Southern right whale
(*Eubalaena australis*)

5-Year Review:
Summary and Evaluation

Photo Credit: Anthony Davidson (University of Otago)

National Marine Fisheries Service
Office of Protected Resources
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5-YEAR REVIEW
Southern right whale (*Eubalaena australis*)

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1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional or Headquarters Office: Heather Austin, Office of Protected Resources, 301-427-8422

1.2 Methodology used to complete review

A 5-year review is a periodic analysis of a species' status conducted to ensure that the listing classification of a species currently listed as threatened or endangered on the List of Endangered and Threatened Wildlife and Plants (List) (50 CFR 17.11 – 17.12) is accurate. The 5-year review is required by section 4(c)(2) of the Endangered Species Act of 1973, as amended (ESA) and was prepared pursuant to the joint National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service's 5-year Review Guidance and Template (NMFS and USFWS 2018). The NMFS Office of Protected Resources (OPR) conducted the 5-year review. Information was updated from the 5-year review completed in 2015, based on peer-reviewed publications, government and technical reports, conference papers, workshop reports, dissertations and theses. We gathered information through September 2020. The information on the southern right whale biology and habitat, threats, and conservation efforts were summarized and analyzed in light of the ESA section 4(a)(1) factors (see Section 2.3.2) to determine whether a reclassification or delisting may be warranted (see Section 3.0).

NMFS initiated a 5-year review of the southern right whale and solicited information from the public on August 14, 2020 (85 FR 49640). Two public comments were received and incorporated as appropriate in this review.

1.3 Background

1.3.1 FR Notice citation announcing initiation of this review

85 FR 49640, August 14, 2020

1.3.2 Listing History

Original Listing
FR notice: 35 FR 18319
Date listed: 12/02/1970
Entity listed: *Eubalaena spp.*
Classification: Endangered

In 1970, the U.S. Fish and Wildlife Service listed all members of the genus *Eubalaena* on the List of Endangered Foreign Fish and Wildlife under the Endangered Species and Conservation Act (ESCA) of 1969. In 1974, following the passage of the ESA, all

members of the genus *Eubalaena* were transferred to the List of Endangered and Threatened Wildlife under the ESA.

1.3.3 Associated rulemakings

None

1.3.4 Review History

S.L. Perry, D.P. DeMaster, and G.K. Silber. 1999. The Great Whales: History and Status of Six Species Listed as Endangered Under the U.S. Endangered Species Act of 1973. Marine Fisheries Review 61:1, pp.44-51. Department of Commerce.

Conclusion: No change in classification indicated.

NMFS. 2007. Southern right whale (*Eubalaena australis*) 5-year review: summary and evaluation. Office of Protected Resources Silver Spring, MD. 43 pages.

Conclusion: No change in classification indicated.

NMFS. 2015. Southern right whale (*Eubalaena australis*) 5-year review: summary and evaluation. Office of Protected Resources Silver Spring, MD. 53 pages.

Conclusion: Recommended downlisting from endangered to threatened.

1.3.5 Species' Recovery Priority Number at start of 5-year review

No recovery priority number has been issued for the southern right whale.

1.3.6 Recovery Plan or Outline

No recovery plan has been completed for the southern right whale. Section 4(f) of the ESA requires NOAA Fisheries to develop and implement recovery plans for conservation and survival of all endangered or threatened species, unless such a plan will not promote the conservation of the species. In general, listed species which occur entirely outside U.S. jurisdiction – such as the southern right whale – are not likely to benefit from recovery plans (55 FR 24296; June 15, 1990).

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy[1]

[1] To be considered for listing under the ESA, a group of organisms must constitute a "species," which is defined in section 3 of the ESA to include "any subspecies of fish or wildlife or plants, and any distinct population segment [DPS] of any species of vertebrate fish or wildlife which interbreeds when mature". NMFS and USFWS jointly published a policy regarding the recognition of DPSs of vertebrate species under the Endangered Species Act (61 FR 4722, February 7, 1996). "DPS" is not a scientifically defined term; it is a term used in the context of ESA law and policy. Furthermore, when passing the provisions of the ESA that give us authority to list DPSs, Congress indicated that this provision should be used sparingly. We have discretion with regard to listing DPSs and, in order to be consistent with the directive of the Congressional report that followed the introduction of the DPS language in the ESA to identify DPSs sparingly. We will generally not, on our own accord, evaluate listings below the taxonomic species

2.1.1 Is the species under review a vertebrate?

__X_**Yes**
_____**No**

2.1.2 Is the species under review listed as a DPS?

_____**Yes**
___X__**No**

2.1.3 Is there relevant new information for this species regarding the application of the DPS Policy?

_ X _**Yes**
____ **No**

The 2007 5-year review reported that sufficient new scientific information had been published indicating that there may be DPSs of the southern right whale (NMFS, 2007). Information from the 2007 5-year review suggested that there may be four DPSs: western South Atlantic, eastern South Atlantic, Australia, and New Zealand. The 2007 finding was based largely on Patenaude et al. (2007), which found two maternal clades that differ in frequency between oceans with significant mitochondrial deoxyribonucleic acid (mtDNA) differentiation between the four calving grounds (Argentina, South Africa, Western Australia and New Zealand) and two summer feeding grounds (South Georgia and south of Western Australia) (Patenaude et al., 2007). However since the 2007 5-year review, information presented in the 2015 5-year review indicated that southern right whales from different ocean basins may be mixing on feeding grounds in the Antarctic (NMFS, 2015). Additionally, the 2015 5-year review stated that no genetic differentiation was found between Argentina and both feeding grounds (South Georgia and southwestern Australia), which may reflect a recent increase in gene flow between populations across ocean basins (NMFS, 2015). Furthermore, information from the 2015 5-year review based on nuclear DNA and photo identification indicate breeding between Australia and New Zealand (NMFS, 2015).

Although overall limited gene flow between populations in the oceans and in most of the calving grounds occurs through maternal site fidelity (Carroll et al., 2020; Carroll et al., 2019; Harcourt et al., 2019; Jackson et al., 2016), consideration of mtDNA haplotype frequencies is only one line of evidence in determining whether a population is discrete. Other lines of evidence provided in this 5-year review which may indicate genetic differentiation amidst southern right whale subpopulations, include nuclear DNA differentiation, mitochondrial and microsatellite DNA haplotype frequencies, physical or behavioral characteristics, habitat use, and migratory patterns. Even if southern right whale populations were found to fit the DPS criteria, for purposes of this 5-year review, we conclude it is unlikely that designation of DPSs would result

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or subspecies level if the best available information indicates that the species or subspecies is in danger of extinction throughout all or a significant portion of its range. We should only identify DPSs if there is an overriding conservation benefit to the species.

in an overriding conservation benefit, because the species occurs solely outside of U.S. jurisdiction, and the benefits from the global ESA listing would not change with a DPS listing.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan[2] containing objective, measurable criteria?

_____***Yes***
__*X*__***No***

Section 4(f) of the ESA requires NOAA Fisheries to develop and implement recovery plans for the conservation and survival of endangered or threatened species, unless such a plan will not promote the conservation of the species. In general, listed species which occur entirely outside U.S. jurisdiction – such as the southern right whale – are not likely to benefit from recovery plans (April 30, 2019; 84 FR 18243 and 55 FR 24296; June 15, 1990).

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

In this section, we present new information since the last 5-year review was completed in 2015.

Southern right whales were hunted extensively by pre-modern whaling beginning in the early 17th century, and in the 18th and 19th centuries by American and European whalers (Cooke et al., 2018). Prior to whaling, it is estimated that approximately 120,000 southern right whales were found in 12 wintering grounds (Figure 1; Harcourt et al., 2019). However, between 1790 and 1971 up to 150,000 southern right whales were killed, reducing them to near extinction globally (Carroll et al., 2019; Charlton, 2017; Harcourt et al., 2019; J. Jackson et al., 2008). There is some uncertainty over the numbers of southern right whale individuals killed but not landed, since not all whaling records have survived. The total number processed between 1770 and 1900 is conservatively estimated to be approximately 150,000 (of which 48,000 – 60,000 were taken in the 1830s alone) (Charlton, 2017; Cooke et al., 2018). Thus, by the start of modern whaling at the beginning of the 20th century, the species was already rare, and subsequent catches (until right whales were legally protected in 1935) totaled at approximately 1,000. Over 3,000 were taken illegally by Soviet whaling fleets predominantly in the 1960s. However, the species began to recover following protection in 1935, but illegal Soviet catches in the 1960s are estimated to have removed over half of the remaining population and slowed the species' recovery for several years (Charlton, 2017; Cooke et al., 2018). In 2009, there were around 14,000 individuals.

[2] Although the guidance generally directs the reviewer to consider criteria from final approved recovery plans, criteria in published draft recovery plans may be considered at the reviewer's discretion.

Populations off of Argentina/Brazil, South Africa and Australia are recovering strongly at 7-8% per year. However, other populations (e.g. the Chile-Peru population) remains small (International Whaling Commission, 2018a).

Survival

Since the 2015 5-year review, demographic data have been published by Jackson et al. (2016) in New Zealand which uses a Bayesian population dynamics model integrating multiple data sources for their assessment: nineteenth century catches, genetic constraints on bottleneck size, and individual sightings histories informing abundance and trend. Annual survival rate of males in New Zealand waters (a combination of survival and fidelity) was estimated to be 0.84 using the POPAN open population model and recapture data from field surveys from 1995-2009; while annual female survival rate was approximately 1.00 (Jackson et al., 2016).

The International Whaling Commission (IWC) SC/67a/SH08 reported calving rate estimates for the New Zealand southern right whale population from the Auckland Islands at 3.31 years (95% CI 3.06-3.57) and juveniles and adult survival at 0.98 (SE 0.07) (International Whaling Commission, 2018b).

Annual survival of non-calf southern right whales (i.e. juveniles and adults) in New Zealand waters has been estimated at 0.980 (SE 0.070) (Davidson, 2016). This estimate was derived using photo-ID capture-recapture data gathered in the Aukland Islands from 2006-2011. However, another study indicates an annual survival for juveniles ranges between 0.87 (SE 0.17, to age 1) and 0.95 (SE 0.05: ages 2–8) (Carroll et al., 2016).

In South African waters, the IWC SC/67b/SH22 measured first year survival of southern right whales at 0.852, with subsequent annual survival of 0.988 (International Whaling Commission, 2018b). Calf survival in the South African population was reported as 0.914 (SE 0.05) (Brandao et al., 2012). Additionally, the calf mortality rate shows substantial variation over time around a median level of ~18%, with no overall upward or downward trend (Cooke et al., 2015).

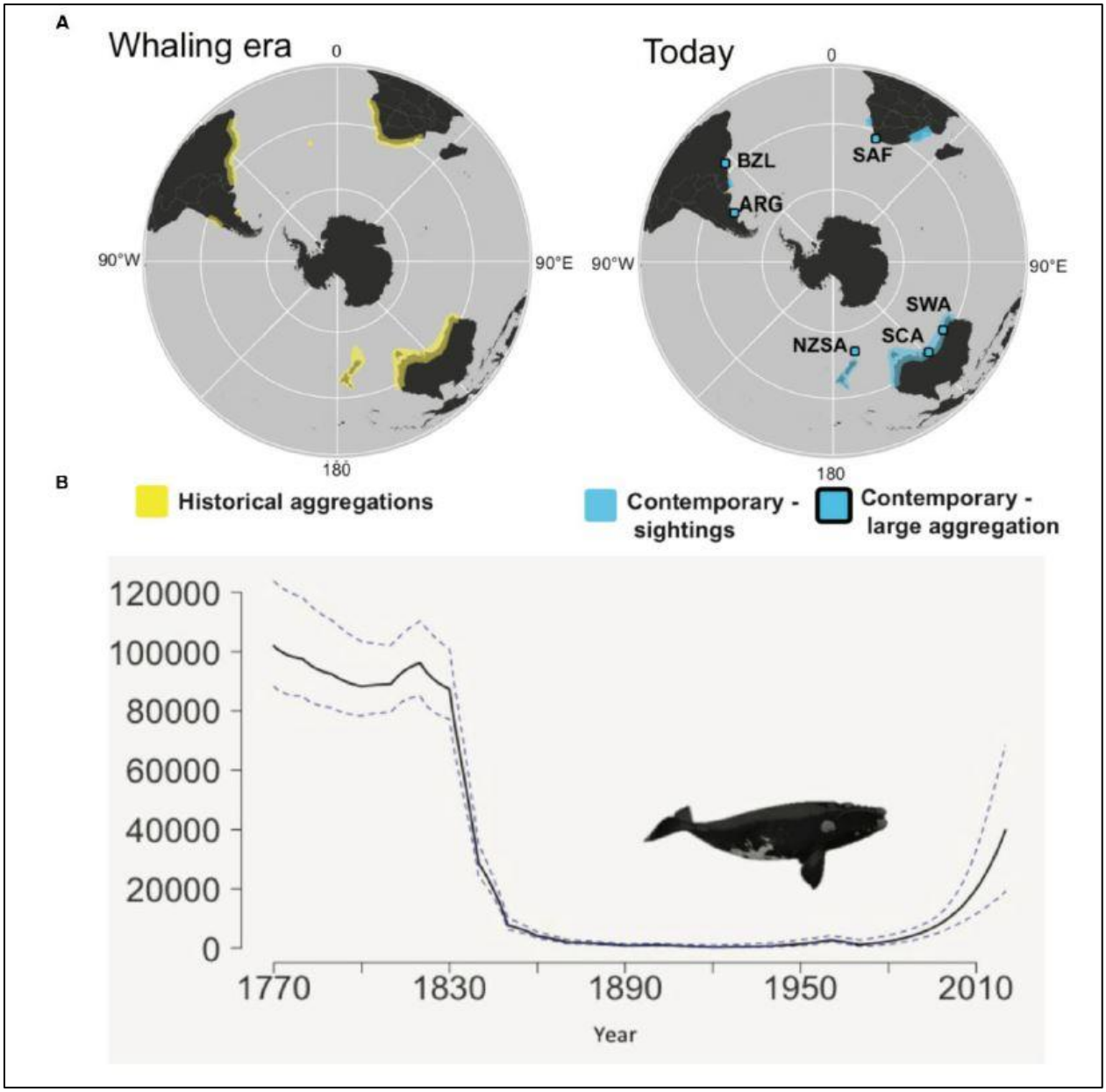

Figure 1. Change in distribution and abundance of southern right whales. **(A)** Shows historical and contemporary wintering distributions (Figure 1 from Carroll et al., 2018), and **(B)** shows decline in abundance and subsequent recovery (solid line is the mean, dashed line shows upper and lower 95% Cl). Modified Figure 1 from Jackson et al. (2008). Contemporary sightings are divided into regions where large aggregations are seen during winter: Argentina (ARG), Brazil (BZL), South Africa (SAF), southwest Australia (SWA), south central Australia (SCA), and New Zealand sub-Antarctic (NZSA) and regions where sightings are typically of small numbers of individuals per year. The large aggregations are IWC management units and correspond to historical whaling grounds, although another 5 whaling grounds show little sign of recovery. Summer feeding areas are poorly described and so not shown (*source:* Harcourt et al., 2019).

