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STATUS AND MONITORING OF MARINE SHAGS IN OTAGO CONSERVANCY, WITH RECOMMENDATIONS ON RESEARCH NEEDS

(Short Answers in Conservation Science)

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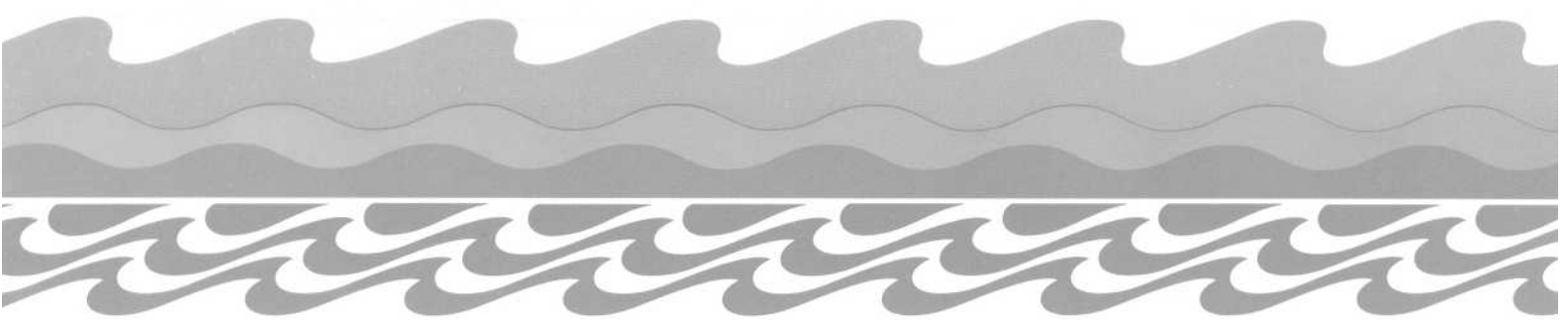

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Status and monitoring of marine shags in Otago Conservancy, with recommendations on research needs

External Unprogrammed Science Advice / Service
prepared for Otago Conservancy
Department of Conservation

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Contents

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1.1. Specifications set by Otago Conservancy

Bird Species:
Stewart Island Shag, Spotted Shag, Black Shag, and Little Shag

1. What is the status of these four shag species in the marine environment in Otago Conservancy?

2. What is the current state of monitoring of these species there?

3. What gaps are there in monitoring of these species there?

4. Recommendations on the research needs of these species taking account of the current threats and marine perturbations.

1.2. Sources of information

This report is based on data collected from 1977 to 1982 for a PhD thesis (Lalas 1983) and a discontinuous series of records by Lalas from 1983 to 1993. Published data on New Zealand shags are summarised and reviewed in Marchant and Higgins (1990). Unless otherwise referenced, source of information is from Lalas unpublished data.

Common and scientific names in this report follow Turbott (1990). Three genera of shags are recognised by this New Zealand convention: *Phalacrocorax* ("black-footed shags"), *Leucocarbo* ("blue-eyed shags"), and *Stictocarbo* ("yellow-footed shags"). This contrasts to overseas convention (Marchant & Higgins 1990) that recognises only a single genus of shags: *Phalacrocorax*.

The term "breeding pairs" is used here as an indicator of the number of adult birds in a population. This term is not always interchangeable with "nest numbers" because annual nest numbers can fluctuate wildly in some species. Robertson and Bell (1984) presented conservative estimates for numbers of seabirds breeding in the New Zealand region, including shags. They allocated each species or subspecies into a category of abundance, expressed as a range in number of breeding pairs.

2. Summary

Stewart Island Shags in Otago Conservancy probably are an unique taxonomic entity. Numbers doubled through the 1980's to 1 850 breeding pairs in 1987, but dropped following a failed breeding season in 1990. The total population now stands at an estimated 1 500 breeding pairs spread between four colonies. Colony locations in order of size are at Maukiekie Island, Taiaroa Head, Green Island and Wharekakahu Island. Another breeding colony might have been initiated on Kinakina Island since 1986: this needs checking.

Spotted Shags might cross conservancy boundaries with movements in and out of Otago Conservancy probably southward and possibly northward. Research into the taxonomic identity of local Spotted Shags is a prerequisite to deduce the discreteness of the population. The dispersive behaviour and inconsistency in nesting of Spotted Shags complicates attempts for accurate population estimates. Synchronised surveys within the same season are needed not only throughout Otago but also in adjacent conservancies. Four key locations hold the bulk of the breeding birds in Otago Conservancy: Stony Creek, Heyward Point, tip of Otago Peninsula (including Taiaroa Head) and Nugget Point. South East Otago should be a priority because parts have never been surveyed.

