey remains analysis done total = 28
DNA & Remains done total = 28

Blu	Blu01	Blu02	Blu03	Blu04	Blu05
Blumine	yes	yes	yes	yes	yes

Pellet code	Blu	Blu	Blu	Blu	Blu
20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20

Minimum number of items per taxon	Occurrence of taxon in pellets
Number	Number
% total	% total

Minimum number of items per taxon	Occurrence of taxon in pellets
Number	Number
% total	% total

Species	Number per pellet	% total of all prey	of all pellets	Number of pellets
Not prey species				
Parasitic isopod	2	7%		2
Hermit crab	4	14%		4
Definite or likely prey species				
Pill-box crab	0	0.0%		0
Red swimming crab	0	0.0%		0
Arrow squid	0	0.0%		0
Midget octopus	1	0.2%	4%	1
Silver conger	1	0.2%	4%	1
Sandfish	0	0.0%		0
Ling	0	0.0%		0
cf. Twosaddle rattail	0	0.0%		0
Rock cod	0	0.0%		0
Dwarf cod	0	0.0%		0
cf. Red cod	3	0.7%	7%	2
Common roughy	0	0.0%		0
Jock stewart	21	5.0%	29%	8
Red scorpionfish	0	0.0%		0
Red gurnard	4	0.9%	11%	3
Butterfly perch	7	1.7%	11%	3
Greenbone	0	0.0%		0
Wrasse	1	0.2%	4%	1
Blue cod	0	0.0%		0
Opalfish	50	11.8%	32%	9
Stargazer	0	0.0%		0
Tripletfin	10	2.4%	11%	3
Witch	307	72.4%	93%	26
Lemon sole	0	0.0%		0
Sole	12	2.8%	18%	5
Flounder	7	1.7%	25%	7
Leatherjacket	0	0.0%		0

VALID prey remains analysis done? yes
DNA analysis done? yes
Jeffs & van der Reis notes
Lalas & Schuckard notes
Colony
Date pellet collected
DNA+Remains=yes=2
Minimum number prey items
Number prey taxa

WIT
WIT

If 1 species enter species code

King shag pellet analysis 2020 draft report

Lalas and Schuckard

King shag Prey number and occurrence	Pellet code DNA analysis done? Jeffs & van der Reis notes Lalas & Schuckard notes	Blu18	Blu19	Blu20	Blu21	Blu22	Blu23	Blu24	Blu25	Blu26	Blu27	Blu28
Blu	VALID prey remains analysis done? Colony	yes Blu	yes Blu	yes Blu	yes Blu	yes Blu	yes Blu	yes Blu	yes Blu	yes Blu	yes Blu	yes Blu
Blumine	Date pellet collected	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20	20-Mar-20
	DNA+Remains=yes=2	2	2	2	2	2	2	2	2	2	2	2
	Minimum number prey items	19	15	16	11	20	12	16	10	8	7	4
	Number prey taxa	4	2	2	2	2	2	2	1	3	2	2

If 1 species enter species code

WIT

Not prey species

Parasitic isopod	1
Hermit crab	
Definite or likely prey species	
Pill-box crab	cf. <i>Halicarcinus</i> sp. or spp.
Red swimming crab	<i>Nectocarcinus antarcticus</i>
Arrow squid	<i>Nototodarus gouldi</i>
Midget octopus	<i>Octopus</i> cf. <i>huttoni</i>
Silver conger	<i>Gnathophis habenatus</i>
Sandfish	<i>Gonorynchus forsteri</i>
Ling	<i>Genypterus blacodes</i>
cf. Twosaddle rattail	cf. <i>Coelorinchus biclinozonalis</i>
Rock cod	<i>Lotella rhacina</i>
Dwarf cod	<i>Notophycis marginata</i>
cf. Red cod	<i>Pseudophycis</i> 1-3 spp.
Common roughy	<i>Paratrachichthys trailli</i>
Jock stewart	<i>Heliocolenus percooides</i>
Red scorpionfish	<i>Scorpaena papillosa</i>
Red gurnard	<i>Chelidonichthys kumu</i>
Butterfly perch	<i>Caesioperca lepidoptera</i>
Greenbone	<i>Odax pullus</i>
Wrasse	<i>Notolabrus</i> & <i>Pseudolabrus</i> 4 spp.
Blue cod	<i>Paraperca coltas</i>
Opalfish	<i>Hemerocoetes</i> cf. <i>monopterygius</i>
Stargazer	<i>Leptoscopidae</i> spp.
Tripletfin	<i>Tripterygiidae</i> spp.
Witch	<i>Arnoglossus scapha</i>
Lemon sole	<i>Pelotretis flavilatus</i>
Sole	<i>Peltothamphus</i> 1-3 spp.
Flounder	<i>Rhombosolea</i> 1-3 spp.
Leatherjacket	<i>Meuschenia scaber</i>