In Argentina, calf mortality continues to be high and increasing (Cooke et al., 2015). Cooke et al. (2015) reported a calf mortality of 0.810 (SE 0.027) and non-calf mortality of 0.974 (SE 0.003) (Cooke et al., 2015). During the last decade, southern right whale calves began dying in large numbers on their nursery ground at Peninsula Valdes (564 calf deaths in 2005-2013) (International Whaling Commission, 2016). Normally, adult females give birth once every three years. Two, four and five-year calving intervals are interpreted as evidence of calving failure (International Whaling Commission, 2016). An IWC workshop noted that the increase in calf mortality has been abrupt and that the increase in calf mortalities (and the estimated decrease in population growth rate) at Peninsula Valdes, Argentina have not been recorded in any other southern right whale population, and that the level of mortality may be anomalously high. However, a long-term analysis of calf mortality rates in this population showed that the rate has remained fairly low over most of the last 40 years, averaging around 18% with some inter-annual fluctuation, with recent levels not being unusually high (Cooke et al., 2015). It was also noted that the Peninsula Valdes, Argentina population continues to increase (although the rate of increase is lower), and the increase in calf mortality could be directly related to the increase in population size and hence that density-dependence factors are already affecting southern right whales of Peninsula Valdes (International Whaling Commission, 2016). See section 2.3.1.2 for further details.

Sex Ratios

Davidson et al. (2016) reports that the South African population is the only reported population of southern right whales to show evidence of a skewed sex ratio (Brandao et al., 2012; Davidson, 2016). Additionally, Davidson et al. (2016) noted that biopsy data from previous studies conclude that an alternative to a 50:50 sex ratio would be a female-biased sex ratio of 54:46 for the South African population. Brandao et al. (2012) incorporated this into South African population models to estimate growth rate and population size.

Reproduction

Southern right whales calve in sub-tropical shallow coastal waters during the winter. Important reproduction and breeding areas include coastal waters off southern Australia, New Zealand, Argentina, Brazil and South Africa. Calves are born from June to October with a peak in August after a 12-13 month gestation period (Cooke et al., 2018). Females usually produce calves at 3-year intervals when these are successfully reared, but the interval can shorten to 2 years following perinatal loss of a calf, which often results in an apparent 5-year interval (Cooke et al., 2018). Estimates of mean calving intervals have been generated for southern right whales, ranging from 3.16 years (95% CI 3.13 – 3.19) for the South African population to 3.64 years (95% CI 2.88 – 3.38) for the western Australian

population (Davidson et al., 2018). Current environmental and human pressures may contribute to observed regional differences in calving intervals.

Recently, Davidson et al. (2018) produced the first estimate of an observed calving interval of 3.31 years (95% CI = 3.06 – 3.57) for southern right whales in New Zealand, which is similar to that found in other southern right whale populations. This estimate was derived from 45 observed calving intervals between 2006 and 2013 (Davidson et al., 2018). The cost of reproduction was quantified for southern right whales over a 3 month breeding season (Christiansen et al., 2018). 1,118 body volume estimates were recorded from 40 female and calf pairs over 40 to 89 days; calf growth rate was positively correlated to rate of loss in maternal body volume, suggesting that maternal volume loss is proportional to energy investment into the calf (Christiansen et al., 2018). Additionally, it was noted that longer and more rotund females invested more volume into their calves compared to shorter and leaner females, which highlights the importance of sufficient maternal energy reserves for reproduction in this species (Christiansen et al., 2018). Additionally, it was reported that breeding females seek sheltered, near-shore waters during the early life-stages of their calves and are more selective of these habitats than non-calving southern right whales, indicating that sheltered habitat is very important for vulnerable life-history stages for this species (Rayment et al., 2014). Southern right whales show a form of migratory culture, with females transmitting preferences for both winter calving/breeding areas and summer foraging areas to their calves during the first year of life (Carroll et al., 2016).

Off the coast of South Africa, non-offspring nursing was recorded in southern right whales (Best et al., 2015). This type of nursing is generally rare for a monotocous species, and the costs to the female are potentially high, such as the southern right whale, which is a seasonally feeding mysticete, where costs of lactation cannot be recovered until the female resumes feeding about 4 months after parturition (Best et al., 2015). This was the first recorded observation of this type of nursing behavior for this species.

In recent years, the population of southern right whales off Peninsula Valdes, Argentina saw unusually high calf mortality beginning in 2003, with mortality peaking in 2012 with 113 dead calves (estimated age of dead calves ranged from 1 day to 4-6 months) (M. Sironi et al., 2019). A recent study reported the first observation (with photographic and video documentation of an unsuccessful parturition of a southern right whale calf in the coastal waters off Peninsula Valdes, Argentina) (M. Sironi et al., 2019). Greater numbers of dead calves and a correspondingly greater number of documented two-year intervals have also been observed in this

area (Cooke et al., 2018; Sironi et al., 2016). However, causes for this high mortality are unknown and there is a concern that it is affecting population growth rates (Maron. et al., 2015). Data from annual aerial photographic surveys of the Peninsula Valdes population was used to determine the frequencies of directly observed two-, three-, four-, and five-year calving intervals that began with calving in 1971-2009 (Maron. et al., 2015). Two-year intervals constituted 3% of the total in years of relatively low calf mortality (1971-2002, 2004 and 2006), but 22% in years of high calf mortality (2003, 2005 and 2007-2009) (Maron. et al., 2015).

Behavior

Behavioral observations have been limited to calving grounds since the locations of feeding grounds are largely unknown or not frequently visited by researchers (NMFS, 2015). Data on courtship behavior for southern right whales is limited due to the difficulties in determining the sex of individual whales. Studies off South Africa by Best et al. (2003) suggest that southern right whales are most socially active during the winter in coastal waters where they engage in courtship behavior. Southern right whales were observed in surface-active groups composed of two to seven individuals where the majority of whales were male but the focal animal was female. This behavior may reflect a female breeding strategy in order to maximize a female's chances of conceiving with a large male (Best et al., 1993). In addition, non-reproductive sexual behavior has been recorded in southern right whales off the coast of Peninsula Valdes, Argentina based on observations from shore (D'Agostino et al., 2017). Furthermore, sexual harassment by an adult male on a southern right whale calf was reported in calving and mating grounds near Peninsula Valdes, Argentina (D'Agostino et al., 2017).

The behavioral development of southern right whale calves and mother-calf relationships has also been studied in nursery grounds in Argentina. In general, these studies indicate that calf development and mother-calf relationships occur in five distinct stages over the course of up to 13 months (NMFS, 2015). Stages one through three occur during the first four months, when mothers and their newborn calves remain in the nursery ground. Stage four begins when mother-calf pairs migrate to feeding grounds for the summer. Little is known about their behavior during this time. Finally, in stage five, which begins six months after leaving the nursing ground, some mothers and their nursing calves return to the nursery and remain together for two to six weeks before finally separating (NMFS, 2015). Recently, in a breeding ground off of South Australia, Nielsen et al. (2019) conducted behavioral focal follows of 51 mother-calf pairs over the breeding season, using unmanned aerial vehicles (UAVs). Observations from this study showed that the proportion of time calves spent in the nursing position and the duration of potential nursing bouts increased with increasing calf size, suggesting that calves

seek to maximize energy acquisition (Nielsen et al., 2019). This highlights the importance of the mothers' ability to maintain low energy expenditure to ensure sufficient energy is available for their calves during the nursing season (Nielsen et al., 2019).

Movements of mother-calf pairs between Argentina and Brazil has been recorded. Mother-calf pairs exhibited northbound movements from Argentina to Santa Catarina State, Brazil more frequently than unaccompanied whales (Danilewicz et al., 2017). Comparing these data with those from Uruguay and Santa Catarina State, Brazil showed that southern right whales of different gender and reproductive status may use the eastern coast of South America. Within these regions, the proportion of mother-calf pairs increased substantially as latitude decreased (from 8% in Uruguay to 58.5% in Santa Catarina State, Brazil), while the proportion of unaccompanied whales exhibited the opposite trend (Danilewicz et al., 2017).

Southern right whale sounds and their role in communication have been fully described by Clark (1983) and are categorized into three general classes (blow, slaps, and calls). Calls are generally low frequency (peak frequencies < 500 Hertz (Hz)) and one common call—'Up'—has been described to function as a way for individuals to find and make contact with each other (NMFS, 2015). These 'Up' calls were of shorter duration in the southern right whale than those of the North Atlantic right whale and longer than those calls in the North Pacific right whale, which is not surprising given they are different species and reproductively isolated (NMFS, 2015). Recently, vocal behavior of southern right whale mother-calf pairs has been documented in a calving area off Brazil. Manual inspection of spectrograms revealed seven call classes: upcall, downcall, down-upcall, tonal variable, tonal constant, hybrid, and pulsive calls, which are consistent with those previously described for southern right whales in Argentina (Dombroski et al., 2016). Upcalls (but not gunshots) have also been described from southern right whales on feeding grounds (Dombroski et al., 2017). However, mean duration of upcalls from Brazil were significantly different from upcalls from other southern right whale populations, which could be driven by differences in demographic factors or background noise features among study areas (Dombroski et al., 2016). More recently, quiet sounds (grunt, single, and double pulse calls) were detected for the first time in southern right whales in a calving area off Brazil, with social interaction increasing call-type diversity and call rates (Dombroski et al., 2020).

Calls recorded off the coast of New Zealand, as part of a year-round monitoring study of southern right whale presence, noted that upcalls were the most common (Webster et al., 2019). Additionally, vocal behavior varied diurnally with the highest call rates detected at dusk and night,

consistent with the concept that upcalls function mainly as contact calls (Webster et al., 2019).

Acoustic crypsis has recently been documented as a means to avoid predation of southern right whale calves by killer whales (*Orcinus orca*). This was recently studied and documented in a breeding ground off Western Australia, where researchers deployed multi-sensor DTAGs on nine lactating whales, and used a SoundTrap to estimate the natural background noise (Nielsen. et al., 2019). Vocalizations were recorded at low rates and low levels, thus proving that acoustic crypsis in southern right whales decreases the risk of alerting potential predators (Nielsen. et al., 2019).

Movement

Like other baleen whales, studies of movements, migration patterns, and destinations of southern right whales indicate seasonal migrations, and can cover thousands of kilometers. Movements of individuals between subantarctic waters in the summer and winter calving grounds have been recorded using photo-identification and satellite tracking (NMFS, 2015; Zerbini et al., 2018). Short and long range movements for southern right whales have been recorded. Short range movements between Argentina and Uruguay have been documented (Zerbini et al., 2018). Movement patterns in this region in October 2016 and September 2017 showed marked individual variation, with five satellite tagged individuals moving southwards towards Golfo San Jose and Golfo Nuevo off the coast of Peninsula Valdes, Argentina, while the other four whales moved north along the coast of the Buenos Aires Province in Argentina and of Uruguay (Zerbini et al., 2018). All whales eventually moved east towards offshore waters along the coast of Argentina and then migrated east/southeast later in the season (after January), with one individual migrating east past 22°W longitude (Zerbini et al., 2018).

Long range movements for the southern right whale have been recorded between Gough Island and South Africa, and between Argentina and Tristan da Cunha, Brazil and South Georgia (Best et al., 1993). Migrations range from 210-2,287 km and average 1,036 km (Burnell, 2001), but individual whales have been documented traveling as far as 4,424 km to 8,200 km (Bannister et al., 1999; Best et al., 1993; Mate et al., 2011). For example, southern right whales satellite-tagged off South African waters traveled 3,800–8,200 km over 53–110 days before transmissions ceased (NMFS, 2015). Southern right whales feeding in the Antarctic were found to have made long-distance migrations from the Indo-Atlantic and Indo-Pacific basins (Kanda et al., 2014).

Along the southeastern coast of Brazil, possible interaction of a southern right whale calf with humpback whales was reported by Iwasa-Arai et al. (2017). Southern right whales are known to host three species of whale-

lice, *Cyamus gracilis*, *Cyamus ovalis* and *Cyamus erraticus*. These cyamids have no free-swimming stage, so transmission can only occur via direct contact between whales (Iwasa-Arai et al., 2017). However, Iwasa-Arai et al. (2017) found one southern right whale stranded along the Brazilian coast was parasitized by a totally different species of cyamid – *Cyamus boopis*, which is a typical ectoparasite of humpback whales (*Megaptera novaeangliae*). This is the first record of *C. boopis* in the southern right whale (Iwasa-Arai et al., 2017). Since both southern right whales and humpback whales are found in Brazilian waters and the presence of humpback's whale-louse together with the lack of the three specific parasites of southern right whales suggest an interspecific interaction between these whales based on the parasite's biology. Additionally, the authors suggest that since the transmission of cyamids from humpback whales to southern right whales could be related to the population expansion of humpback whales in the southwestern Atlantic Ocean and of southern right whales recovering from exploitation, which increases the chance of an encounter between these two baleen species (Iwasa-Arai et al., 2017).

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Worldwide

According to the most recent estimate, the southern right whale is estimated to have recovered to 12,000 – 15,000 individuals across its circumpolar distribution in the Southern Hemisphere, and this population has been increasing across its range (Figure 1) (Cooke et al., 2018; Harcourt et al., 2019). In recent years, there has been evidence of several breeding populations (Brazil, South Africa, and Australia) of southern right whales that have shown evidence of strong recovery, with a doubling time of 10-12 years; however other breeding populations are still very small, and data are insufficient to determine whether they are recovering (Falabella, Campagna, Bordino, Capella, Crespo, Franco-Trecu, Hevia, Sepulveda Martiznez, et al., 2019). In addition, a levelling-off of increase rates in the western South Atlantic and western Australia has been observed (J. L. Bannister et al., 2016; Cooke et al., 2018). However, the southeast Atlantic population (i.e. South Africa and Namibia) appears to have declined sharply since 2015 for unknown reasons (K. Findlay et al., 2017). Overall, while strong population growth rates have been observed for most populations, there has been evidence for a levelling-off in the population growth rates for some of the major areas, with lower counts since 2015 (i.e. western South Atlantic and western Australia) (Cooke et al., 2018). Furthermore, major die offs of calves at the Argentinean wintering ground may reduce population growth in the future, however the

drivers of these events remain as yet unknown. Thus, given the estimated total population size of 15,000, and the 5-10 fold increase in the population since the 1970s, the population size is estimated to be larger now than it was three generations ago (87 years, assuming a generation time of 29 years), this species is not considered under threat across its range as a whole (Cooke et al., 2018).