Estimated population totals for Spotted Shags in Otago Conservancy fluctuate through time between 1 000 and 2 000 (perhaps 2 500) breeding pairs. This relatively low total, for a region where Spotted Shags are regarded as abundant, casts doubt on the species total population estimate of 60 000 - 150 000 breeding pairs which might be too high by an order of magnitude.

Black Shags are widespread but not numerous along the coastline of Otago Conservancy, with a total population estimate of 50 - 100 birds.

Little Shags in Otago Conservancy are concentrated within Otago Harbour where 90-130 pairs nest annually. Numbers here probably double outside the breeding season to at least 800 birds, presumably an influx from inland waters. Elsewhere along the coast small breeding colonies of about 20 nests each are on Maukiekie Island and Green Island. A total lack of known breeding along the coastline of South East Otago is regarded as an anomaly.

3. Status of shags in New Zealand: Taxonomic identity, distribution and abundance

3.1. *Leucocarbo* (Stewart Island Shag)

Six species of *Leucocarbo* shags are recognised from the New Zealand mainland and subantarctic islands (Turbott 1990). Each is endemic and exclusively marine, with a very restricted distribution and a small total population (Marchant & Higgins 1990). Two species have mainland distributions: New Zealand King Shag *(L. carunculatus)* and Stewart Island Shag *(L. chalconotus)*. New Zealand King Shags are restricted to Marlborough Sounds, with a tiny but stable population totalling less than 300 birds (Marchant & Higgins 1990). Stewart Island Shags, the most widespread and abundant of the six species, range from Otago south to Stewart Island. Breeding locations and population estimates have been given by Watt (1975) and Lalas (1983). The species totalled 1 800 - 2 000 breeding pairs in 1981, the only year in which a census has encompassed all breeding locations (Lalas 1983).

Stewart Island Shags are a species with dimorphic plumage. Adults of the bronze morph are entirely black and adults of the pied morph are black above and white below. Stewart Island Shags in Otago Conservancy (900 - 1 000 breeding pairs in 1981) can be distinguished from those in Southland Conservancy (900 - 1 000 breeding pairs in 1981) by their larger average size, and a difference in proportion of the two morphs in populations (Lalas 1983).

Pied morph Stewart Island Shags are considered distinct from New Zealand King Shags because they are regarded as much smaller and distributions do not overlap (Marchant & Higgins 1990). However, Stewart Island Shags in Otago Conservancy are the same size as King Shags (Lalas 1983). Further, a study of the pre-nuptial and nuptial plumages of pied morph Stewart Island Shags at Taiaroa Head during 1992 indicated that they are indistinguishable from King Shags.

The two *Leucocarbo* species on mainland New Zealand can be separated into three groups by a combination of distribution, ratio of morphs, and size (Lalas 1983):

a. King Shags, restricted to Marlborough Sounds, are monomorphic (all pied).
b. Stewart Island Shags in Otago are dimorphic (15-35% pied), and the same size as King Shags.
c. Stewart Island Shags in Southland, Foveaux Strait, and Stewart Island are dimorphic (50-60% pied), and smaller than Stewart Island Shags in Otago.

3.2. *Stictocarbo* (Spotted Shag)

Two species of *Stictocarbo* shags are recognised from the New Zealand region (Turbott 1990). Both are endemic and exclusively marine (Marchant & Higgins 1990): Spotted Shag *(S. punctatus)* around mainland New Zealand and Pitt Island Shag *(S. featherstoni)* restricted to Chatham Islands. Two subspecies of *S. punctatus* are recognised: Spotted Shag *(S. p. punctatus)* with breeding colonies scattered around North Island and along the eastern coast of South Island south to Otago Peninsula; and Blue Shag *(S. p. steadi)* with breeding colonies scattered along the western coast of South Island, in Foveaux Strait, and around Stewart Island. The status of birds breeding in South East Otago has not been defined.

The two subspecies of *S. punctatus* are differentiated by the extent of the white supercilium in pre-nuptial and nuptial plumages: this neck and head stripe is broad and extends forward to the bill in *S. p. punctatus* but is narrow and stops at the eye in *S. p. steadi* (Marchant & Higgins 1990). The validity of this subspeciation has been questioned (Marchant & Higgins 1990), based on the lack of any consistent plumage differences (Lalas 1983) and on the lack of any osteological differences (Siegel-Causey 1988). Extent of the white supercilium is a variable character among *S. punctatus* from Otago and further south, but all lack the white forehead common for birds further north (Lalas 1983, Marchant & Higgins 1990). Plumage variability in *S. punctatus* probably is best regarded as an indicator of geographical variation rather than an easily delineated taxonomic subspeciation.