**King shag
Prey number
and occurrence**

pellet code total = 10
DNA analysis done total = 10
Prey remains analysis done total = 10
DNA & Remains done total = 10

Total minimum number
of items = 168
Total number of pellets
analysed = 10

Minimum number
of items per taxon

Occurrence of
taxon in pellets

Number % total
per pellet of all prey

Number
of pellets

of all pellets of pellets

0 0%
6 40%

0 0.0%
1 0.6%
0 0.0%
3 1.8%
0 0.0%
0 0.0%
0 0.0%
0 0.0%
0 0.0%
0 0.0%
0 0.0%
0 0.0%
0 0.0%
7 4.2%
0 0.0%
3 1.8%
9 5.4%
4 2.4%
1 0.6%
0 0.0%
0 0.0%
1 0.6%
40 23.8%
0 0.0%
29 17.3%
39 23.2%
4 2.4%
1 0.6%
2 1.2%
24 14.3%

0 0
6 4

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1 1
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3 3
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7 7
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3 3
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Not prey species

Parasitic isopod

Hermit crab

Definite or likely prey species

Pill-box crab
cf. *Hallicarcinus* sp. or spp.

Red swimming crab
Nectocarcinus antarcticus

Arrow squid
Nototodarus gouldi

Midget octopus
Octopus cf. huttoni

Silver conger
Gnathophip habenatus

Sandfish
Gonorynchus forsteri

Ling
Genypterus blacodes

cf. Twosaddle rattail
cf. *Coelorinchus biclinozonalis*

Rock cod
Lotella thacina

Dwarf cod
Notophycis marginata

cf. Red cod
Pseudophycis 1-3 spp.

Common roughy
Paratrachichthys trailli

Jock stewart
Helicolenus percoides

Red scorpionfish
Scorpaena papillosa

Red gurnard
Chelidonichthys kumu

Butterfly perch
Caesioperca lepidoptera

Greenbone
Odax pullus

Wrasse
Notolabrus & Pseudolabrus 4 spp.

Blue cod
Paraperca colias

Opalfish
Hemerocoetes cf. monopterygius

Stargazer
Leptoscoptidae sp.

Triplefin
Tripterygiidae spp.

Witch
Arnoglossus scapha

Lemon sole
Pelotretis flavilatus

Sole
Peltothamphus 1-3 spp.

Flounder
Rhombosolea 1-3 spp.

Leatherjacket
Meuschenia scaber

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Pellet code
DNA analysis done?
Jeffs & van der Reis notes
Lalas & Schuckard notes
VALID prey remains analysis done?
Colony
Date pellet collected
DNA+Remains=yes=2
Minimum number prey items
Number prey taxa

11-Mar-19
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11-Mar-19
11-Mar-19

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King shag Prey number and occurrence	Pellet code DNA analysis done? Jeffs & van der Reis notes Lalas & Schuckard notes	HS06 yes	HS07 yes	HS08 yes	HS09 yes	HS10 yes
HS	VALID prey remains analysis done? Colony	yes HS	yes HS	yes HS	yes HS	yes HS
The Haystack	Date pellet collected	11-Mar-19	11-Mar-19	11-Mar-19	11-Mar-19	11-Mar-19
	DNA+Remains=yes=2	2	2	2	2	2
	Minimum number prey items	12	8	12	12	5
	Number prey taxa	1	3	2	2	5