In 2018, a separate Red List assessment noted that the "southern right whale Chile-Peru subpopulation" had fewer than 50 mature individuals, and subsequently listed this population as "Critically Endangered" (Cooke 2018).

Estimates for worldwide abundance and population trends are based on information for different breeding stocks. The status of southern right whales by known breeding populations is provided below.

South Africa

In 2006, southern right whale abundance for the South African population was estimated to be 4,100 and increasing approximately 6-7% each year (Brandao et al., 2012; NMFS, 2015). The population in Saldanha Bay on the west coast of South Africa appears to be increasing at almost double the total population rate, indicating the increased incidence of southern right whales on the west coast is not only a result of overall population growth, but also reflects local and seasonal movement patterns (NMFS 2015). Based on cumulative catch estimates from 1785-1805, the 2006 population estimate likely represents about 20% of historical abundance (NMFS, 2015). However, a recent decline was noted in southern right whales off South Africa, evident in single animals since 2010 and cow-calf pairs since 2015 (K. Findlay et al., 2017). A 2016 survey conducted by Findlay et al. (2017) reported an extremely low abundance of southern right whales off the coast of South Africa; with marked declines of both the cow-calf and unaccompanied adult groups recorded in recent years (K. Findlay et al., 2017). Overall, a total of 54 groups of 55 cow-calf pairs of southern right whales (110 animals) and 8 groups of nine unaccompanied adult southern right whales were encountered during the survey.

Additionally, unaccompanied adult encounters have been declining off the coast of South Africa since 2009 and cow-calf encounters have been declining since 2015 (K. Findlay et al., 2017). A subsequent analysis of seasonal presence patterns does not suggest that there has been a shift in coastal longshore distribution, since sightings have been reduced at all locations along the South African coast. It suggests that southern right whales have remained offshore and not returned to the coast to calve in 2015 and 2016 (K. Findlay et al., 2017; International Whaling Commission, 2018b). This trend was also noted by Roux et al. (2015), where aerial surveys of the Namibian coastline from 1978 onwards

revealed increasing numbers of right whales, but few cow-calf pairs since 2009 (Roux et al., 2015).

Argentina

Southern right whales occur in waters off Argentina, and are found throughout the Patagonian Sea, centered primarily in the Península Valdes region (NMFS, 2015). The estimated total number of individuals in the Peninsula Valdes ranges from 3,300-4,000, with approximately 2,000 individuals visiting the area each year (Falabella, Campagna, Bordino, Capella, Crespo, Franco-Trecu, Hevia, Sepulveda Martiznez, et al., 2019). The population growth rate in the Peninsula Valdes area was 7-8% until 2007, however after 2007 the rate of population increase in the area has decreased, with the latest estimation being 0.54% (Romero et al., 2018). Additionally, in Peninsula Valdes there was an increase from 240 calves (1998) to 500 calves (2015) that were observed over the last 17 years and in San Matias there was an increase from 0 calves (1998) to 60 calves (2015) observed over the last 5 years. The analysis of the available information shows that the southern right whale population is increasing in the nursing area around Peninsula Valdes (Falabella, Campagna, Bordino, Capella, Crespo, Franco-Trecu, Hevia, Sepúlveda Martínez, et al., 2019), and southern right whale density has been increasing and whales have been expanding their distribution to deeper waters and Golfo San Matias over the last decade (Falabella, Campagna, Bordino, Capella, Crespo, Franco-Trecu, Hevia, Sepúlveda Martínez, et al., 2019).

Abundance estimates for Bahia San Antonio, a bay located in the north-western region of the San Matias Gulf, Argentina, were highest in September, with 85$\pm$71, 207$\pm$108, and 117$\pm$55 whales in 2009, 2010, and 2011, respectively (NMFS, 2015). Abundance for August and October was almost half that of September, and whales were absent in November 2010 and August 2011, indicating September is a peak season for occupying the area. Long-term monitoring is needed to determine trends in abundance in the area (NMFS, 2015). From 2007 to 2016, data on right whale distribution, group composition and relative abundance were collected in Golfo San Matias, Patagonia through aerial surveys, where southern right whales were observed from August to October, with a peak in late August to early September, with a maximum of 160 individuals recorded (M. Arias et al., 2018). The latest growth rate estimated for southern right whales for the Golfo San Matias region is a rate of increase between 8% and 13% (M. Arias et al., 2018). Growth rates of this magnitude have been observed in other regions such as southern Brazil (increase rate of 14%), where it was suggested that these growth rates were not only the result of overall population growth, but also reflect immigration and seasonal movement between different wintering grounds (M. Arias et al., 2018). Additionally, Crespo et al. (2018) reported that the number of southern right whales tripled from 1999 to 2016, however the

rate of increase decreased from near 7% in 2007 to 0.06% in 2016 for total number of whales. Overall, it was noted that whales are increasing their abundance, while the rate of increase is decreasing (Crespo et al., 2019). This declining trend in rate of increase, increase of mortality rate, and the relocation of adults to deep waters of the Northern Golfo San Matias is thought to provide evidence of a density dependence process and indicates that southern right whales are reaching carrying capacity for the Peninsula Valdes region (International Whaling Commission, 2018b).

Brazil

Southern right whales have been studied off southern Brazil since 1981 and have been the subject of aircraft surveys and photo-identification studies in this area since 1987. From 1987 to 2003, the number of reproductive females has increased annually by 14%; however, this rate of increase is far above the maximum possible for this species, so other factors, such as migration or expansion from other populations, must be at least partly responsible (NMFS, 2015). Shore-based surveys conducted off Torres and Rio Grande do Sul, Brazil, reported southern right whales in this area between July and October with peaks in August and September (Danilewicz et al., 2017). Group sizes were relatively small (x=1.6; range=1-3). Distribution in relation to distance from the coast varied from 0.5 to 8.9km (median=1.9km) (Danilewicz et al., 2017). De Morais et al. (2017) noted the main area of concentration for the southern right whale, especially during the breeding season, is off the coast of Santa Catarina state, particularly between south of Florianopolis (27°25'5, 48°30'W) and the Cape of Santa Marta (28°36'5, 48°48'W) (de Morais et al., 2017). Figueiredo et al. (2013), examined sightings records from 1981-2011 of southern right whales off southern Brazil. Their analysis indicates sightings have decreased since the late 1990s despite an increase in monitoring. From 1981-1999, sightings per year were 0.74 off São Paula State and 2.63 off Rio de Janeiro State compared to 2000-2011, when sightings per year were 0.58 and 1.92, respectively (G. C. Figueiredo et al., 2013). However, the authors did not pool the data across all years, and it is unknown whether the decrease in sightings per year is significant. Recently, three high concentration areas were identified off the Brazilian coast: from Guarda/Gamboa to Garopaba/Sirui, from Silveira/Ferrugem to Camacho, and from Rincao to Torres (although two higher concentration areas were located within the Right Whale Environmental Protection Area between Florianopolis 27.768°5 and Rincao 28.823°5, Santa Catarina State) (Eduardo Pires et al., 2018).

Peru and Chile

Southern right whales occur in coastal waters off southern Chile and central Peru during the austral winter and spring and off southernmost Chile in the fall and summer (NMFS, 2015). Population abundance estimates for Peru and Chile are not available and Seguel et al. (2018)

notes that the Chile-Peru subpopulation of southern right whale is critically endangered, with approximately 50 individuals left in the southeastern Pacific Ocean (J. G. Cooke, 2018; Seguel et al., 2018). However, a mother-calf pair was recorded on January 2006 on the northwest coast of Guafo Island (43°35' S; 74°42'W) which is located in the middle of the Chiloense ecoregion, off the coast of southern Chile; this sighting was rare sighting due to the critically low population size for this area (Seguel et al., 2018). Whale population size in waters off Chile appears to be not increasing; however, for the area north of 47°S the population appears to have increased between 1976 and 2008, though not significantly (Aguayo-Lobo et al., 2008). Since the early 2000s, sightings of southern right whales have increased in coastal waters off Peru, indicating the population may be recovering in the area (Van Waerebeek et al., 2009).

Australia

Historically, the Australian population of southern right whale was approximately 15,000 individuals. Current abundance of the Australian population is approximately 2,500 whales and they are divided into two sub-populations (the 'western' with approximately 2,200 individuals and the 'eastern' with approximate 300 individuals) (Charlton, 2017). The International Whaling Commission (IWC) Scientific Committee reported the results from the latest of a series of aerial surveys conducted in South and West Australia in 2017 (International Whaling Commission, 2018b). Counts were obtained of 628 individuals including 228 calves of the year. These counts were the highest yet in the series with an exponential increase of ~6% per year (International Whaling Commission, 2018b). Regression analysis from 1993-2016 gives increase rates for all animals of 5.55% (95% CI 3.78-7.86), and for cow/calf pairs 6.01% (3.49 – 8.59) per annum (International Whaling Commission, 2018b). Work at the Head of the Bight (South Australia) now comprises 26 years of cliff-based counts and photo-identifications; southern right whales are particularly concentrated in this location (International Whaling Commission, 2018b). The estimated increase rate of whales sighted there from 1991-2016 is 5.5% (95% CI=0.03) per annum (International Whaling Commission, 2018b). There is no evidence for a population increase in calving females at Logan's beach, southeastern Australia, where they are most concentrated.

Additionally, an aerial survey over a 23-year period from 1993 to 2015 was conducted to survey southern right whales in the winter and spring on the coast of South Australia, between Cape Leeuwin (Western Australia) and Ceduna (South Australia) (J. L. Bannister et al., 2016). These surveys have provided evidence of a population trend of approximately 6% per year, and a 2014 population size of approximately 2,200 individuals for the 'western' Australian southern right whale sub-population (J. L.

Bannister et al., 2016; Charlton, 2017). Current estimates show that the 'western' sub-population is increasing at or near the maximum biological rate for the species (approximately 6% per year) and the western sub-population is increasing at an annual rate of approximately 5.5% per year (Charlton, 2017). An increased abundance of southern right whales was also recorded at Fowlers Bay, South Australia, a previous shore-based whaling station (C. Charlton et al., 2019). Sighting and photo identification data collected during annual aerial (19930-2016) and vessel surveys (2014-2016) resulted in a rate of mean increase from 1993 to 2016 (29% per year, 95% CI = 0, 54.2) with peak relative abundance recorded in July and August (C. Charlton et al., 2019).

Stamation et al. (2020) provided an abundance estimate derived from a breeding female superpopulation mark-recapture model for the southeastern southern right whale population (Stamation et al., 2020). This population includes 268 individuals (with 68 breeding females) and has increased at a rate of 4.7% per year between 1996 and 2017 (Stamation et al., 2020). However, there has been no significant change in the annual abundance of mother-calf pairs sighted at the only calving ground (Logans Beach in Victoria) over the last three decades (Stamation et al., 2020). The total number of southern right whales (i.e. all adults and calves) using the southeastern Australian coastline has increased by 7% since 1985 (Stamation et al., 2020). Unlike the population estimate (which was restricted to breeding females sighted prior to the post-breeding southward migration), this estimate is likely to include transiting whales from the southwestern population (Stamation et al., 2020). The size of the southwestern southern right whale management unit was estimated via annual coastal aerial surveys at around 3,191 whales in 2018, and strong population growth was observed between 1993 and 2018 (~6% per year) (Stamation et al., 2020). There have been no population estimates for the southeastern management unit, apart from a preliminary estimate of 257 whales based on coastal aerial surveys over 2 seasons (Watson M et al., 2015) and Kemper et al. (1997) who identified 54 adults (including 22 breeding females) from aerial surveys between 1991 and 1993 (Kemper C et al., 1997; Stamation et al., 2020).

New Zealand

Populations around mainland and subantarctic islands of New Zealand are severely depleted from pre-whaling estimates, which were approximately 27,000 (95% CL 22,000, 38,000) (L. G. Torres et al., 2017). However, the ‘western’ sub-population appears to show signs of recovery. As noted in the above subsection, the ‘western’ Australian southern right whale sub-population has an abundance of approximately 2,200 individuals, compared to an estimate of 300 individuals in the same year for the ‘eastern’ Australian sub-population (Charlton, 2017). The main wintering ground in New Zealand is the sub-Antarctic Aukland Island with an

estimated population size of 2,139 whales in 2009 (Bailleul et al., 2020). Both the 'western' Australian sub-population and New Zealand sub-population are estimated to be recovering at approximately 6-7% per year, and the 'western' Australian sub-population is presently expanding into former calving grounds and in New Zealand, whales are recolonizing waters around mainland New Zealand (Bailleul et al., 2020). Additionally, as the sub-population recovers, the winter range of the sub-population is expanding to include more of the historical range, for example, Aukland Islands and Campbell Island to mainland New Zealand (Cooke et al., 2018).

Torres et al. (2017) used visual surveys of abundance and distribution, photo-identification, genetic and stable isotope analysis of tissue samples to provide details on the demography, population connectivity and ecology of southern right whales wintering off Campbell Island during the austral winter (July) and found increased abundance estimates of the southern right whale at Campbell Island over the last 20 years (L. G. Torres et al., 2017). Torres et al. (2017) reported photo-ID capture-recapture abundance estimates of 278 (95% CI 105-735) and 288 (95% CI 124-670) from photos compiled into right hand side and left hand side catalogues, respectively (with each individual assigned a unique alphanumeric code), however these estimates should be interpreted with caution as the low level of survey effort, coupled with high turnover rates of whales in the study area, resulted in few recaptures (L. G. Torres et al., 2017).

From 2003 to 2010, 28 mother-calf pairs were sighted around mainland New Zealand compared with 11 sightings from 1991 to 2002 (NMFS, 2015). However, there is no evidence of any significant recovery for the 'eastern' Australian sub-population (Bailleul et al., 2020). Based on capture-recapture (N. J. Patenaude, 2002) combined with microsatellite genotyping (E. L. Carroll et al., 2011) analysis of individuals during the years 1995-1998, the population was estimated to be about 900 individuals. For 1995-2009, the population estimate was 2,169 whales (95% CL 1,836, 2,563) and was increasing annually at about 7% (95% CL 5%, 9%) (E.L. Carroll et al., 2013). A more recent study by Jackson et al. (2016) estimated the abundance of the 'super-population' of New Zealand southern right whales to be 2,200 individuals with population growth estimated at 7% per year (95% CI 5% - 9%) (Jackson et al., 2016). This estimate was part of a 2009 genotype capture-recapture survey and used sex-specific POPAN models for males and females using recapture data from eight years of field surveys from 1995-2009 (Jackson et al., 2016). The female POPAN model was modified to account for capture heterogeneity between years in reproductive females and total abundance was estimated by combining data from the sex-specific models; the 'super-population' was defined as the total number of individuals that enter focal population between the first and last surveys (Jackson et al., 2016).