Total population estimates given by Robertson and Bell (1984) are 50 000 - 100 000 breeding pairs for *S. p. punctatus* and 10 000 - 50 000 for *S. p. steadi*. These figures are combined by Marchant and Higgins (1990) to produce a total population estimate of 60 000 - 150 000 breeding pairs for the species. This estimate appears too high, possibly by an order of magnitude. Synchronised annual nest counts in North Otago and Otago Peninsula (Lalas), in South East Otago (Lalas, Brian Murphy DoC, Hiltrun Ratz) and around Banks Peninsula (DoC Canterbury Conservancy) began with the 1992-93 breeding season. They should produce comparative population estimates within a few years. An expected scenario is that the species totals 5 000 - 10 000 breeding pairs with one-third in Otago Conservancy, one-third around Banks Peninsula, and one-third elsewhere around New Zealand.

3.3. *Phalacrocorax* (Black Shag and Little Shag)

There are four species of *Phalacrocorax* shags in the New Zealand region:

Black Shag	*P. carbo novaehollandiae*
Little Shag	*P. melanoleucos brevirostris*
Pied Shag	*P. varius varius*
Little Black Shag	*P. sulcirostris*

In contrast to *Leucocarbo* and *Stictocarbo* species, none are endemic, exclusively marine, nor taxonomically controversial.

Black Shags are almost cosmopolitan (Marchant & Higgins 1990), possibly with the most widespread natural breeding distribution of any bird in the world. The Australasian subspecies is represented in New Zealand where it is widespread in coastal and inland waters throughout the mainland and at Chatham Islands. The total population estimate for the New Zealand region is 5 000 - 10 000 breeding pairs (Robertson & Bell 1984).

Little Shags are the New Zealand representatives of an Australasian species. Although subspecies elsewhere are monomorphic, the New Zealand subspecies is polymorphic (Marchant & Higgins 1990). Little Shags are widespread throughout mainland coastal and inland waters, with a total population estimate for New Zealand of 10 000 - 50 000 breeding pairs (Robertson & Bell 1984).

Pied Shags are restricted to Australia and New Zealand. The New Zealand subspecies has a discontinuous, primarily marine, breeding distribution around the mainland (Marchant & Higgins 1990). The total population estimate for New Zealand is 5 000 - 10 000 breeding pairs (Robertson & Bell 1984). Curiously, Pied Shags are absent from Otago Conservancy, although they are common from Banks Peninsula northward and also to the south at Stewart Island and to the west in Fiordland (Lalas 1983). A probable explanation for this gap in distribution is a lack of suitable nesting habitat (Lalas 1983). At Stewart Island, Pied Shags nest exclusively in large trees overhanging water (Lalas 1979), a habitat rare in Otago. One record of 36 pairs in Otago Harbour in 1982, reported in Marchant and Higgins (1990), was most likely a species misidentification.

Little Black Shags are a monotypic species spread through Australasia and Indonesia. Breeding in New Zealand is restricted to inland waters of North Island. Little Black Shags in New Zealand are dispersive (possibly migratory) with a movement after breeding to coastal waters, including South Island at Marlborough Sounds and Nelson (Marchant & Higgins 1990). The total population estimate for New Zealand is 1 000 - 5 000 breeding pairs (Robertson & Bell 1984). The absence of Little Black Shags from Otago Conservancy is to be expected given that breeding is restricted to North Island.

3.4. Species dispersion - open or closed populations

Department of Conservation conservancies have map boundaries that do not necessarily bear any relationship to the delineation of animal populations. A review of the breeding distributions and dispersion of shags in Otago Conservancy gives an indication of the accuracy and consistency of census figures.

Stewart Island Shags are sedentary (Lalas 1983, Marchant & Higgins 1990). Within Otago Conservancy, the most southern concentration of Stewart Island Shags (at Kinakina Island) is 75 - 80 km east of the nearest concentration of the species in Foveaux Strait. Consequently, some spread or interchange could be expected. However, Stewart Island Shags from Otago Conservancy can be distinguished by sight from those from Foveaux Strait by differences in ratios of the two colour morphs. To the north, Stewart Island Shags in numbers are not encountered beyond Oamaru, although individuals occasionally reach Timaru. The distributions of Stewart Island Shags and King

Shags are separated by 600 km, thus precluding any likelihood of interchange between species. A record of three King Shags at Oamaru in 1981, reported in Marchant and Higgins (1990), was sure to have been a misidentification of pied morph Stewart Island Shags because plumages are indistinguishable.
In conclusion, the boundaries of Otago Conservancy encompass a closed population of Stewart Island Shags.