If 1 species enter species code LEA

Not prey species

Parasitic isopod						
Hermit crab						6
Definite or likely prey species						
Pill-box crab	cf. <i>Halicarinus</i> sp. or spp.					1
Red swimming crab	<i>Nectocarcinus antarcticus</i>					
Arrow squid	<i>Nototodarus gouldi</i>					
Midget octopus	<i>Octopus</i> cf. <i>huttoni</i>					
Silver conger	<i>Gnathophis habenatus</i>					
Sandfish	<i>Gonorynchus forsteri</i>					
Ling	<i>Genypterus blacodes</i>					
cf. Twosaddle rattail	cf. <i>Coelorinchus biclinozonalis</i>					
Rock cod	<i>Lotella thacina</i>					
Dwarf cod	<i>Notophycis marginata</i>					1
cf. Red cod	<i>Pseudophycis</i> 1-3 spp.					
Common roughy	<i>Paratrachichthys trailli</i>					1
Jock stewart	<i>Heliocolenus percooides</i>					1
Red scorpionfish	<i>Scorpaena papillosa</i>					
Red gurnard	<i>Chelidonichthys kumu</i>					4
Butterfly perch	<i>Caesioperca lepidoptera</i>					
Greenbone	<i>Odax pullus</i>					
Wrasse	<i>Notolabrus</i> & <i>Pseudolabrus</i> 4 spp.					
Blue cod	<i>Parapercis coltas</i>					
Opalfish	<i>Hemerocoetes</i> cf. <i>monopterygius</i>					
Stargazer	<i>Leptoscopidae</i> sp.					1
Tripletfin	<i>Tripterygiidae</i> spp.					11
Witch	<i>Arnoglossus scapha</i>					1
Lemon sole	<i>Pelotretis flavilatus</i>					1
Sole	<i>Peltothamphus</i> 1-3 spp.					
Flounder	<i>Rhombosolea</i> 1-3 spp.					
Leatherjacket	<i>Meuschenia scaber</i>					12

**King shag
Prey number
and occurrence**

pellet code total = 51
DNA analysis done total = 37
Prey remains analysis done total = 46
DNA & Remains done total = 36

also 7 pellets entered in "Burp ball" series 24-Aug-19

DR

Total minimum number
of items = 839
Total number of pellets
analysed = 46

Pellet code
DNA analysis done?
Jeffs & van der Reis notes
Lalas & Schuckard notes
VALID prey remains analysis done?
Colony
Date pellet collected
DNA+Remains=yes=2
Minimum number prey items
Number prey taxa

If 1 species enter species code

Minimum number
of items per taxon
Occurrence of
taxon in pellets

Number % total
of all prey
of all pellets of pellets

Not prey species

Parasitic isopod
Hermit crab

Definite or likely prey species

Pill-box crab	cf. <i>Hallicarcinus</i> sp. or spp.	1	0.1%	1	0	0%	0
Red swimming crab	<i>Nectocarcinus antarcticus</i>	2	0.2%	2	6	43%	6
Arrow squid	<i>Nototodarus gouldi</i>	0	0.0%	0			
Midget octopus	<i>Octopus cf. huttoni</i>	7	0.8%	5			
Silver conger	<i>Gnathophis habenatus</i>	0	0.0%	0			
Sandfish	<i>Gonorynchus forsteri</i>	0	0.0%	0			
Ling	<i>Gerypterus blacodes</i>	0	0.0%	0			
cf. Twosaddle rattail	<i>Coelrinchus biclinozonalis</i>	1	0.1%	1			
Rock cod	<i>Lotella rhacina</i>	1	0.1%	1			
Dwarf cod	<i>Notophycis marginata</i>	0	0.0%	0			
cf. Red cod	<i>Pseudophycis</i> 1-3 spp.	4	0.5%	3			
Common roughy	<i>Paratrachichthys trailli</i>	0	0.0%	0			
Jock Stewart	<i>Helicolenus percoides</i>	29	3.5%	12			
Red scorpionfish	<i>Scorpaena papillosa</i>	2	0.2%	2			
Red gurnard	<i>Chelidonichthys kumu</i>	10	1.2%	5			
Butterfly perch	<i>Caesioperca lepidoptera</i>	1	0.1%	1			
Greenbone	<i>Odax pullus</i>	0	0.0%	0			
Wrasse	<i>Notolabrus & Pseudolabrus</i> 4 spp.	12	1.4%	5			
Blue cod	<i>Parapercis colias</i>	0	0.0%	0			
Opalfish	<i>Hemerocoetes cf. monopterygius</i>	215	25.6%	24			
Stargazer	<i>Leptoscoptidae</i> sp.	2	0.2%	1			
Triplefin	<i>Tripterygiidae</i> spp.	62	7.4%	13			
Witch	<i>Arnoglossus scapha</i>	371	44.2%	32			
Lemon sole	<i>Pelotretis flavilatus</i>	25	3.0%	19			
Sole	<i>Peltothamphus</i> 1-3 spp.	30	3.6%	13			
Flounder	<i>Rhombosolea</i> 1-3 spp.	13	1.5%	6			
Leatherjacket	<i>Meuschenia scaber</i>	51	6.1%	16			