Other Areas

In addition to the areas described above, small numbers of right whales also occur off Tristan da Cunha, South Georgia, South Sandwich Islands, Namibia, Mozambique, Uruguay, Falkland Island (Malvinas), French Southern Territories (Kerguelen), Mozambique, and the east coast of Madagascar (Cooke et al., 2018). Less is known about the whales in these areas relative to other locations as their populations are smaller, sightings are infrequent, and little research has been done in these areas (Cooke et al., 2018; NMFS, 2015).

Wintering populations of southern right whales off Tristan da Cunha Archipelago in the South Atlantic Ocean have been estimated at 226 whales. The Tristan da Cunha is considered a mid-ocean pelagic feeding ground and nursery area for the southern right whale (Best et al. 2009). From 1991 to 2010, southern right whales were the most frequently sighted whales off South Georgia with a peak of reported sightings from 2001 to 2005, which were concentrated around Shag Rocks, at the northwest tip of South Georgia, and along the north/east coastlines of South Georgia (NMFS, 2015). Although the populations in these areas are relatively small, the areas may be important to southern right whale recovery. Confirmed calving in Namibia waters represents the northernmost established breeding population in the southeast Atlantic (NMFS, 2015). Abundance and trends are unknown for the Namibia population. The southwest Indian Ocean - Madagascar and Mozambique - are suspected breeding populations remain at very low numbers and show no clear evidence of increase (Cooke et al., 2018).

Sightings of southern right whales have been reported along the coast of Uruguay since the 1970s (NMFS, 2015). Systematic studies have demonstrated that the occurrence of southern right whales in Uruguay has been increasing and the low-frequency of mother-calf pairs reported and the reproductive behavior displayed by unaccompanied whales indicate that the Uruguayan coast could be primarily an area of socialization and breeding for southern right whales (Danilewicz et al., 2017; NMFS, 2015).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

Genetic analyses supports the concept that the southern right whale is a separate phylogenetic species from the two phylogenetically distinct species of the North Atlantic and North Pacific right whale. This concept is currently accepted by the International Whaling Commission and the Society for Marine Mammology's Taxonomy Committee (Taxonomy,

2017) (Cooke et al., 2018). Simulation studies suggest that the centuries-long demographic bottleneck due to whaling reduced mitochondrial genetic diversity in the southern right whale (Harcourt et al., 2019; Jackson et al., 2008) with Indo-Pacific populations showing significantly lower mtDNA diversity than their South Atlantic counterparts (Carroll et al., 2019). However, it is not yet resolved whether this has impacted nuclear DNA diversity, as microsatellite studies show high levels of heterozygosity in the extant southern right whale wintering grounds (Carroll et al., 2019). Recent genetic analysis by Carroll et al. (2019) shows significant genetic differentiation, particularly between the South Atlantic (Argentina, South Africa) and the Indo-Pacific (Australia, New Zealand) ocean basins.

Patenaude et al. (2007) analyzed the population structure of southern right whales on four major winter calving grounds (Argentina, South Africa, Western Australia and New Zealand) and two summer feeding grounds (South Georgia and south of Western Australia). Results indicated there are two maternal clades that differ in frequency between oceans with significant mtDNA differentiation between the four calving grounds. Additional statistical tests (FST and χ^2) were not significant for the South Africa and Argentina populations (Patenaude et al., 2007). Kanda et al. (2014) compared haplotypes from southern right whales feeding in the Antarctic to the 37 haplotypes reported in Patenaude et al. (2007) and found similar clades matching both Atlantic and Pacific Ocean basins (Kanda et al., 2014; NMFS, 2015; Patenaude et al., 2007). These results suggest that some southern right whales undergo much longer-distance migrations between their feeding and breeding grounds than previously thought, and those individuals from the different ocean basins are mixing on feeding grounds in the Antarctic.

A recent circumpolar study by Carroll et al. (2020) assessed genetic diversity and differentiation at four major extant southern right whale wintering grounds and found that there was hierarchical genetic structure in both mitochondrial DNA (mtDNA) and microsatellite loci amongst ocean basins (Carroll et al., 2019). The level of differentiation was higher in mtDNA than microsatellite loci, suggesting female philopatry was a strong driving factor, although sex-biased dispersal was not detected. This is an example of how both philopatry and migratory culture can be inferred as drivers of population structure and recovery patterns in southern right whales (Carroll et al., 2020; Harcourt et al., 2019).

South Atlantic

A recent study by Carroll et al. (2020) built on previous long-term, large-scale collaboration on southern right whales to combine new and published mtDNA and microsatellite genetic data from all major South Atlantic southern right whale wintering grounds (i.e. Argentina, Brazil,

South Africa, Chile-Peru, and the Indo-Pacific) and the South Georgia Island feeding grounds, to investigate the position of previously unstudied habitats in the migratory network (i.e. Brazil, South Georgia Island, and Chile-Peru). The new genetic data indicate that Brazil and Argentina are not genetically distinct due to their connectivity and proximity which likely suggests immigration from Argentina to Brazil, exemplified by the movement of one genetically identified individual between these South American wintering grounds (Carroll et al., 2020). Furthermore, a single sample from Chile- Peru had a mtDNA haplotype previously only observed in the Indo-Pacific and had a nuclear genotype that appeared admixed between the Indo-Pacific and South Atlantic, based on genetic clustering and assignment algorithms (Carroll et al., 2020). South Georgia Island samples were clearly South Atlantic and were more similar to the South American than the South African wintering grounds (Carroll et al., 2020).

Australia and New Zealand

In Australian waters, southern right whales form two genetically distinct populations based on genetic and geographical diversity: a western population in south Australia and western Australia and an eastern population in southeastern Australia (i.e. Tasmania, Victoria and New South Wales) (Carroll et al., 2019; Stamation et al., 2020). Evidence of genetic differentiation in mitochondrial and microsatellite DNA haplotype frequencies between these two regions led to the delineation of distinct southwestern and southeastern Australian management units (Carroll et al., 2011). However, more recent work has shown that this situation is more complex than originally thought, providing evidence of whales from different calving grounds mixing in the migratory corridors, which may actually lead to gene flow between these management units (E. L. Carroll et al., 2015). Thus, Carroll et al. (2011, 2015) found no genetic distinction between southern right whales in New Zealand and those in Logans Beach Victoria, and hypothesized that some whales from the New Zealand population may be migrating to southeastern Australia or that whales from the two regions mix in the Tasman Sea (Stamation et al., 2020). Southern right whales show a form of migratory culture, with females transmitting preferences for both winter calving/breeding areas and summer foraging areas to their calves during their first year (Carroll et al., 2016). Carroll et al. (2015) assessed the role of maternally directed learning of migratory habitats on the population structure of the Australian and New Zealand southern right whale. Using DNA profiles, comprising mitochondrial DNA (mtDNA) haplotypes (500bp), microsatellite genotypes (17 loci) and sex from 128 individually-identified whales, significant differentiation among winter calving grounds was found based on both mtDNA haplotype ($F_{ST} = 0.048$, $\Phi_{ST} = 0.109$, $p < 0.01$) and microsatellite allele frequencies ($F_{ST} = 0.008$, $p < 0.01$), consistent with long-term fidelity to calving areas (E. L. Carroll et al., 2015). However,

most genetic comparisons of calving grounds and migratory corridors were not significant, supporting the idea that whales from different calving grounds do mix in migratory corridors (E. L. Carroll et al., 2015). Data from this study indicates genetic structuring across the species' migratory network, and may explain the species' patchy recovery (E. L. Carroll et al., 2015; Harcourt et al., 2019). Essentially, when southern right whales inhabiting a region were extirpated the memory of that area as a good migration destination was also lost – this loss of 'cultural memory' coupled with low density and loss of adjacent populations, mean it is unlikely that once-inhabited areas will be recolonized on a timeframe relevant to management (i.e. decades) (Harcourt et al., 2019). This may help explain the lack of recovery around mainland New Zealand and east Australia wintering grounds compared with the strongly recovering populations in the New Zealand subantarctic Islands and southwest Australia.

A recent study by Torres et al. (2017) off the coast of New Zealand used genetic and stable isotope analyses of tissue samples and visual surveys of abundance and distribution, to provide details on the demography, population connectivity and ecology of the southern right whale, and found no genetic differentiation between southern right whales at Campbell Island (an important wintering habitat) and the broader New Zealand population around the Aukland Islands from 2006 to 2009 (mtDNA Fst = 0.00). Furthermore, Torres et al. (2017) reported that confirmation of connectivity between these two wintering areas is based on the absence of genetic differentiation between individuals sampled at Campbell Island and at the Auckland Islands. This is consistent with previous research in the 1990s that also found matches between Auckland and Campbell Islands (Patenaude et al., 2001; L. G. Torres et al., 2017).

Eastern South Atlantic

The stock structure and relationship between southern right whales from Namibia and South Africa remains less studied, but there is recent photographic evidence for connectivity between these two areas (Roux et al., 2015). Twelve out of 13 individuals off Namibia with distinctive dorsal pigmentation were first seen as calves off South Africa. These results strongly indicate connectivity between the two regions and represents a possible range expansion rather than any genetic differentiation between the two areas of Namibia and South Africa (Roux et al., 2015).

2.3.1.4 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):

Southern right whales have a circumpolar distribution, occurring throughout the middle latitudes of the Southern Hemisphere from around 20°S to 65°S (Figure 2; (Bannister et al., 1999; Cooke et al., 2018), and evidence suggests the southern right whale infrequently travels north of 20°S (NMFS, 2015). The breeding component of the population's distribution in winter is concentrated near the coastlines in the northern part of the range (Figure 1). They migrate from southern middle latitudes at the beginning of winter and stay roughly near continents where they breed near coastlines (Bester, 2020). Major current breeding areas are off southern Australia, New Zealand (particularly Aukland Islands and Campbell Islands), the Atlantic coast of South America (Argentina and Brazil), and southern Africa (South Africa and Namibia) (Figure 2(Cooke et al., 2018). Smaller numbers are also see off central Chile, Peru, Tristan da Cunha, and the east coast of Madagascar (Figure 2)(Cooke et al., 2018). Summer distribution of southern right whales are found mainly in latitudes 40-50°S, but can also occur in the Antarctic as far south as 65°S (Bannister et al., 1999; Cooke et al., 2018) and around South Georgia and the South Sandwich Islands (Figure 2; (Nijs et al., 2017). As noted in section 2.3.1.1, movements of individual southern right whales between subantarctic waters in summer and photo identification and satellite tracking have documented individuals in winter calving grounds.

South Africa

The southern right whale occurs predominantly along the coast of South Africa between the southwest coast of Saldanha Bay around the south Cape to Woody Cape. Four main concentration areas lie within the southwest coast of Saldanha Bay (Barendse et al., 2014) and three areas of the southern Cape coastline: St. Sebastian Bay, De Hoop and Walker Bay (NMFS, 2015). Saldanha Bay appears to be an especially important feeding and socializing area where whales were observed year-round along the southwest coastline (NMFS, 2015). Additionally, Walker Bay is an important mating and calving area. Recently, increases in numbers of southern right whales visiting the north-eastern part of South Africa (i.e. around Ballito and off Umdloti Beach) suggests the whales' extended seasonal presence may all be indicative of reoccupation of their former range along the west coast (NMFS, 2015). Whales observed in this area likely come from points south along the Cape and north along the west coast, including the coast of Namibia (Barendse et al., 2014).

Recently, the IWC provided the results of a 2016 survey of southern right whales along the coast of South Africa, part of an extensive long-term monitoring program. They recorded only 55 cow-calf pairs and 9 unaccompanied whales during the entire survey (International Whaling Commission, 2018b). This is the lowest sighting density of the last 25 years and about 10-15% of the expected total based on surveys up to 2014 (International Whaling Commission, 2018b). This marked decline has been recorded in the last few years, with unaccompanied adults declining since 2010 and cow-calf pairs since 2015. A subsequent analysis of seasonal presence patterns does not suggest that there has been a shift in coastal longshore distribution, since sightings have been reduced at all locations along the South African coast. It suggests that animals have remained offshore and not returned to the coast to calve in 2015 and 2016 (International Whaling Commission, 2018b). Furthermore, there are no reports of an increase in southern right whale sightings in other areas along the coast of South Africa, Namibia, or Mozambique, and the reasons remain unknown (International Whaling Commission, 2018b).

Historical whale catch statistics off the Durban whaling ground documented two sightings of individual southern right whales offshore of KwaZulu-Natal, South Africa from 1972-1975 (K. P. Findlay et al., 2016). This study suggested that these two southern right whales were en route to Maputo Bay (one of the right whaling centers in southern African waters at the time) (K. P. Findlay et al., 2016).

Argentina

Southern right whales in the southwest Atlantic have been recorded using aerial surveys from the mouth of the Chubut River (42°30') to Puertos Lobos (42°S), with long-term efforts to document temporal changes in distribution by age and sex classes (International Whaling Commission, 2018b). Data from these surveys support the increasing trend in abundance for southern right whales in Peninsula Valdes nursing area (however, the rate of increase is decreasing) (International Whaling Commission, 2018b). Additionally, it was noted that numbers of solitary individuals and breeding groups are no longer increasing, suggesting that southern right whales may be relocating within and out of the Peninsula Valdes area (International Whaling Commission, 2018b).

Opportunistic sightings coupled with satellite-telemetry data of southern right whales along the Patagonian shelf and shelf break off Argentina during the austral summer showed encounter rates in the Patagonian shelf between 42°S to 46°S were higher than south of 46°S and in the shelf break, which indicates a potential feeding ground on the Patagonian shelf (International Whaling Commission, 2018b). Additionally, information summarized from distribution and abundance data on southern right whales annually observed since 2007 from August to October in the San

Matías Gulf showed southern right whales peaking in late August/early September, with a maximum of 160 individuals recorded in early September 2015 (International Whaling Commission, 2018b). Solitary whales were always the predominant group, but the proportion of breeding groups and cow-calf pairs typically increased in September and October, respectively. Non-social, active groups were present in every month in similar proportions. Whales were mainly found near the northwest coast of the San Matías Gulf, particularly from San Antonio Este to Caleta de los Loros. Since 2008, the areas in which whales were found concentrated along the coast of Rio Negro changed from mainly around Puerto Lobos (near Peninsula Valdes) to the northern coast of the San Matías Gulf (International Whaling Commission, 2018b).

Arias et al. (2018) suggested that the southern right whale is experiencing a density-dependent process while expanding its distribution range in Patagonia. From 2007 to 2016, data on right whale distribution, group composition and relative abundance were collected in Golfo San Matias, Patagonia via aerial surveys, and group composition and the relative abundance of right whales among the northern Patagonian gulfs were compared. Results from this study suggest a geographic distribution change with a regular use of the northwest coast of the gulf in recent years and a positive trend in the population growth rate inside Golfo San Matias (M. Arias et al., 2018). This area was dominated by unaccompanied whales (solitary individuals and breeding groups) as opposed to Peninsula Valdes where the dominant group type was mother-calf pairs (M. Arias et al., 2018). Therefore, Golfo San Matias appears to be important for socializing and mating but not as a nursery ground. In addition, the density of whales was four times greater in the gulfs of Peninsula Valdes. These findings were complemented by a study done by Sueyro et al. (2018), which found that the density of whales increased to three whales per kilometer in high-density areas which resulted in a decrease in density in high-density areas and an increase of density in low-density areas. The authors suggest that this threshold in density triggers a density-dependent response in habitat use, with mother-calf pairs remaining in the area, while other groups are displaced to new areas (Sueyro et al., 2018).