Spotted Shags concentrate around breeding locations when breeding, then disperse to other coastal areas (Marchant & Higgins 1990) typically through January to July in Otago. None nest between Moeraki and Banks Peninsula, a gap of 250 km that lacks suitable nesting habitat. However, Otago birds can disperse northward (Lalas 1983) and Canterbury birds southward (Grant 1969) after breeding, and also through poor breeding years. Hundreds of Spotted Shags roosting on breakwaters at Timaru and Oamaru are typical at these times. To date it is impossible to judge the degree of mixing or interchange of birds between Otago and Canterbury. Future investigation on distinguishing plumage characters is needed to determine if populations are discrete. To the south, Spotted Shags are scattered continually along the coastline and offshore islands, with no distinguishing plumage characters between Otago and Southland birds.
In conclusion, Spotted Shags in Otago Conservancy must be regarded as an open population, without a discrete boundary to the south and possibly none to the north. Consequently, annual fluctuations in population estimates might be attributable to emigration or immigration of birds northward and/or southward.

Little Shags are a dispersive species, with fledglings from an Australian study dispersing an average 300 km in their first six months (in Marchant & Higgins 1990). Nearer home, large seasonal changes in numbers of Little Shags in Otago Harbour have been recorded by Hamel (1991). Little Shags along the coastline of Otago Conservancy must be regarded as an open population. Not only might there be northward and/or southward movements, but also there might be seasonal movements between coastal and inland habitats.

Black Shags are a nomadic species in Australia, but information is lacking for movements in New Zealand (Marchant & Higgins 1990). There are too few Black Shags along the coastline of Otago Conservancy to permit comment on delineation of populations.

4. Status in the marine environment in Otago Conservancy

4.1. Stewart Island Shag

All breeding colonies of Stewart Island Shags in Otago Conservancy are on small offshore islands and rock stacks except one on the mainland at Taiaroa Head.

Locations of breeding colonies and number of nests in recent years are shown in Table 1. Present known colonies are described below, from north to south. For further details see Lalas (1984a, 1984b, 1985) and Anon. (1992).

Maukiekie Island

Location:	Moeraki, between Moeraki Point and Tikoraki Point, 100m offshore
Land status:	Maori Land
Description:	flat-topped stack bordered by cliffs to 10m high; maximum dimensions 80 x 70m; area 0.2 hectares.

Taiaroa Head

Location:	at the tip of Otago Peninsula
Land status:	Wildlife Sanctuary and adjacent Nature Reserve
Description:	foreshore slopes west of signal station.

Wharekakahu Island

Location:	Otago Peninsula, between Cape Saunders lighthouse and Allans Beach, 300m offshore
Land status:	Nature Reserve
Description:	flat-topped stack bordered by cliffs to 50m high; maximum dimensions 200 x 150m; area c.1.0 ha.

Green Island

Location:	to the south of Dunedin, near Brighton, 2.2km offshore
Land status:	Nature Reserve
Description:	island, one half wave-cut platform and one half cone-shaped rising to 40m high; maximum dimensions 300 x 200m; area 3.0 hectares.

Table 1.: Stewart Island Shags
Location of breeding colonies and nest numbers in Otago
Four to five-year intervals to show recent population trends. * see text.

Location (north to south)	Number of nests			
	1979-80	1983-84	1987-88	1992-93
Maukiekie Island (Moeraki)	'c.260	800	920	?
Taiaroa Head (Otago Peninsula)	c.400	470	c.620	480
Wharekakahu Is.(Otago Peninsula)	0	c.130	130	?
Lion Rock (Otago Peninsula)	0	20	0	?
Green Island (off Brighton)	60	170	170	110
Otago totals (round figures) *	**700**	**1600**	**1850**	**est. 1500**

Table 2.: Spotted Shags
Number of nests at key locations in Otago
Approximately five-year intervals to show recent population trends.

Location (north to south)	Number of nests			
	1977-78	1982-83	1985-86	1992-93
Stony Creek (North Otago)	est.270	360	580	450
Heyward Point	90	200	300	100
Tip of Otago Peninsula	280	680	350	360
Nugget Point (South East Otago)	c.100	140	c.120	170

Table 3.: Spotted Shags
Estimated number of breeding pairs in Otago
Breeding seasons as for Table 2, to show recent population trends.