DF05
yes

DF04
yes

DF03
no

DF02
yes

DF01
yes

DF02
yes

DF03
no

DF04
yes

DF05
yes

DF06
no

DF07
yes

DF08
no

DF09
yes

DF10
no

DF11
yes

DF12
no

DF13
yes

King shag Prey number and occurrence	Pellet code DNA analysis done? Jeffs & van der Reis notes Lalas & Schuckard notes	DF06 no hard parts	DF07 yes	DF08 no Does not exist	DF09 yes	DF10 yes	DF11 yes	DF12 no	DF13 yes	DF14 yes	DF15 no no hard parts	DF16 no	DF17 yes
DR	VALID prey remains analysis done? Colony	no	yes	no	yes	yes	yes	yes	yes	yes	yes	yes	yes
Duffers Reef	Date pellet collected	26-Nov-19	26-Nov-19	26-Nov-19	26-Nov-19	26-Nov-19	26-Nov-19	26-Nov-19	26-Nov-19	26-Nov-19	26-Nov-19	26-Nov-19	26-Nov-19
	DNA+Remains=yes=2	0	2	0	2	2	2	1	2	2	1	1	2
	Minimum number prey items	10	46		12	9	12	8	31	11	69	19	15
	Number prey taxa	4	5		3	4	5	4	5	4	3	5	3
	If 1 species enter species code		1										
Not prey species													
Parasitic isopod													
Hermit crab													
Definite or likely prey species													
Pill-box crab	cf. <i>Halicarinus</i> sp. or spp.												
Red swimming crab	<i>Nectocarcinus antarcticus</i>												
Arrow squid	<i>Nototodarus gouldi</i>												
Midget octopus	<i>Octopus cf. huttoni</i>	1	1										
Silver conger	<i>Gnathophis habenatus</i>												
Sandfish	<i>Gonorynchus forsteri</i>												
Ling	<i>Genypterus blacodes</i>												
cf. Twosaddle rattail	cf. <i>Coelorinchus biclinozonalis</i>												
Rock cod	<i>Lotella rhacina</i>												
Dwarf cod	<i>Notophycis marginata</i>												
cf. Red cod	<i>Pseudophycis</i> 1-3 spp.												
Common roughy	<i>Paratrachichthys trallii</i>												
Jock steward	<i>Helicolenus percoides</i>				2		4						
Red scorpionfish	<i>Scorpaena papillosa</i>												
Red gurnard	<i>Chelidonichthys kumu</i>		2										
Butterfly perch	<i>Caesioperca lepidoptera</i>												
Greenbone	<i>Odax pullus</i>												
Wrasse	<i>Notolabrus & Pseudolabrus</i> 4 spp.												
Blue cod	<i>Paraperca colias</i>												
Opalfish	<i>Hemerocoetes cf. monopterygius</i>	2			5			1	2	3	64	2	
Stargazer	<i>Leptoscopidae</i> sp.												
Triplefin	<i>Tripterygiidae</i> spp.	1	7		2		3				3		
Witch	<i>Arnoglossus scapha</i>	6	28		9		3	5	21		2	13	12
Lemon sole	<i>Pelotretis flavilatus</i>				1		1	1	3	3		1	1
Sole	<i>Peltorhamphus</i> 1-3 spp.		8			1		1	2	2			2
Flounder	<i>Rhombosolea</i> 1-3 spp.												
Leatherjacket	<i>Meuschenia scaber</i>					1			3	3		1	