Brazil and Uruguay

Southern right whales use the waters off the Brazilian coast as breeding and calving grounds. Historical information on their distribution in this region derives predominantly from whaling data, and contemporary data only became available when dedicated studies were conducted (de Morais et al., 2017). Southern right whales regularly use the Brazilian coast as a calving and breeding ground from the northeastern coast (~8 ºS where

Figure 2. Southern right whale (*Eubalaena australis*) distribution map (*source:* Cooke & Zerbini, 2018).

there are occasional sightings) to the southern limit of the country's coastline at 32ºS (Figueiredo et al., 2019).Today, southern right whales are mainly concentrated off the coast of Santa Catarina state, particularly between south of Florianopolis (27°25'5, 48°30'W) and the Cape of Santa Marta (28°36'5, 48°48'W (de Morais et al., 2017). Individuals are commonly found in shallow waters inside bays with dissipative beaches, along the south and the southeastern coast of Brazil, where they can remain for days or weeks at a time (Figueiredo et al., 2019; Elisa Seyboth et al., 2015). Additionally, it was noted that mother-calf pairs avoid bays facing southeast during days of strong east-west winds (Elisa Seyboth et al., 2015). When southern right whales are found in groups, (ranging from 1-6 individuals), mother-calf pairs are the most common group formation reported. However, the number of sightings of southern right whales along the south-eastern Brazilian coast is decreasing which may be correlated to the increase in vessel traffic in the area (Figueiredo et al., 2017).

A recent study which applied Kernel density estimators to aerial survey data between 2003 and 2012 to determine main occurrence and concentration areas of southern right whales in southern Brazil, resulted considerable variation in area usage both within and among years, and changes in the general distribution pattern of southern right whales (Pires Renault-Braga et al., 2018). Intra-annually, higher concentration areas tended to expand from July to September and decrease in November; and the following three areas stood out as high-density areas for southern right whales: Ribanceira/lbiraquera, ltapiruba Sul/Sol, and from Arroio to Gaivota (Pires Renault-Braga et al., 2018).

Shore-based surveys carried out of Torres (29°19'5, 49°43'W) Rio Grande do Sul between July and October reported a varied distribution in relation to distance from the coast (ranging from 0.5 to 8.9 km), and unlike in other areas mother-calf pairs were not observed in shallower waters more often than unaccompanied whales (Danilewicz et al., 2017). Rather, mother-calf pairs presented northbound movements to Santa Catarina state, Brazil more frequently than unaccompanied whales. Data from this study was compared to data from Uruguay and Santa Catarina state, Brazil which indicated that southern right whales of different gender and/or reproductive status may distinctively use the eastern coast of South America (Danilewicz et al., 2017). Within these regions, the proportion of mother-calf pairs increased progressively as latitude decreases (from 8% in Uruguay to 58.5% in Santa Catarina state), while the proportion of unaccompanied southern right whales showed an opposite trend, indicating that Rio Grande do Sul is an important reproduction area as the three phases (birth, nursing, and mating) proposed for a breeding ground occur there (Danilewicz et al., 2017).

Australia

In Australian coastal waters, southern right whales occur along the southern coast including Tasmania, and generally as far north as Sydney (33°53'S, 151°13'E) on the east coast and Perth (31°55'S, 115°50'E) on the west coast (Australia, 2012). There is occasional presence further north, with the extremities of range recorded as Hervey Bay (25°00'S, 152°50'E) and Exmouth (22°23'S, 114°07'E) (Australia, 2012). In coastal habitat these whales are generally within two kilometers of shore (Australia, 2012). Main aggregation areas in Australia are along the southern coast, which is occupied regularly from May through November, with peak abundance around September (NMFS, 2015). The greatest concentrations are observed along the southwestern coast from Albany, Western Australia to the Head of the Bight, South Australia, and sightings are also common off the southeastern coast of Tasmania. Smaller concentrations are known to occur along the coasts of South Australia and Victoria between Port Lincoln and Warrnambool and off the southeastern coast of Tasmania. Southern right whales have been reported in the coastal waters of all States, with sightings ranging from Stradbroke Island and Hervey Bay in Queensland and along the entire southern coastline, including Tasmania to Exmouth in Western Australia. But the species has not been sighted in the Northern Territory (NMFS, 2015).

Across the coastal range, southern right whale spatial distribution is clearly clumped and whales aggregate in predictable locations; and calving aggregations occur over a wide environmental range, but habitat that provides some protection from weather conditions is usually preferred (Australia, 2012). Winter calving grounds used by southern right whales extend from Western Australia across southern Australia to the New Zealand sub-Antarctic Islands (Bailleul et al., 2020; Gill et al., 2015).

Across southern Australia to the New Zealand sub-Antarctic Islands aggregation areas are well known with the largest being Doubtful Island Bay area (38°15'S, 119°32'E), Israelite Bay area (33°37'S, 123°53'E) and Head of Bight (31°28'S, 131°08'E) (Australia, 2012). Southern right whales are particularly concentrated at the Head of Bight (South Australia), which now comprises 26 years of cliff-based counts and photo-identifications (International Whaling Commission, 2018b), and the only area where mothers and calves are seen with regularity in southeastern Australia is at Logans Beach near Warrnambool in southwestern Victoria (International Whaling Commission, 2018b). Other smaller areas that are regularly occupied by southern right whales are the Yokinup Bay (33°53'S, 123°05'E) and the Warrnambool region noted above (38° 25'S, 142°30'E) (Australia, 2012).

Recently, a number of additional areas for southern right whales are emerging, which could be important for the south-eastern population. These areas include small, but growing numbers of non-calving whales

which regularly aggregate for short periods of time. These areas include coastal waters off Peterborough, Port Campbell, Port Fairy and Portland in Victoria; Great Oyster Bay and Frederick Henry Bay in Tasmania; Storm Bay and Sleaford Bay in South Australia; and Twofold Bay and Jervis Bay in New South Wales, Australia (Australia, 2012).

In general, observations north of 34°S remain infrequent. However, in recent years there has been an increase in sightings of southern right whales in northern, sub-tropical waters along the eastern and western coasts. This trend suggests that either the southern right whale range is expanding or whales are repopulating (NMFS, 2015).

New Zealand

Historical whaling records indicate that southern right whales were more widely distributed pre-whaling. The range of the southern right whale today is a fraction of its historical range. No mother-calf pairs were sighted around mainland New Zealand from 1976 to 1991 and only 11 were reported between 1992 and 2002 (NMFS, 2015). However, recolonization of mainland New Zealand may be occurring by expansion from the New Zealand subantarctic populations. As the population increases, southern right whales are now more frequently observed around mainland New Zealand and are likely distributed throughout all New Zealand waters, including those areas off the Kermadec Islands (approximately 30° S, 800 km northeast of mainland New Zealand), the subantarctic Islands (approximately 50°S, over 400 km south of mainland New Zealand), and both the North and South Islands of mainland New Zealand (NMFS, 2015; Stephenson et al., 2020).

Southern right whales currently use the subantarctic Auckland Islands as a primary winter breeding ground, moving further south to feed (Stephenson et al., 2020). Social factors most likely influence the whales' primary winter aggregation in Port Ross, Auckland Islands where increasing numbers of whales come into this harbor despite the availability of similar habitat on the island (Rayment et al., 2014). With predicted changes in prey availability (L. G. Torres et al., 2017) and increasing population size, Stephenson et al. (2020) suggests that southern right whales will continue to re-establish former habitat around New Zealand and the Kermadec-Louisville region to the northeast.

Recently, Torres et al. (2017) surveyed southern right whales around the sub-Antarctic Campbell Island in the austral winter of 2014, using a variety of techniques (L. G. Torres et al., 2017). Primary findings from Torres et al. (2017) suggest that this area is part of the broader New Zealand southern right whale population, and primarily used by sub-adults who forage in the sub-Antarctic. Additionally, southern right whales at Campbell Island have been observed from Perseverance Harbor and

Northwest Bay located on the eastern and western shoreline, respectively (NMFS, 2015).

Other Areas

Less is known about the distribution of the southern right whale outside of the major foraging and breeding areas discussed above.

In waters off Chile and Peru, southern right whale sightings over the past 40 years have been scarce (J. G. Cooke, 2018). However, during the austral winter and spring, southern right whales off the coast of Chile and Peru are known to occur from southern Peru to central Chile; however there are no sightings off Peru and Chile in the summer (J. G. Cooke, 2018). The northernmost sighting in the eastern South Pacific is from 12°S along the coast of Chorillos in Lima, Peru and the southernmost was recorded at 47°S in Golfo de Penas, Chile in 1976 (J. G. Cooke, 2018; Jacobs et al., 2019). Mother-calf pairs have been sighted from 15°S to 42°S (J. G. Cooke, 2018). Unlike other southern right whale subpopulations, no localized breeding or nursery ground has yet been identified. Cooke et al. (2018) stated that all confirmed sightings have been in coastal waters, but it is unclear whether this reflects an exclusively coastal distribution or a relative lack of offshore sighting opportunities. A few sightings of individuals in the Magellan Strait and Beagle Channel are thought to be whales from the southwest Atlantic subpopulation (J. G. Cooke, 2018). Additionally, a recent study by Jackson et al. (2019) provided evidence that southern right whales are using waters off Isla de Chiloe not only during the breeding season but also likely during the feeding season for possible foraging activities (Jacobs et al., 2019).

The Falkland Islands southern right whale occurrence was assess via whaling records, a literature review, systematic surveys (boat, aerial and shore-based), and public sightings (Weir et al., 2020). The combined data sources indicate a year-round presence of southern right whales in pelagic areas around the Falkland Islands, with a peak in the austral summer. However, nearshore records originated in the austral late autumn and winter (May to August), including a marked increase in sightings along the north-east coast during 2017 compared with previous years (Weir et al., 2020). This indicates that spatio-temporal variation occurs in Falkland waters by southern right whales (Weir et al., 2020).

There were 36 incidental sightings of southern right whales off the Namibian coastline since 1971, and calving was recorded 1996 to 1999. The southern right whale is known to have occurred along this shoreline historically, and was hunted to near extinction there in the early 1800s. Sightings of right whales off Namibia have been as far north as 17°S and represent the northernmost calving area for the southeastern Atlantic (NMFS, 2015). Aerial surveys of the Namibian coastline from 1978 onwards revealed increasing numbers of right whales, but few cow-calf

pairs and aerial surveys off South Africa since 2009 showed a major decline in the availability of mothers without calves (Roux et al., 2015). Twelve out of thirteen individuals off Namibia with distinctive dorsal pigmentation were first seen as calves off South Africa, which suggests connectivity between the two regions and also represents a range expansion from South Africa (Roux et al., 2015). Recently, southern right whale sightings have been documented primarily from the Walvis Bay and Luderitz areas off the coast of Namibia (De Rock et al., 2019). However, very few calves have been reported in Namibia, and there is little evidence of the Namibian coast ever serving as a nursery ground (De Rock et al., 2019).

Off the coast of the sub-Antarctic waters of South Georgia southern right whales were the most commonly sighted species up to 2011. A recent study by Jackson et al. (2020) indicates that southern right whale numbers are not increasing on their South Georgia feeding ground, but are instead suggest a plateau, despite the significant increase in cruise ships and associated opportunistic sighting effort since 1995. Since southern right whales use multiple feeding areas in the southwest Atlantic, prey availability may limit the number of southern right whales that feed in each location every year (Jackson et al., 2020). Offshore sightings of southern right whales have been reported along the sub-Antarctic coast of the South Sandwich Islands (Nijs et al., 2017).

2.3.1.5 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Southern right whale habitat includes coastal and open ocean waters in the Southern Hemisphere primarily between 20°S to 65°S although they have occasionally been recorded beyond these latitudes (Bannister et al., 1999; Cooke et al., 2018). Southern right whales have been well-studied on their wintering grounds, especially off the coasts of Peninsula Valdes, Argentina, South Africa, and southern coast of Australia. In winter their habitat includes shallow, protected, and nearshore waters for calving and nursing off Australia, New Zealand, South America, Southern Africa, and various mid-oceanic islands (Cooke et al., 2018; Gill et al., 2015; NMFS, 2015). Off the coast of Brazil, Seyboth et al. (2015) found that that both cow-calf pairs and unaccompanied adults prefer bays with dissipative beaches, and that cow-calf pairs avoid bays facing southeast during days of strong east-west winds.

In summer, southern right whales feed in productive coastal and open ocean waters where they forage primarily on krill and copepods (NMFS, 2015). For feeding that occurs north of 40°S, the diet consists mainly of copepods, and feeding that occurs south of 50°S consists mainly of euphausiids, with varying proportions of copepods and euphausiids at

intermediate latitudes (Cooke et al., 2018). However, the location of summer feeding grounds is less well known compared to the wintering grounds; however, feeding right whales have been recorded at approximately 45°S south of Western Australia, around South Georgia, and near the Antarctic Peninsula (Cooke et al., 2018; Jackson et al., 2020; NMFS, 2015). Recently, researchers found that potential feeding grounds of southern right whales changes from mid-latitude shelf and oceanic waters in September towards higher latitude waters in December, a situation that holds throughout the summer (González Carman et al., 2019). Three likely foraging grounds were also recently identified: southwest Western Australia, the Subtropical Front, and Antarctic waters, with the Subtropical Front appearing to be a feeding ground for both New Zealand and Australian southern right whales (Mackay et al., 2020). Off the Falkland Islands, southern right whales appear to use pelagic waters to comprise their summer foraging habitat, and may also use these waters as a migration corridor between the Patagonian shelf and feeding grounds located further south and east (Weir et al., 2020). Additionally, a portion of the southwest Atlantic population could also be using the Falkland Islands as a novel wintering destination, for breeding or socializing purposes. Weir et al. (2020) suggests the importance of the Falkland waters as a multi-use southern right whale habitat.

Preferred summer habitat includes areas where oceanographic and bathymetric features such as steep bottom topography, relatively cool water temperature, water column stratification, and ocean currents concentrate euphausiids and other krill species (M. Arias et al., 2018; Australia, 2012; NMFS, 2015). Water depth is also an important determinant of habitat suitability at a fine-scale within aggregation areas, with southern right whales preferentially occupying water less than 10 meters deep off the Australian coast, and in waters less than 2,000 meters deep in spring and winter off the coast of Namibia (Australia, 2012; De Rock et al., 2019). Additionally, highly suitable habitat areas for southern right whales overlap with the Subtropical Frontal Zone and the Polar Front, indicating that these frontal systems stand as important potential feeding grounds for southern right whales from late spring to early fall at a circumpolar scale (González Carman et al., 2019).