Location (north to south)	Number of breeding pairs			
	1977-78	1982-83	1985-86	1992-93
North Otago	est.320	c.420	est.680	est.530
Otago Peninsula	c.450	c.1290	est.980	est.690
South East Otago	est.300	est.420	est.360	est.510
Otago Conservancy	**est.1100**	**est.2100**	**est.2000**	**est. 1700**

Desertion of long-established sites and the occupation of new ones is a well documented feature in the breeding activity of Stewart Island Shags (Watt 1975, Lalas 1983, Lalas 1984b). The Green Island colony is the only one with a history of continual occupation extending back into last century. The present colony at Taiaroa Head only began in the early 1940's and was the most northern breeding site until the adoption of Maukiekie Island in c.1962 (Watt 1975). The colony on Wharekakahu Island was first established in 1980.

Total population estimates and trends for Stewart Island Shags in Otago Conservancy are shown in Table 1. With one exception, chosen years presented are breeding seasons where practically all adults bred, ie. numbers of nests approximately equalled number of breeding pairs. The one exception is Maukiekie Island for 1979-80. Here the area of the colony was expanding rapidly and an estimated 500 resident adults (equivalent to 250 breeding pairs) did not nest that year (extrapolated from Lalas 1983). Instead of an Otago total of 700 breeding pairs in 1979-80, this figure should be read as the equivalent of 950 breeding pairs.

The population size increased rapidly from 950 to 1850 breeding pairs, and breeding range expanded, during the 1980's but numbers dropped following a failed breeding season in 1990-91. The population estimate from the 1992-93 breeding season is approximately 1500 breeding pairs.

The various breeding colonies of Stewart Island Shags in Otago Conservancy do not contain discrete populations. Evidence for movement of breeders between colonies comes from the early 1980's (Lalas 1983, 1984a, 1984b). The number of nests at Taiaroa Head dropped from an estimated 300-400 in 1979-80 to 70 in 1980-81. Concomitantly, a new breeding colony of 35 nests was created on Wharekakahu Island, and nest numbers on Green Island were boosted to 160 nests from the previous 40-60. Through the following two years, numbers on Wharekakahu Island grew to 95 nests in 1981-82 and 120 in 1982-83. Stewart Island Shags take three years to attain adult plumage (Lalas 1983, Marchant & Higgins 1990), and so these increases must have come from immigration.

In addition to Stewart Island Shag breeding colonies, there are several roost sites continually occupied in Otago Conservancy. Numbers of shags using these roosts vary both seasonally and between sites, but all are in the range of 10-120 birds.

These roost sites are, north to south:
Shag Point, North Otago: offshore rocks.
Platform beacons, Otago Harbour: especially off Otakou.
Quarantine Island, Otago Harbour: slope adjacent shipping channel.
Lion Rock, Otago Peninsula: stack, Gull Rocks, off Sandfly Bay.
Nugget Point, South East Otago: offshore stacks.
Kinakina Island, South East Otago: offshore rock.

Lion Rock has been a breeding location in the past (Watt 1975 and Table 1. this report), and is likely to be re-occupied by breeders in the future.

Kinakina Island, South East Otago, deserves special mention because this is a likely breeding location if the breeding distribution of Stewart Island Shags in Otago Conservancy spreads southward. Approximately 120 birds were roosting there when the island was last checked in January 1986 by Greg Lind (DoC) and Lalas. Breeding could have been initiated since then, and so details of the island are given below.

Kinakina Island

Location:	North of Chaslands Mistake, 1 km off Waipati Beach
Land status:	Crown Land
Description:	sloping rock rising to 15m high; maximum dimensions 150 x 50m; area c.0.4 hectares.

If the breeding distribution of Stewart Island Shags spreads northward, then a likely location is on cliff-tops to the south of Bushy Beach at Cape Wanbrow (Oamaru).

4.2. Spotted Shag

Breeding colonies of Spotted Shags in Otago Conservancy are scattered along coastal cliffs and offshore stacks from Moeraki south to at least Chaslands Mistake. None nest between Otago Peninsula and Nugget Point, a strip of coastline that lacks suitable nesting habitat. Reliable population estimates are lacking not only because the whole coastline has not been investigated within one breeding season, but also because there are no figures at all for the strip between Chaslands Mistake and Waikawa Harbour, South East Otago.

Population estimates for Spotted Shags are based on counts over the last 15 years at four key locations that encompass the bulk of breeding in Otago Conservancy. (Large colonies are not expected south of Chaslands Mistake.)
These key locations are described below from north to south. For further details see Gales (1984).

Stony Creek (also known as Andersons Lagoon)
Location: 0.5km of coastline east of Palmerston, North Otago
Land status: unformed legal road.