King shag Prey number and occurrence	Pellet code DNA analysis done? Jeffs & van der Reis notes Lalas & Schuckard notes	DF18 yes	DF19 yes	DF20 yes	DF21 yes	DF22 no	DF23 yes	DF24 no	DF25 no	DF26 yes	DF27 yes	DF28 yes	DF29 yes
DR	VALID pre remains analysis done? Colony	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Duffers Reef	Date pellet collected	26-Nov-19	26-Nov-19	26-Nov-19	26-Nov-19	26-Nov-19	26-Nov-19	26-Nov-19	26-Nov-19	26-Nov-19	26-Nov-19	26-Nov-19	26-Nov-19
	DNA+Remains=yes=2	2	2	2	2	1	2	1	1	2	2	2	2
	Minimum number prey items	4	21	15	29	13	21	19	45	3	18	13	23
	Number prey taxa	2	7	5	5	3	4	5	2	3	1	3	3
	If 1 species enter species code										WWT		
Not prey species													
Parasitic isopod						4	4						
Hermit crab													4
Definite or likely prey species													
Pill-box crab	cf. <i>Halicarcinus</i> sp. or spp.												
Red swimming crab	<i>Nectocarcinus antarcticus</i>						1						
Arrow squid	<i>Nototodarus gouldi</i>												
Midget octopus	<i>Octopus cf. huttoni</i>		1	1									
Silver conger	<i>Gnathophis habenatus</i>												
Sandfish	<i>Gonorynchus forsteri</i>												
Ling	<i>Genypterus blacodes</i>												
cf. Twosaddle rattail	cf. <i>Coelorinchus biclinozonalis</i>		1										
Rock cod	<i>Lotella thacina</i>												
Dwarf cod	<i>Notophycis marginata</i>												
cf. Red cod	<i>Pseudophycis</i> 1-3 spp.												
Common roughy	<i>Paratrachichthys trailii</i>												
Jock stewart	<i>Heliocolenus percoides</i>					5			1				
Red scorpionfish	<i>Scorpaena papillosa</i>												
Red gurnard	<i>Chelidonichthys kumu</i>			2			1						
Butterfly perch	<i>Caesioperca lepidoptera</i>												
Greenbone	<i>Odax pullus</i>												
Wrasse	<i>Notolabrus & Pseudolabrus</i> 4 spp.									1			
Blue cod	<i>Paraperca colias</i>											1	1
Opalfish	<i>Hemerocoetes cf. monopterygius</i>		8	3	7		2	1	37				
Stargazer	Leptoscopidae sp.												
Tripletfin	Tripterygiidae spp.												
Witch	<i>Arnoglossus scapha</i>		3	2	16	7	17	15	8	1	18	11	18
Lemon sole	<i>Pelotretis flavilatus</i>		1	1	1			1					
Sole	<i>Peltothamphus</i> 1-3 spp.		2		3								
Flounder	<i>Rhombosolea</i> 1-3 spp.												
Leatherjacket	<i>Meuschenia scaber</i>		2	5		1				1			4