Calving and nursery grounds occur in a broad latitudinal band between 16°S and 52°S which cover a wide environmental range, but habitat providing some level of protection from prevailing weather conditions is generally preferred by southern right whales (Australia, 2012). Calving/nursery areas appear to be exclusively coastal, either off continental land masses or oceanic islands. These are occupied during late autumn, winter and early spring and other near-shore waters connecting calving/nursery areas are also occupied at that time (Australia, 2012; González Carman et al., 2019).

2.3.1.6 Other:

No other relevant information is available.

2.3.2 Five-Factor Analysis

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

No new habitat threats have been identified since the last 5-year review in 2015 (NMFS, 2015). Threats to southern right whale habitat continue to include local activities and global processes. For example, coastal and marine development, chemical pollution, climate change, and tourism may all adversely impact their habitat.

Globally, oceans are facing pressures from anthropogenic activities (Halpern et al., 2019). A bulk of these pressures include coastal and marine development which has broad implications for southern right whale habitat. Development pressures occur in all countries where the southern right whale is found, and the impacts can be both direct and indirect and can contribute to habitat change, reduction of habitat availability, and loss of ecosystem services (Halpern et al., 2019). In Australia, habitat modification via the development of infrastructure such as ports, marinas, aquaculture facilities, and ocean/marine energy production facilities creates physical displacement of southern right whales from their preferred habitats and can also disrupt their normal behavior (Australia, 2012). For example, the Bonney Upwelling region off the coast of Australia, which includes a winter breeding ground for southern right whales, encompasses development activities that can affect southern right whale habitat. Some of these activities include gas exploration and development, and the proposed development of wave power generators (Gill et al., 2015). This displacement has the potential to reduce breeding success by forcing animals to reproduce in more marginal environments and by increasing their exposure to other threats such as entanglement, predation, vessel strikes and pollution (Australia, 2012). Associated industrial activities in Australia's coastal zone can also reduce habitat suitability for southern right whales. Additionally, Spencer Gulf, in South Australia is a breeding ground for the southern right whale, and industrial development is forecasted to increase this area (Gill et al., 2015). However, the extent and impacts of these forecasted coastal and marine development activities are largely unknown, but significant interest exists to expand resource exploitation and subsequent infrastructure in the region (Gill et al., 2015).

More recently, the southeastern Brazilian coast has experienced increasing coastal development which is an important breeding and possibly calving area for southern right whales (Figueiredo et al., 2017). Within this region, the Campos and Santos basins represent two of the most productive oil and gas basins found in southeastern Brazil. It comprises the most urbanized shoreline in Brazil, holding five of the largest ports, five smaller ports, and several marinas (Figueiredo et al., 2017). Considering the population growth rates estimated at 14% by Groch et al. (2005) and 12% by the IWC (2012) to the Brazilian stock, and 6% by the IWC (2012) to the population in Argentina, it is expected that this population may expand its range far from the main breeding area, possibly reoccupying pre-whaling grounds as was reported for other areas (Figueiredo et al., 2017; Groch et al., 2005; International Whaling Commission, 2012b). However, intense urbanization and coastal development of the southeastern Brazilian coast may

affect this stock recovery. Coastal development activities in this area such as oil and gas production, mineral extraction, seismic survey activities, increase noise pollution in the low frequency which can cause entanglements and collisions, which lead to cumulative human-induced impacts to southern right whales (Figueiredo et al., 2017).

In the Southern Hemisphere, harmful algal bloom (HAB) events have been increasing in strength, intensity resulting in mortality events for many cetacean and marine mammal species (Häussermann et al., 2017). Increased frequency of extreme El Niño events due in part to climate change and increased sea surface temperature, has contributed to the heightening of favorable conditions for HAB events, making toxins a growing concern for marine species and their prey (Häussermann et al., 2017). Within the southern right whale calving ground of Peninsula Valdes, Argentina, satellite data show that phytoplankton dynamics have changed in the region since the 1990s (Wilson et al., 2016). In addition, right whale mortality has increased in this region since 2005, with most deaths (~90%) being calves < 3 months old (Wilson et al., 2016). The magnitude of the spring phytoplankton bloom has also increased considerably and has become more frequent in the region resulting in higher abundances of the diatom, *Pseudo-nitzschia* spp. Frustules of *Pseudo-nitzschia* spp. have been recorded in fecal samples from southern right whales in the region, indicating there is local direct foraging or trophic transfer of these potentially toxic species (Wilson et al., 2016). Furthermore, Wilson et al. (2016) found a positive statistical relationship between *Pseudo-nitzschia* densities and calf deaths at Peninsula Valdes, Argentina.

Overall, the effects of climate and oceanographic change on southern right whales remains uncertain, but these changes have the potential to greatly affect habitat and food availability. It is recognized that climate change will substantially alter ocean conditions (Intergovernmental Panel on Climate Change, 2007) and can affect southern right whale habitat and health. For example, climate change is accompanied by changes in sea surface temperature, salinity, ocean circulation, precipitation, upwelling, ice coverage, and sedimentation. As a result, these changes may alter food availability, migration routes, reproductive rates, and trophic relationships for whale species. See Section 2.3.2.5 for further details.

Summary
Habitat threats are not currently a significant cause of southern right whale mortality, but could become so in the future. Most populations continue to grow at ~7% each year (Harcourt et al., 2019). It is unknown whether these threats will affect population recovery.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

Commercial
Southern right whales were hunted extensively by pre-modern whaling beginning in the early 17th century, and in the 18th and 19th centuries by American and European whalers which depleted populations throughout the Southern Hemisphere (Cooke et al., 2018). Primarily hunted by French, U.S., and British whalers, southern right whales were caught in large numbers off Brazil, Argentina, Southern Africa, New Zealand, Australia and Tristan da Cunha. These efforts reduced some populations to near extirpation (NMFS, 2015). The decline of the southern right

whale is the best understood of all the right whale species. Prior to whaling, it is estimated that approximately 120,000 southern right whales were found in 12 wintering grounds (Figure 1; Harcourt et al., 2019). However, between 1790 and 1971 up to 150,000 southern right whales were killed, reducing them to near extinction globally (Carroll et al., 2019; Charlton, 2017; Harcourt et al., 2019; J. Jackson et al., 2008). There is some uncertainty over the numbers of southern right whale individuals killed but not landed, since not all whaling records have survived or are incomplete. Thus, assessments of whale recovery using pre-modern exploitation indices are therefore rare, despite the intensive, global nature of nineteenth century whaling. Jackson et al. (2016) presented the first integrated population-level assessment of the whaling impact and pre-exploitation abundance of the New Zealand southern right whale using a Bayesian population dynamics model integrating multiple data sources from 19th century catches, individual sightings histories, and genetic constraints on bottleneck size. Jackson et al. (2016) reported that from a pre-exploitation abundance of 28,800-47,100 whales, nineteenth century whaling greatly reduced the population to approximately 30-40 mature females between 1914 and 1926. Today, New Zealand southern right whales stand at less than 12% of pre-exploitation abundance (Jackson et al., 2016).

Full protection from commercial whaling was provided for all right whale species under the Convention for Regulation of Whaling (CRW) in 1931 under the League of Nations. Japan did not accede to the CRW, but the CRW provided the framework for the future regulation of whaling that continues to today as the 1946 International Convention for the Regulation of Whaling (ICRW) (Harcourt et al., 2019). Both the Soviet Union and Japan acceded to the ICRW. However, like the CRW, the ICRW was not perfect and even as various species recovered from historical whaling, southern right whales were targeted illegally by the Soviet whaling fleet from the 1950s through 1970s (Harcourt et al., 2019; NMFS, 2015). From 1950 – 1971, Soviet whalers killed 3,364 southern right whales illegally in the Antarctic (NMFS, 2015). The largest of these documented illegal catches was 1,335 right whales off Patagonia during the 1960s by Soviet vessels (NMFS, 2015). Illegal whaling greatly impacted the southern right whale population, which killed half the extant population at the time. Today, the southern right whale is estimated to have recovered to 12,000 – 15,000 individuals across its circumpolar distribution (Figure 1) (Cooke et al., 2018; Harcourt et al., 2019). There has been no direct evidence of directed killing since the 1980s, and direct kill for human consumption has not been documented since the 1990s (NMFS, 2015). In addition to international protection, commercial whaling of southern right whales is prohibited by various state and national laws.

Recreational

The growth of whale-based tourism continues to increase in popularity and is both a catalyst and product of coastal development. Major whale tourism industries operate in Argentina (Península Valdés, Puerto Madryn, and San Matias Gulf), South Africa (Walker Bay and Hermanus), Brazil (Santa Catarina), and Australia (Head of the Bight and Warrnambool). Whale watching attracts tourists from around the world and generates millions of dollars in revenue for national governments and local businesses. Globally, whale-watching has increased exponentially in recent decades (B. A. Chalcobsky et al., 2017). Whale watching has been defined as any activity involving sighting or listening to any species of whale, dolphin or porpoise from the air, land or vessel tours with commercial purpose (B. A. Chalcobsky et al., 2017). More than 13 million people travel around the world to experience whale watching, spending more than US $2.1

billion during 2008; in Latin America, each year, there are more than 885 whale watchers who spent more than USD $278 million (B. A. Chalcobsky et al., 2017).

In Argentina, whale watching has become an increasingly popular tourist activity. In fact whale watching has become so popular in the San Matias Gulf region of Australia that an experimental program of whale watching tourism was started in 2012 (Arias et al., 2015). This program, designed according to the current legal framework for the San Matias Gulf region and enforced by the Environment and Sustainable Development Secretary of the Rio Negro Province, authorized four small tourism companies to develop whale watching in the San Antonio Bay Marine Protected Area with oversight from a local university to monitor the activity and assess the environmental and species impact (Arias et al., 2015). The annual number of tourists since 2012 ranged between 1,041 and 2,150 (data provided by the coast guard service -Prefectura Naval Argentina- and tourism companies), with a total of 145 whale watching trips carried out during 2014 (Arias et al., 2015), however adverse impacts from these whale watching activities remain uncertain. Additionally, whale watching in Puerto Piramide, Argentina started in 1973, and the demand has increased from 70 passengers to more than 100,000 passengers in 2010 making it the main economic activity in that area (Chalcobsky et al., 2020). In Brazil, whale watching grew 4% each year from 1999-2008, and the number of whale watchers exceeded 228,000 in 2006 (e. a. Groch, 2009).

In Australia, commercial and private boat based whale watching targeting southern right whales is currently located primarily in Flinders Bay and off Albany in southern Western Australia, around the Fleurieu Peninsula in South Australia, in south-west Victoria off Portland, in Warrnambool and in Eden, New South Wales. Opportunistic whale watching also occurs in Tasmania, Western Australia and New South Wales (Australia, 2012). As opportunistic whale watching occurs where the numbers of whales are lowest and most inconsistent, there may be a more significant impact on the animals if the activity causes disturbance and is not actively managed (Australia, 2012). While the IWC recognizes commercial whale watching as a potentially "sustainable use" of whales and other cetaceans, some concerns have been raised regarding collisions and disturbance from boat noise (Argüelles, Coscarella, et al., 2016; Australia, 2012). Repeated exposure of individuals with long residency periods may also be problematic. Detailed analysis of the behavioral response of southern right whales to boats in Australian waters is not yet available but boat avoidance has been demonstrated in other areas (Argüelles, Coscarella, et al., 2016).

Overall, the possible adverse impacts of tourist activities on whale populations are inconclusive. For example, only short-term effects of whale watching on behavior has been evaluated thus far off the coast of Argentina, where whale watching began in 1973 targeting southern right whales (Chalcobsky et al., 2020). However, little is known regarding the long-term effects of whale watching behavior. A recent study off the coast of Golfo Nuevo, Peninsula Valdes, Argentina trying to understand some of the long-term effects of whale watching suggest that a proportion of whales that visit this whale watching area may come once and never return (Lindner et al., 2020). The authors do note that due to the limitations of the study and data gathered it is unknown if whale watching is the cause (Lindner et al., 2020). Other studies off the coast of Peninsula Valdes, Patagonia, Argentina have shown that the southern right whale exhibited short-term reactions to boats, changing their behavior in response to the approaching boats (Argüelles, Coscarella, et al., 2016). If the boat approached appropriately (i.e. with the engines

off), individuals reacted positively by approaching the boat and seeking contact, whereas if the boat approached inappropriately (i.e. with the engines on), individuals reacted negatively by moving away from the boat and avoiding contact (Argüelles, Coscarella, et al., 2016). This study illustrates that if whale watching is carried out with the appropriate regulations and environmental responsibility, it could be sustainable.

A more recent study conducted by Chalcobsky et al. (2020) off the coast of Puerto Piramide, Argentina evaluated boat effects on individual southern right whales and found that short-term movement patterns of individuals in the area were not severely affected by whale watching operations. However, significant changes in breathing rates in the presence of boats was observed which deserves further attention and study to see if whale watching activities are detrimental to the physiological health of the southern right whale (Chalcobsky et al., 2020). Furthermore, other studies have shown that interactions between whale watching boats and whales can also cause short-term changes and interruptions of breast-feeding and of resting, and the dissolution of mating groups (Lindner et al., 2020). Senigaglia et al. (2016) conducted the first meta-analysis of whale watching studies across multiple cetacean species and found that the most consistent short-term responses to whale watching vessels were disruptions of whale activity and path directionality. Additionally, cetaceans were more likely to travel and less likely to rest and forage in the presence of whale watching vessels (Senigaglia et al., 2016).

Whale watching is regulated by a variety of laws, guidelines, and policies throughout the Southern Hemisphere. Nations take varied approaches to regulating whale watching within their waters. In Argentina, the Province of Chubut started regulating whale watching in 1984 by the law of marine wildlife watching (e.g. Provincial Law of Chubut N°2381) and passed several provincial regulations (e.g. Provincial Law of Chubut N°5714 and Provincial Decree of Chubut N°167) which established a restricted area for whale watching boats, along with the number, activities, approach distance, trip duration, and conduct of whale watching boats (Chalcobsky et al., 2020). In addition, the regulations in place prohibit boats to approach new-born calves until August 31st and set the duration for sighting and boat maneuvers that are prohibited, mainly to protect calves (Chalcobsky et al., 2020). In Australia, whale watching guidelines have been incorporated into federal legislation. The guidelines set national standards to minimize the impacts of these activities on whale populations and aim to help local governments develop consistent whale watching regulations (Australia, 2017). In New Zealand's Aukland Islands, a moratorium on all whale tourism between April and October was put in place in 2002 to further protect southern right whales (Carlson, 2007). A detailed review of whale watching guidelines and regulations for Argentina, Australia, Brazil, New Zealand, South Africa and other nations within the Southern Hemisphere is provided in Carlson (2007).