Heyward Point (considered part of Otago Peninsula)
Location: 0.5km of coastline 3km north-east of Taiaroa Head
Land status: Scenic Reserve.

Tip of Otago Peninsula
Location: 4km of coastline extending from within Otago Harbour at Harington Point, around Taiaroa Head and south to Penguin Beach (Lalas 1984b)
Land status: various classifications of reserve, plus private land.

Nugget Point
Location: lkm of coastline, plus offshore stacks, around headland south of Clutha River, South East Otago
Land status: Scientific Reserve.

Nest numbers for Spotted Shags at the four key locations in Otago Conservancy are shown in Table 2. Chosen years presented are breeding seasons when practically all adults bred, ie. number of nests approximately equalled number of breeding pairs. Nest numbers have fluctuated wildly but not in the same proportions at each location. This highlights the likelihood of movement by breeders between locations. Redistribution of breeders not only is likely within conservatory boundaries, but also birds might move further afield (section 3.4. this report).

Population estimates for Spotted Shags in Otago Conservancy over recent years are shown in Table 3. Numbers perhaps doubled between the late 1970's and early 1980's, from about 1 000 to about 2 000 breeding pairs. The population size probably then remained stable until a collapse in 1986. The species probably is now showing a recovery, with a present estimate of 1 700 breeding pairs. Reliable estimates are unavailable for the late 1980's because many birds did not breed. For example, fewer than 30 birds nested at the tip of Otago Peninsula in the 1989-90 and 1990-91 breeding seasons.

4.3. Black Shag

Black Shags frequent coastal Otago only in small numbers, where they are a feature of coastal lagoons and inlets. They rarely feed at sea (Lalas 1983, Marchant & Higgins 1990). One curiosity is that Otago Harbour is avoided by Black Shags although they are regularly encountered on nearby coastal inlets. The maximum count for Otago Harbour is 10 birds in winter 1991 but, in general, even the presence of a single bird is exceptional. The total population of Black Shags along the coastline of Otago Conservancy is estimated to be 50-100 birds.

The only record for coastal breeding by Black Shags in Otago Conservancy is from Stony Creek, North Otago, along the coastal cliff-top within the Spotted Shag colony described in section 4.2. of this report. This site was occupied throughout the year by 8-15 Black Shags, with 4-6 nests annually, at the time of its discovery in 1978 (Lalas 1983, Gales 1984). Unfortunately, last breeding at this site occurred in 1983. Breeding presumably was terminated by human disturbance from researchers walking below the cliff while monitoring Spotted Shags.

4.4. Little Shag

Little Shags are common on all sheltered coastal waters in Otago Conservancy but their main concentration is at Otago Harbour. Breeding locations within Otago Harbour are occupied continually only for a number of years (Lalas 1991a). Shifts are common, with creation of new colonies and concomitant desertion of long-established colonies.
Records for 1992-93 breeding season in Otago Harbour are given below:

Quarantine Island: south end (used since 1984)	c.78 nests
Near Glenfalloch: macrocarpa tree (used since 1990)	c.32 nests
Taiaroa Head: Kopuni Point (used since c.1982)	c.8 nests
Otago Harbour total:	c.120 nests

Annual nest numbers for Little Shags within Otago Harbour are relatively stable and do not exhibit the long term changes shown by Stewart Island Shags and Spotted Shags. Records since 1977 have varied between 90 and 130 nests annually (Lalas 1983, 1991a).

Numbers of Little Shags within Otago Harbour vary seasonally. Two surveys taken 11 years apart (1977-78 and 1988-89) indicated that Little Shags are among the most numerous bird species inhabiting the harbour: numbers varied from summer minima of 160-180 birds to winter maxima of 740-870 birds (Hamel 1991). These figures should be regarded as minimum counts because the summer minima, coinciding with the breeding season, were less than double the number of nests. For example, a November 1990 census produced counts of c.90 nests and c.570 birds (Lalas 1991a).

Two other coastal colonies of Little Shags are known elsewhere in Otago Conservancy, both on offshore islands described in section 5.1. of this report: approximately 20 nests annually on Maukiekie Island and 10-20 nests annually on Green Island (Lalas 1983, 1984a). Curiously, coastal nesting by Little Shags has not been documented for South East Otago, even though birds are present in good numbers. The cause could be a lack of suitable nesting habitat (especially around Catlins Lake), or more simply a failure to discover colonies or uncover appropriate records.

5. State of monitoring – methods, continuity and recommendations

5.1. Stewart Island Shag

A census taken during the first half of November is sure to give an accurate count of the number of occupied nests in any year.