King shag pellet analysis 2020 draft report

Lalas and Schuckard

King shag Prey number and occurrence	Pellet code DNA analysis done? Jeffs & van der Reis notes Lalas & Schuckard notes VALID prey remains analysis done?	Taw31 yes Taw 11-Mar-19	Taw32 yes Taw 11-Mar-19	Taw33 yes Taw 11-Mar-19	Taw34 yes Taw 11-Mar-19	Taw35 yes Taw 11-Mar-19	Taw36 yes Taw 11-Mar-19	Taw37 yes Taw 11-Mar-19	Taw38 yes Taw 11-Mar-19	Taw39 yes Taw 11-Mar-19	Taw40 yes Taw 11-Mar-19	Taw41 yes Taw 11-Mar-19	Taw42 yes Taw 11-Mar-19
Tawhitinui	Colony Date pellet collected DNA+Remains=yes=2 Minimum number prey items Number prey taxa	2 63 5	2 9 2	2 54 5	2 5 4	2 8 5	2 2 2	2 36 6	2 5 4	2 32 4	2 2 2	2 17 4	2 5 2
If 1 species enter species code													
Not prey species													
Parasitic isopod							1						
Hermit crab													
Definite or likely prey species													
Pill-box crab	cf. <i>Hallicarcinus</i> sp. or spp.												
Red swimming crab	<i>Nectocarcinus antarcticus</i>												
Arrow squid	<i>Nototodarus gouldi</i>												
Midget octopus	<i>Octopus cf. huttoni</i>												
Silver conger	<i>Gnathophis habenatus</i>												
Sandfish	<i>Gonorynchus forsteri</i>							1					
Ling	<i>Genypterus blacodes</i>												
cf. Twosaddle rattail	cf. <i>Coelorinchus biclinozonalis</i>												
Rock cod	<i>Lotella thacina</i>												
Dwarf cod	<i>Notophycis marginata</i>				1								
cf. Red cod	<i>Pseudophycis</i> 1-3 spp.												
Common roughy	<i>Paratrachichthys trailli</i>				1								
Jock steward	<i>Helicolenus percoides</i>						1						
Red scorpionfish	<i>Scorpaena papillosa</i>												
Red gurnard	<i>Chelidonichthys kumu</i>												
Butterfly perch	<i>Caesioperca lepidoptera</i>												
Greenbone	<i>Odax pullus</i>												
Wrasse	<i>Notolabrus & Pseudolabrus</i> 4 spp.					1							
Blue cod	<i>Paraperis colias</i>					2		6	2	1	1	5	
Opalfish	<i>Hemerocoetes cf. monopterygius</i>			10									
Stargazer	Leptoscopidae sp.												
Triplefin	Tripterygiidae spp.			3		1			1			7	
Witch	<i>Arnoglossus scapha</i>			4	2	2			1	16		1	2
Lemon sole	<i>Pelotretis flavilatus</i>			1				6		1			
Sole	<i>Peltorhamphus</i> 1-3 spp.			31				14		14			
Flounder	<i>Rhombosolea</i> 1-3 spp.			2				2	1				
Leatherjacket	<i>Meuschenia scaber</i>				1	2					1	4	3

King shag pellet analysis 2020 draft report

Lalas and Schuckard

King shag Prey number and occurrence	Pellet code DNA analysis done? Jeffs & van der Reis notes Lalas & Schuckard notes	TN18 yes	TN19 no no hard parts	TN20 no	TN21 no	TN22 no	TN23 yes	TN24 yes	TN25 yes	TN26 yes	TN27 yes	TN28 yes	TN29 no
TN	VALID prey remains analysis done? Colony	yes TN	yes TN	yes TN	yes TN	yes TN	yes TN	yes TN	yes TN	yes TN	yes TN	yes TN	yes TN
North Trio	Date pellet collected DNA+Remains=yes=2	26-Nov-19 2	26-Nov-19 1	26-Nov-19 1	26-Nov-19 1	26-Nov-19 1	26-Nov-19 2	26-Nov-19 2	26-Nov-19 2	26-Nov-19 2	26-Nov-19 2	26-Nov-19 2	26-Nov-19 1
	Minimum number prey items	20	9	23	22	23	27	15	17	5	22	22	9
	Number prey taxa	4	1	3	4	7	1	4	3	4	1	4	2
	If 1 species enter species code		GUR			operculum	WIT	operculum			WIT		
Not prey species													
Parasitic isopod													
Hermit crab													
Definite or likely prey species													
Pill-box crab	cf. <i>Halicarcinus</i> sp. or spp.												
Red swimming crab	<i>Nectocarcinus antarcticus</i>									1			
Arrow squid	<i>Nototodarus gouldi</i>												
Midget octopus	<i>Octopus</i> cf. <i>huttoni</i>												
Silver conger	<i>Gnathophis habenatus</i>												
Sandfish	<i>Gonorynchus forsteri</i>												
Ling	<i>Genypterus blacodes</i>												
cf. Twosaddle rattail	cf. <i>Coelorinchus biclinozonalis</i>												
Rock cod	<i>Lotella thacina</i>												
Dwarf cod	<i>Notophycis marginata</i>												
cf. Red cod	<i>Pseudophycis</i> 1-3 spp.					1							
Common roughy	<i>Paratrachichthys trilli</i>												
Jock stewart	<i>Heliocolenus percoides</i>												
Red scorpionfish	<i>Scorpaena papillosa</i>												
Red gurnard	<i>Chelidonichthys kumu</i>												
Butterfly perch	<i>Caesioperca lepidoptera</i>												
Greenbone	<i>Odax pullus</i>												
Wrasse	<i>Notolabrus & Pseudolabrus</i> 4 spp.												
Blue cod	<i>Paraperca colias</i>												
Opalfish	<i>Hemerocoetes</i> cf. <i>monopterygius</i>	2						1		2			
Stargazer	Leptoscopidae sp.												
Tripletfin	Tripterygiidae spp.												
Witch	<i>Arnoglossus scapha</i>	13		20	12	4	27	12	14	15	22	15	8
Lemon sole	<i>Pelotretis flavilatus</i>	3				1			2				
Sole	<i>Peltorhamphus</i> 1-3 spp.	2				2		1					1
Flounder	<i>Rhombosolea</i> 1-3 spp.												
Leatherjacket	<i>Meuschenia scaber</i>				1			1	1	1			