Scientific Research

Satellite tagging is a powerful tool for studying and monitoring the actual migration patterns, movements, and distribution of cetaceans and other marine animals. It is an especially unique tool to track marine animals that are otherwise difficult to access or exhibit cryptic behavior commonly found in large whale species. However, deep tissue application of satellite tags to cetaceans can be invasive, which may result in potential tissue damage and infection. Best (2015), satellite-tagged sixteen southern right whales on the South African coast to determine tag retention, injury, and healing from tag application, and compare reproductive output between

tagged and untagged females. Tags were shed within 36 months of application, with one exception where a tag was present after 11 years. Healing at the tag site occurred gradually within 5 years of tagging and 2 years after tag shedding. Calving frequency was similar between 12 tagged and 382 untagged females. The results from this study are similar to P.B. Best et al. (2007), which compared calving frequencies before and after tagging in seven satellite-tagged southern right whales off South Africa and found no significant differences between tagged and untagged animals, but the samples sizes were too small to detect possible long-term effects. Nonetheless, six out of seven tagged cows with calves gave birth to a subsequent calf within intervals comparable to those prior to tagging suggesting the procedure had no major negative impact on reproduction (P. B. Best et al., 2007).

Summary
Take is prohibited throughout the Southern Hemisphere, and illegal catches have not been documented or known to occur in the last three decades. Whale watching has increased in some areas, but the possible adverse impacts (especially long-term impacts) of these activities on whale populations remain uncertain. Many nations have adopted regulations to minimize impacts. The available information does not support adverse effects resulting from scientific research activities. Thus, overutilization is not considered a significant threat to the southern right whale.

2.3.2.3 Disease or predation:

There has been an increase of stranded southern right whale carcasses since 2003 within two bays (Golfo Nuevo and Golfo San Jose) on Peninsula Valdes, Argentina, where the whales congregate in winter and spring (Cooke et al., 2018). The number of carcasses found averaged 63 per year during 2006-2015, of which about 90% were newborn calves and 93% and 96% were newborn calves in 2016 and 2017, respectively (Cooke et al., 2018; Sironi et al., 2016; Sironi et al., 2018). A number of possible factors in the calf deaths have been suggested, including nutritional stress, biotoxin exposure from harmful algal blooms (Wilson et al., 2016), and harassment by from Kelp gulls, *Larus dominicanus*, resident to the region of Peninsula Valdes (International Whaling Commission, 2016). There has been concern that the level of mortality may be anomalously high (a “die-off”) (Cooke et al., 2018). However, a long-term analysis of calf mortality rates in this population showed that the rate has remained fairly low over most of the last 40 years, averaging around 18% with some inter-annual fluctuation but with recent levels not being unusually high (Cooke et al., 2015). For a number of cetacean populations, only a small proportion of dead animals are ever found (Williams *et al*. 2011), but the geography of the Peninsula Valdez wintering ground with its two semi-enclosed bays likely facilitates the stranding and discovery of dead calves. This provides a unique opportunity to study the causes of southern right whale calf mortality.

Kelp gulls have developed a unique behavior of landing on the backs of southern right whale adults and calves, where they feed on their skin and blubber. This parasitic behavior results in large open wounds on the dorsal surface of the whale, and is of particular concern in the Peninsula Valdes region as it may contribute to disease transmission or other physiological adverse effects in southern right whales. Kelp gull attacks which result in gouging skin and blubber from the whales’ backs, is extensive in the Peninsula Valdes nursery ground (Cooke et

al., 2018). However, this appears to be learned behavior that has spread through the growing gull population and has increased by 2.7% per year from 1994-2008 (Cooke et al., 2018). It is thought that the resulting wounds are a contributory factor in some calf deaths, and a number of mitigation measures have been proposed to reduce the rate of kelp gull attacks on southern right whales (Maron et al., 2015).

The study of physiological impacts from these Kelp gull attacks are informative in assessing the importance of this threat to southern right whales since they can potentially impact the health of both adults and calves, such has dehydration, impaired thermoregulation, and energy loss due to wound healing (Maron et al., 2015). Ajo et al. (2020) quantified levels of glucocorticoids and thyroid hormone extracted from the baleen of 36 dead southern right whale calves to evaluate the endocrine response of whale calves to gull wounding and harassment. While glucocorticoids (GCs) are known to increase in response to stressors such as disturbance, the metabolic hormone triiodothyronine (T3) has been shown to remain stable (Ajo et al., 2020; Ajo et al., 2018). The authors found a positive correlation of GCs with wound severity, while T3 levels remained stable irrespective of the severity of the wounding, indicating that heavily wounded calves are suffering high levels of chronic physiological stress, but do not suffer from malnutrition before they die. This study suggests that Kelp gull wounding may have contributed to the high southern right whale calf mortality observed in the Peninsula Valdes region of Argentina (Ajo et al., 2020; Ajo et al., 2018). Biopsies of skin lesions obtained from living and dead southern right whales attacked by Kelp gulls at Peninsula Valdes showed the presence of poxvirus, which is linked to stress due to environmental degradation (Fiorito et al., 2014). Swabs of wounds caused by the kelp gulls revealed anaerobic bacteria, *Erysiphelotrix* spp, which results in a disease called erysipelas in birds and mammals. The bacteria has been reported in cetaceans and is thought to be acquired through their diet, but opportunistic colonization could occur in the wounds from kelp gull attacks (Fiorito et al., 2014). More recently, Fiorito et al. (2016) detected the presence of *Erysipelothrix rhusiopathiae* via culture and PCR in calf tissue samples, which is the first time *E. rhusiopathiae* has been isolated from wounds produced by Kelp gull attacks on southern right whale calves, supplying evidence that these wounds may act as an entry route for pathogens.

Behavioral changes have also been documented in southern right whales in response to Kelp gull attacks. Fazio et al. (2015) noted that southern right whales react negatively and alter their behavior in response to gull attacks; individuals submerge their backs when resting on the surface, and only expose their head and blowhole when emerging to breathe (Fazio et al., 2015). Additionally, since it has been noted that mother-calf pairs are the primary targets, pairs attacked by gulls spend less time nursing, resting, and playing than pairs not under attack (Maron et al., 2015).

To help mitigate and ameliorate the problem of Kelp gull interactions with southern right whales, the people of Puerto Piramedes (in the Province of Chubut), Argentina has taken part in many meetings to start some actions against Kelp gulls. Kelp gulls in the region has been tied to poor waste management, which has led to an overpopulation of this species of gull (Argüelles, Coscarella, et al., 2016; Fazio et al., 2015; Stefanski et al., 2015). Thus, the government of Chubut Province has implemented a management action plan to reduce kelp gull attacks to southern right whales.

Many southern right whales calves have died at the Peninsula Valdes calving ground in Argentina (at least 706 right whale calf mortalities have been recorded between 2003 and 2017). Maron et al. (2019) analyzed the intestinal contents from 44 dead calves that stranded at Peninsula Valdes from 2005 to 2010, and found 108 bacterial genera, and identified many commensal and beneficial bacterial species. They also identified several potential pathogens such as *Clostridium perfringens* (Marón et al., 2019). However, further research is required to determine whether *C. perfringens* or other pathogens detected in this study are causative agents of calf deaths at Peninsula Valdes (Marón et al., 2019). Poxvirus skin disease has been reported in several cetacean species, principally odontocetes, and a single report in mysticetes. Southern right whales have exhibited a variety of skin lesions of unknown etiology, and the number of these lesions has increased in recent years. Fiorito et al. (2015) took samples from dead whales to study the etiology of these skin lesions and found poxvirus in southern right whales in Argentina. This study provides the first evidence of poxvirus skin lesions in southern right whales in Argentina and provide evidence for a new disease that possibly threatens this population of southern right whale (Fiorito et al., 2015). Other possible causes of disease-related death of southern right whales at Peninsula Valdes reported by McAloose et al. (2016) include pneumonia, myocarditis, and meningitis. Additionally, ante-mortem Kelp gull parasitism was associated with systemic disease in a single 1-3 month old calf (possibly from resulting skin lesions) (McAloose et al., 2016). In 2015, the first ever documented isolation of *Leptospira* spp. strain from a southern right whale calf's kidney was reported in Peninsula Valdes, Argentina (Loffler et al., 2015). Leptospirosis is the most widespread zoonotic disease in the world and is caused by pathogenic spirochetes of the genus *Leptospira* spp. (Loffler et al., 2015). Isolation of a *Leptospira* strain in a southern right whale calf and further PCR analysis indicated that this strain is likely pathogenic to the species, however, further studies are needed to confirm the possibility of this strain as a new potential threat to the species (Loffler et al., 2015).

Recently, off the coast of Brazil, Bianchi et al. (2018) reported streptococcal septicemia in a southern right whale calf and determined that this was responsible for the stranding and death in this individual and additionally confirms pathogenicity of streptococci in cetaceans which adds to the limited health and disease related pathology knowledge for this species (Bianchi et al., 2018). Groch et al. (2019) documented cetacean morbillivirus in three necropsied southern right whales from a breeding and calving ground in Santa Catarina state, Brazil (Groch et al., 2019). Thus, a number of cases of bacterial and viral infections have been reported in southern right whales off the Brazilian coast.

Summary

Attacks by kelp gulls are a significant threat to individual southern right whales in coastal waters off Argentina, and may explain the decrease in the population growth rate, with the latest estimation being 0.54% (Romero et al., 2018). However, it is still unclear whether the attacks are directly affecting calf mortality rates, since long-term analysis of calf mortality rates in this population showed that the rate has remained fairly low over most of the last 40 years, averaging around 18% with some inter-annual fluctuation, but with recent levels not being unusually high (Cooke et al., 2018). Additionally, newly described cases of bacterial and viral infections, and several potential pathogens identified in the southern right whale could pose a potential threat to the population, however further research is required to determine whether these cases are affecting the southern right whale at the population level.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

The southern right whale has been legally protected from commercial hunting since the 1930s, but this has only been fully respected since the early 1970s when the presence of the international observers discouraged illegal catching by Soviet fleets, and land stations in South America also stopped taking right whales. Today, the southern right whale continues to be protected and managed under a number of international instruments, federal, national, and state laws, regulations, policies, plans, strategies, and protected areas throughout the Southern Hemisphere. The adequacy of these regulatory mechanisms varies by nation and region. In general, the relevant management authorities have established either (a) comprehensive protection of southern right whales or (b) a regulatory framework which could lead to comprehensive protection. These regulatory mechanisms are independent of the listing status of the southern right whale under the ESA and would continue irrespective of a status change.

International

At the international level, the southern right whale receives several protections from the IWC. Under the 1946 International Convention for the Regulation of Whaling, the IWC can designate sanctuaries for the conservation of whale resources (Article V(1)(c)). In 1979, the IWC created the Indian Ocean Sanctuary, essentially closing the entire Indian Ocean to commercial whaling. Several decades later, the IWC established the Southern Ocean Sanctuary, which prohibited all commercial whaling within a 50 million km^2 area surrounding Antarctica. In addition, southern right whales received international protection in 1935 when the 1931 Geneva Convention for the Regulation of Whaling entered into force and prohibited the taking or killing of right whales by all nations bound by the Convention. A conservation management plan (CMP) was developed for the south Atlantic populations with the objective to protect southern right whale habitat and minimize anthropogenic threats to maximize the likelihood that southern right whales will recover to healthy levels and recolonize their historical range (International Whaling Commission, 2012a).The conservation plan calls for increasing public awareness and building capacity in range states; determining movements, migrations, and location of feeding grounds; and developing a GIS database on human activities that may have adverse effects to southern right whales (International Whaling Commission, 2012a). Recent progress to date includes capacity building of range states to respond to whale strandings, studies of satellite telemetry on southern right whales off Peninsula Valdes to determine their migratory route, and efforts to share data across catalogues that provide complementary information (South Atlantic Southern Right Whale CMP). Several workshops have also been held, including on calf mortality and possible links with kelp gull harassment in nursery areas, and on identification of sensitive areas in Argentine waters (International Whaling Commission, 2016). In 2012, the eastern South Pacific southern right whale CMP was endorsed by the IWC. Both Chile and Peru are signatories to the CMP, and Chile was appointed coordinator for the CMP in 2017. The overall aim of the CMP is to guide and encourage the recovery of the population to a level that will allow it to withstand both environmental and anthropogenic impacts, and ensure its long-term survival (Eastern South Pacific Southern Right Whale CMP). In November 2018, the first multi-national Combined Capacity Building on Cetacean Strandings and Entanglement Response Training under the CMP was successfully conducted in Lima, Peru. The training was attended by nearly 60 representatives from government, universities, and NGOs from Chile and Peru. Also in

November 2018, a Memorandum of Understanding was signed between Chile and Peru's Ministries of Foreign Affairs, to coordinate co-operation on the conservation of the population.

The southern right whale is also protected by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention on the Conservation of Migratory Species of Wild Animals (CMS), and the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR). CITES regulates the international trade of over 35,000 species to ensure their survival is not threatened. Under CITES, the southern right whale is listed as an Appendix I species, meaning the species is threatened with extinction and trade of the species (whole or parts) is prohibited except in exceptional cases such as scientific research. There are 183 Parties to the Convention, including the four nations known to contain primary wintering grounds for the species (Argentina, Australia, New Zealand, and South Africa).

The CMS also aims to conserve migratory species on a global scale and promotes conservation action among nations. The southern right whale is listed as an Appendix I species, meaning it is threatened with extinction, and as a result, nations are obligated or strive to protect, conserve, and restore the species and their habitat and mitigate any threats or impacts. There are 132 parties to the CMS including South Africa, Australia, New Zealand, and Argentina. CCAMLR was adopted in 1980 and entered into force in 1982. CCAMLR applies to the Antarctic marine living resources of the area south of 60°S and to the Antarctic marine living resources of the area between that latitude and the Antarctic Convergence, which form part of the Antarctic marine ecosystem. CCAMLR's purpose is to conserve the living resources of the Southern Ocean, but not to exclude harvesting carried out by nations. CCAMLR can contribute to recovery of the southern right whale through management of krill stocks, establishment of marine protected areas (MPAs), and management of other human activities that may affect the Antarctic ecosystem. There are 26 Members and 10 Acceding States to CCAMLR including South Africa, Australia, New Zealand, Chile, Brazil, Peru, and Argentina.