Stewart Island Shags breed in closely-packed nests on coastal plateaux, or on slopes, overlooking the sea. The sites of all known colonies preclude nest counts from land, even though nests might be easily accessible. This is because disturbance of nesting birds can be destructive. Shags incubate with their feet placed under their eggs: a sudden scare can result in eggs thrown out of nests as birds become airborne.

Appropriate census methods differ between the four main colonies in Otago Conservancy listed in Table 1. Colonies at Taiaroa Head and Green Island are on slopes and so nests can be counted accurately from photographs taken from a boat. Colonies at Maukiekie Island and Wharekakahu Island are on the top of rock stacks and so aerial photographs are needed for accurate nest counts.

Lalas has a discontinuous series of annual nest counts since 1977 for Stewart Island Shags at Taiaroa Head and Green Island. These annual counts are envisaged to continue in the future, primarily in association with other monitoring studies. In contrast, nest counts for Maukiekie Island and Wharekakahu Island have been sporadic because flights for aerial photography have been funded privately. The last census flight was in 1987, coinciding with the last time Lalas had spare money.

<u>Recommendation</u>
DoC could finance census flights for Stewart Island Shags in Otago Conservancy at three to five year intervals. Spanning the coastline between Moeraki and Dunedin airport, these flights could coincide with other monitoring projects eg. progress of revegetation of penguin breeding habitats.

5.2. Spotted Shag

The timing of the breeding season of Spotted Shags in Otago Conservancy varies both annually and geographically. Ideally, breeding is synchronised throughout the region and a census taken during the second half of November will give an accurate count of the number of occupied nests. In practice, the exact timing of breeding defies predication, and the most appropriate time for census can vary from early November to late January. An idea of timing in any year can be judged from occasional observations of Spotted Shags at Taiaroa Head. If breeding is asynchronised, timing shows a geographical progression with birds in North Otago up to one month earlier than those on Otago Peninsula which, in turn, are up to one month earlier than those in South East Otago.

Annual nest numbers of Spotted Shags can fluctuate wildly. Not only do many adults not breed in some years, but also they can change breeding locations. Non-breeders tend to disperse far afield (section 3.4. this report) and are almost impossible to monitor. Consequently, the population can be surveyed accurately only when numbers are rising or stable.

Spotted Shags generally nest on cliffs and so a boat is a prerequisite for breeding surveys. The only notable exception is the key location at Stony Creek, where cliffs rise behind a sandy beach accessible by foot at low tide.

Lalas has a discontinuous series of annual nest counts since the late 1970's for Spotted Shags at Stony Creek, Heyward Point and Nugget Point and sporadic records for elsewhere in North Otago and Otago Peninsula. Logistics have been privately funded and are unlikely to continue without financial support. An attempt was made to survey the coastline of South East Otago in the 1992-93 breeding season from the DoC inflatable based at Owaka (skipper Brian Murphy DoC, with Chris Lalas and Hiltrun Ratz). About two-thirds of the coast was surveyed before the exercise was abandoned through bad weather, and 440 Spotted Shags nest were counted, estimated as 85% of the total of the region. Other seabirds were surveyed at the same time.

Recommendations

Synchronised nest counts for Spotted Shags are a necessity, not only within Otago Conservancy but also within the adjacent Canterbury and Southland Conservancies. All Spotted Shags in Otago Conservancy could be surveyed if DoC financed logistics for Lalas to cover North Otago and Otago Peninsula, and the DoC Owaka inflatable was used in South East Otago.

5.3. Little Shag

A census taken during December generally will give an accurate count of the number of occupied nests in any year. For most colonies, a count from a boat is most appropriate. At Green Island, however, nest are visible only from above and can be counted form the island's summit.

Most Little Shags are very timid in comparison to other seabirds. They usually fly off if approached closer than about 50 metres. Breeders circle overhead and return immediately to their nests once human disturbance has ceased. Consequently, rapid surveys are imperative.

Lalas has a discontinuous series of annual nest counts since the late 1970's for Little Shags in Otago Harbour and at Green Island. These annual counts are envisaged to continue in the future. The colony at Maukiekie Island is rarely surveyed.

6. Recommendations on research needs

6.1. Spotted Shags as monitors of marine perturbations

Spotted Shags nest on inaccessible cliffs and so their breeding has been unaffected by human-induced alterations to the terrestrial environment. Monitoring of nest numbers and breeding success is relatively easy because they breed in large aggregations and are not prone to researcher disturbance. Spotted Shags have a restricted diet, primarily short-lived pelagic fish, that can be studied unobtrusively from the contents of regurgitated pellets (Lalas 1983).