King shag Prey number and occurrence	Pellet code DNA analysis done? Jeffs & van der Reis notes Lalas & Schuckard notes	TN42 yes	TN43 yes	TN44 yes	TN45 yes	TN46 yes	TN47 yes
TN	VALID prey remains analysis done? Colony	yes TN	yes TN	yes TN	yes TN	yes TN	yes TN
North Trio	Date pellet collected	11-Mar-20	11-Mar-20	11-Mar-20	11-Mar-20	11-Mar-20	11-Mar-20
	DNA+Remains=yes=2	2	2	2	2	2	2
	Minimum number prey items	9	10	18	5	19	16
	Number prey taxa	3	2	2	1	3	2
	operculum						
	If 1 species enter species code				LEA		
Not prey species							
Parasitic isopod							
Hermit crab							
Definite or likely prey species							
Pill-box crab	cf. <i>Hallicarcinus</i> sp. or spp.						
Red swimming crab	<i>Nectocarcinus antarcticus</i>						
Arrow squid	<i>Nototodarus gouldi</i>						
Midget octopus	<i>Octopus cf. huttoni</i>						
Silver conger	<i>Gnathophis habenatus</i>						
Sandfish	<i>Gonorynchus forsteri</i>						
Ling	<i>Genypterus blacodes</i>						
cf. Twosaddle rattail	cf. <i>Coelorinchus biclinozonalis</i>						
Rock cod	<i>Lotella rhacina</i>						
Dwarf cod	<i>Notophycis marginata</i>						
cf. Red cod	<i>Pseudophycis</i> 1-3 spp.						
Common roughy	<i>Paratrachichthys trailli</i>						
Jock stewart	<i>Helicolenus percoides</i>						
Red scorpionfish	<i>Scorpaena papillosa</i>						
Red gurnard	<i>Chelidonichthys kumu</i>						
Butterfly perch	<i>Caesioperca lepidoptera</i>						
Greenbone	<i>Odax pullus</i>						
Wrasse	<i>Notolabrus & Pseudolabrus</i> 4 spp.	1					
Blue cod	<i>Paraperca colias</i>						
Opalfish	<i>Hemerocoetes cf. monopterygius</i>	2					
Stargazer	<i>Leptoscopidae</i> sp.						
Triplefin	<i>Tripterygiidae</i> spp.	2					
Witch	<i>Arnoglossus scapha</i>		8	17		15	8
Lemon sole	<i>Pelotretis flavilatus</i>					3	
Sole	<i>Peltorhamphus</i> 1-3 spp.			1			8
Flounder	<i>Rhombosolea</i> 1-3 spp.						
Leatherjacket	<i>Meuschenia scaber</i>	6					5