Spotted Shags are an ideal indicator species for the long-term monitoring of the impact of marine perturbations on seabirds. Nest numbers and breeding success respectively reflect the distal and proximal availability of prey whose abundance, in turn, reflects marine perturbations.

6.2. Little Shags as indicators of the health of Otago Harbour

Little Shags forage in water up to five metres deep where they dive to the bottom to chase small fish, mainly triplefins (Lalas 1983). The shallow nature of Otago Harbour is an ideal foraging habitat. The most numerous piscivores in Otago Harbour, over 500 Little Shags are resident throughout the year (Lalas 1991a). Their foraging should be evenly distributed throughout appropriate water depths.

Knowledge of the distribution of foraging Little Shags would offer a very powerful indicator of the health of Otago Harbour. Anomalous areas would be highlighted. The study would determine the carrying capacity for Little Shags in Otago Harbour and create a benchmark for future comparisons. Results emphasising the lack of competition with fishers would help alter the public perception of shags as vermin.

6.3. Population dynamics of Stewart Island Shags

Little is known of the population dynamics of Stewart Island Shags. However, the Richdale Observatory at present offers unobtrusive viewing of the colony at Taiaroa Head and the perfect opportunity to monitor breeding success. Stewart Island Shags are sedentary throughout life, and their first-year juvenile and second-year immature plumages are distinctive (Lalas 1983). Consequently, estimates can be deduced for age-related survival rates.

Stewart Island Shags are the most numerous and widespread representatives at the six species of *Leucocarbo* from the New Zealand mainland and subantarctic islands (Marchant & Higgins 1990). Knowledge of their population dynamics might help explain the small total population size of their related species. This insight would assist conservation management strategies should they become necessary. The extreme example is King Shags that total only 300 birds (Marchant & Higgins 1990).

6.4. Kills in set nets

Bird kills in set nets have become a controversial issue in New Zealand. Professional fishers generally deploy set nets in depths too great to catch shags in Otago waters. Professional fishing is prohibited within Otago Harbour. However, New Zealand is one of the few industrialised countries in the world that permits recreational fishing with set nets. An assessment of bird kills in set nets in Otago Harbour has been presented by Lalas (1991b). Here practically all birds killed are shags. Although all three species that forage in Otago Harbour are represented in kills, the impact on local Little Shag and Stewart Island Shag populations appears insignificant. Set nets potentially only threaten the viability of the local Spotted Shag population. This threat would be minimised by the adoption of a code of conduct by set netters.

An accurate count of the number of set nets is a prerequisite to accurately determine the number of bird kills. However, recreational fishers are neither licensed nor do they feel obliged to record bird kills. At present the only reliable method of determine the number of set nets in an area is to mount an independent survey. This laborious task would need to be spread through the year in order to deduce seasonal trends.

6.5. Taxonomy of Spotted Shags and Stewart Island Shags

Taxonomic identities are confused for Spotted Shags and Stewart Island Shags in Otago Conservancy (section 3. this report). From plumages, the Spotted Shags nominally are a mix of the two subspecies, *S. p. punctatus* and *S. p. steadi*. Stewart Island Shags are recognised as a monotypic species. However, they probably are geographically isolated into two populations. Birds in Otago Conservancy differ in size and plumage from those in Southland Conservancy and arguably more closely resemble New Zealand King Shags, nominally a different species.

Accurate taxonomic identities of animals can have important implications in conservation management. A study of blood proteins and of pre-nuptial and nuptial plumages of Spotted Shags around South Island will help determine if Otago Conservancy holds closed or open populations. A comparable study of *Leucocarbo* shags will deduce the taxonomic status of Stewart Island Shags.

6.6. Monitoring of human disturbance

While breeding, the various shag species differ in their tolerance to human disturbance. Black Shags are the most vulnerable and disturbance can result in disruption of nesting and possibly desertion of breeding colonies (section 4.3. this report). Little Shags also are easily disturbed, but breeders quickly return and breeding is not disrupted (section 5.3. this report). Stewart Island Shags vary in their reaction to the approach of humans but breeders are prone to unpredictable, simultaneous lift-off (section 5.1. this report). In particular Stewart Island Shags are prone to disturbance by loud noises, eg. outboard engines, and so care is needed when approaching colonies from water. In comparison with the other species, Spotted Shags are not prone to unintentional disturbance.

Everyone involved in monitoring, research or eco tourism along the coast should be aware of the possible impact of unintentional human disturbance of breeding shags. The most vulnerable location is the large breeding colony of Little Shags at the south end of Quarantine Island in Otago Harbour. Nests not only are within 100m of the St Martin Island Community residences, but they also border the boating channel around the island.

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