South Africa

Protection of southern right whales within waters belonging to South Africa primarily falls under the 1998 Marine Living Resources Act (MLRA). By regulation, the MLRA prohibits the taking of whales without a permit. Under Section 43 of the MLRA the Minister of the Department of Environmental Affairs and Tourism (DEAT) may designate waters as MPAs for the conservation and protection of species and their habitat. In 2019, DEAT announced 20 new MPAs, a move that increases the oceans protected around the country's mainland territory from 0.4% to 5%, which took effect on August 1, 2019. These additions build on and revise the existing network of 25 MPAs, bringing the country's total number of mainland territory MPAs to 41. Nearly all of the MPAs include known southern right whale habitat. MPAs designated under the MLRA prohibit any activity that may adversely impact the ecosystem such as fishing, dredging, drilling, seabed mining, fishing and pollution, or construction, unless such activity has been permitted by the Minister. In addition to MPAs, Section 77 of the MLRA allows the Minister to designate closed areas by regulation. Closed areas strongly regulate fishing or prohibit these activities completely. There are ten designated closed areas. Typically these areas either prohibit the setting of rock lobster traps, which are one of the leading causes of whale entanglements, or only allow shore fishing from limited areas.

Despite the number and extent of MPAs, the protection for southern right whales and their habitat may be limited. An assessment of MPAs in South Africa concluded that many of the parks lack a management plan, trained staff, adequate enforcement capabilities or a budget and, as a result, are unable to effectively manage or protect their resources. Many of these problems have been linked to (1) the MLRA's focus on fisheries enforcement rather than ecosystem conservation, and (2) the lack of communication and coordination between the Marine and Coastal Management Branch of the DEAT, which holds legislative authority over MPAs, and the regional conservation agencies that are responsible for day-to-day management (Chadwick. P et al., 2014).

Although southern right whales are not listed under South Africa's Biodiversity Act of 2004, the Act was amended in 2013 to emphasize the need to protect the ecosystems, including species which are not listed or targeted for exploitation. The Act can help protect ecosystems and habitats upon which threatened species depend through the development of bioregional plans (Sec. 40) or biodiversity management plans (Sec. 44). However, no bioregional plans or biodiversity management plans have been established for southern right whales (NMFS, 2007). Protection of southern right whales could also be potentially addressed through the South African National Biodiversity Institute (SANBI). The Biodiversity Act established SANBI and charged the Institute with monitoring the status of the nation's biodiversity and the conservation status of all listed threatened or protected species (Sec. 11(1)(a)). SANBI manages a number of conservation, research, and education programs regarding biodiversity, but the majority focus on terrestrial species. No programs address the conservation, protection, or management of southern right whales, but the marine program is considering including this species in its efforts to establish offshore MPAs and to develop an offshore conservation plan (NMFS, 2015).

Argentina

In Argentina, the southern right whale is protected at both the national and provincial level, but these regulatory mechanisms are not as extensive as those of other nations. In 1988, the Argentine National Congress declared the species a Natural Monument (Law 23094). The designation only applies in national territorial waters, and in 2006 the law was ratified by the Northeast Patagonian province Río Negro, but other provincial governments have not ratified the law (NMFS, 2015). In 1999 the United Nations Educational, Scientific, and Cultural Organization (UNESCO) inscribed Peninsula Valdes as a World Heritage Site. The Peninsula was established specifically for conservation of breeding right whales and their habitat. UNESCO also recognized the site for its in-situ conservation of biological diversity. Designation as a World Heritage Site does not automatically confer protections for southern right whales. Rather it encourages management agencies to address issues that adversely impact these sites. Protected areas with specific management measures aimed at protecting southern right whales in their nursery grounds include the Right Whale Environmental Protection Area the Golfo San José Provincial Marine Park (Parque Marino Golfo San José) in Argentina by the Provincial Chubut government (Provincial Law 1238). The purpose of this park is to provide protection to a critical breeding area for southern right whales.

In 1995, a strict marine reserve was created in Golfo Nuevo to strengthen the protection of the southern right whale, extending five nautical miles from the shore around most of the peninsula. The Chubut Provincial Tourism Organization is in charge of the reserves. Since the 1970s, there

are wildlife guards supporting local police and the National Coast Guard (UNESCO). Most of the land is privately owned in large "estancias". Decision-making requires a dialogue with representatives of all stakeholders, of which landowners are a major group. The management of the property encompasses a strong research component involving the National Centre for Patagonia and many national and international academic and non-governmental partners. In-situ conservation measures are complemented by national and international instruments applicable to the southern right whale (UNESCO).

Locally, whale watching activities are regulated by the government of the Chubut Province and Río Negro. Whale watching was first regulated by the Provincial government in 1984, and is now subject to several laws and decrees. In July 1986, Provincial Decree No. 916 (and its subsequent amending Decree No. 1127/91) established a registry of whale-watch tour operators, stipulating that a maximum of 5 licenses would be granted to operators for a maximum of two years at a time (IWC Whale Watching Handbook). The decree also established a registry for specialist whale guides and skippers, who could register only after having undertaken approved courses on basic whale biology and codes of conduct (vessel-handling) in the presence of whales (IWC Whale Watching Handbook). However, there is a high degree of non-compliance from the industry due to the lack of effective enforcement and the inadequacies of current regulations. Government officials have acknowledged that new regulations need to be created and that these regulations should be based on the findings of studies investigating the adverse impact of whale watching (IWC Whale Watching Handbook) (NMFS, 2015).

The Whale Conservation Institute/Ocean Alliance (WCI/OA) and the Wildlife Conservation Society and Fundación Patagonia Natural direct the Argentine Right Whale Stranding Project. The Project has multiple objectives including collecting data and tissue samples from stranded right whales and developing a health assessment protocol for global comparison of right whale populations (NMFS, 2015). The WCI/OA began recording stranding data in 1971 and in 1994 began systematically surveying the Peninsula (NMFS, 2015).

Brazil

Federal Law no. 7.643/87, instituted in 1987, prohibits whaling including southern right whales. In 1995, the Governor of the State of Santa Catarina declared the southern right whale a State Natural Monument, and the species is listed under the Ministry of the Environment's National Endangered Species List. Listed species are protected by federal law from being hunted, captured, or commercialized, and agencies may develop recovery plans, establish conservation areas, or stimulate research programs. In 2000, Brazil established the Southern Right Whale Environmental Preservation Area off Santa Catarina. The Brazilian Environmental Institute (IBAMA), Brazil's national environmental authority, is responsible for issuing permits for conducting activities in the marine environment. For example, in 2005 IBAMA denied a permit for oil and gas exploration in shallow water in Boipeba, Bahia, due to adverse impacts to southern right whales and other species that occur in the area (NMFS, 2015).

Since 2015, boat-based whale watching has been prohibited, and a government management plan for whale watching is being finalized (IWC). Protected areas with specific management measures aimed at protecting southern right whales in their nursery grounds include the Right Whale Environmental Protection Area (Area de Protecao Ambiental de Baleia Franca) off

Catarina State in Brazil (IWC Whale Watching Handbook). Currently Federal Law 7643/87 forbids the hunting and harassment of cetaceans in Brazilian waters and the Edict 117/96 (modified by the Edict 24/2002) established the whale watching regulations which currently help protect southern right whales (IWC Whale Watching Handbook).

In 2018, the President of Brazil announced an increase in marine protection by 920,000 km^2 in four newly designated MPAs. This new designation increased the coverage of Brazilian MPAs from 1.5% to about 24.5% of the country's waters spread along the Brazilian coastline and hundreds of miles east and northeast of the Brazilian mainland (Mongabay Article from 2018).The protection for southern right whales is ancillary for most of these MPAs. Only one, the Right Whale Environmental Protection Area established in 2000 by Federal Law No. 6.902 and 6.938, is focused on the protection of the southern right whale.

Australia
Two main federal laws protect southern right whales within Australian waters: the Environment Protection and Biodiversity Conservation Act of 1999 (EPBCA) and the Antarctic Living Marine Resources Act of 1981. Under the EPBCA, the southern right whale was listed as endangered in 2000. Endangered is defined as any native species that is facing a very high risk of extinction in the wild in the near future (Sec.179(4)). The EPBCA prohibits any action that will have or is likely to have a significant impact on southern right whales and a recovery plan must be developed. The EPBC Act established the Australian Whale Sanctuary and gives high levels of protection to cetaceans in Commonwealth waters. The Australian Whale Sanctuary encompasses the area of the Australian Exclusive Economic Zone (EEZ) outside state waters and generally extends 200 nautical miles from the coast, but further in some areas to cover the continental shelf and slope. It also includes the waters around the Australian Antarctic Territory and external territories including Christmas, Macquarie, Heard and McDonald Islands.

Within the Australian Whale Sanctuary it is an offense to kill, injure, take, trade, keep, move or interfere with a cetacean. The EPBC Act also makes it an offence for Australians to carry out any of these actions beyond the limits of the Australian Whale Sanctuary, that is, in international or foreign waters. Other than in the case of killing, taking for live display, or trading, permits may be issued by the Australian Government Minister for Sustainability, Environment, Water, Population and Communities to carry out some activities that interfere with this species (e.g. for the purpose of research).

Marine bioregional plans have also been prepared under section 176 of the EPBC Act for the southwest, northwest, north, and east marine regions in Commonwealth waters around Australia. Each marine bioregional plan describes the marine environment and conservation values of the region, identifies and characterises the pressures affecting these conservation values and identifies regional priorities and outlines strategies to address them. As part of this process, southern right whales have been identified as a regional priority for the Southwest Marine Region.

The South Australian Government has declared a whale sanctuary and marine park at the Head of the Great Australian Bight (Head of Bight), which is a significant aggregation and calving area. This declaration permanently excludes activities that are disruptive to habitat, and/or have the potential to conflict with the whales, and prohibits mining from the Conservation Zones in state

waters. The Australian Government has declared a large extension to this sanctuary zone into Commonwealth waters creating the Great Australian Bight Marine Park, which protects over 1,200 km^2 of coastal waters for wintering southern right whales. This marine park has as one of its primary purposes the conservation of southern right whales. The State of South Australia established the Park in 1996, and the park was extended into Commonwealth waters in 1998. The park excludes activities that may negatively affect whales and prohibits mining from certain areas but allows fishing and boating access. Additionally, southern right whales are listed as vulnerable in South Australia and marine mammal regulations can be found under the South Australian National Parks and Wildlife Act 1972.

New Zealand

Under the Department of Conservation (DOC) New Zealand Threat Classification System, the southern right whale was listed in 2002 as Nationally Endangered in New Zealand. In 2008, a reassessment concluded the species should remain as Endangered due to a lack of a positive trend in abundance, its small subantarctic population, and its history of intense exploitation (NMFS, 2015). However, new information indicates the population is increasing (see Section 2.3.1.2 for further details), and thus the New Zealand Threat Classification System's 2019 assessment categorized this at risk species as 'recovering'. Under the New Zealand Threat Classification System, no specific protective measures are provided to listed species. Instead, the list is a management tool to assist wildlife managers in allocating resources to species recovery and site-based management programs (NMFS, 2015).

New Zealand's 1978 Marine Mammal Protection Act (MMPA) prohibits persons from taking or attempting to take any marine mammal within territorial waters or from importing or exporting marine mammal products (Sec. 4). The MMPA also allows for the designation of Marine Mammal Sanctuaries. Pursuant to this authority, the Auckland Islands Marine Mammal Sanctuary was established in 1993 and a marine reserve in 2003. The Sanctuary includes covers an area of roughly 484,000 ha in the Southern Ocean and stretches 12 nautical miles around the subantarctic Aukland Islands. The islands themselves are a National Nature Reserve and have World Heritage status because they are home, and breeding grounds for a wide variety of species. Both the islands and their aquatic environment are managed together by DOC. The Aukland Islands and marine reserve are completely protected from harvesting and prohibits the taking of all marine life.

In 1998 the UNESCO inscribed the New Zealand Sub-Antarctic Islands as a World Heritage Site. The site includes all lands and waters extending 12 nm from five island groups (the Snares, Bounty Islands, Antipodes Islands, Auckland Islands, and Campbell Island) and was inscribed for its high level of biodiversity, pristine habitats, endemism, and for its conservation, scientific and natural values. Designation of the islands as a World Heritage Site does not automatically confer protections for southern right whales. Rather it encourages management agencies to address issues that adversely impact these sites. For example, in the nomination document UNESCO encouraged the Ministry of Fisheries to regulate commercial fishing within the Sub-Antarctic World Heritage Site.

The New Zealand Biodiversity Strategy also has implications for the conservation of southern right whales. However, the Strategy does not provide protections for whales but rather

establishes a framework to conserve New Zealand's coastal and marine biodiversity. The framework defines desired outcomes for enhancing marine biodiversity and outlines specific actions to achieve these outcomes. Actions include improving monitoring systems to better identify, understand, and assess species and their habitats, mitigating adverse fishing impacts, identifying protected species, and developing recovery plans (Department of Conservation, 2000).

Other
The southern right whale is one of the three whales listed as endangered under Tasmania's Threatened Species Protection Act of 1995, which provides for the protection and management of Tasmania's threatened and endangered native flora and fauna, and to enable and promote the conservation of Tasmania's native flora and fauna. MPAs in Madagascar are located near recent sightings of southern right whales but neither address the species explicitly. The Namibian Islands' Marine Protected Area primarily aims to improve the status of threatened seabird species, but also aims to protect calving sites for the southern right whale (Ludynia et al., 2012).

Summary
Protections for southern right whales include a number of international, national, provincial, and state laws and policies. Within territorial waters, the level of protection and enforcement varies from extensive in some locations to non-existent in others. While a majority of countries have established federal legislation prohibiting the take of southern right whales, many lack comprehensive management or recovery plans for the conservation of right whales and their habitat. A variety of MPAs have been created in the Southern Hemisphere to protect southern right whales. These include the prime calving grounds around Peninsula Valdes (Argentina), Walker Bay (South Africa), Head of the Bight (South Australia), and the Namibian Islands' Marine Protected Area (Namibia). However, many of the these MPAs lack management plans, adequate staffing, funding and enforcement capabilities and it is difficult to assess whether these areas are effective in conserving and protecting southern right whale habitat. Thus, the best available scientific and commercial information do not indicate that existing measures are sufficient to counter threats to the species across its entire range.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Ship Strikes and Entanglements
Collisions with vessels and entanglements in fishing gear are the leading causes of human-induced mortality for southern right whales. From 1970-2010, 62 known or suspected ship collisions with southern right whales were reported in the Southern Hemisphere (NMFS, 2015). In Australian waters, there have been ten ship strikes with at least four mortalities and 28 entanglements with two mortalities, and a number of the fatalities include mother and calf pairs from the small, remnant southeast population (Harcourt et al., 2019).

Ship strikes in the Brazilian population still occur at low levels (<0.5 per year) but between 1999 and 2014, 38 entanglement cases were reported (Figueiredo et al., 2017; Harcourt et al., 2019). Additionally, the detection and exploitation of large oil and gas reserves offshore southeast Brazil, along with expansion of the main ports from Sao Paulo and Rio de Janeiro, has caused an

increase in boat traffic, posing a risk to southern right whales (Figueiredo et al., 2017). In 2012, an adult female southern right whale stranded off the coast of Rio de Janeiro died from the amputation of her peduncle caused by a large ship propeller, resulting in the first confirmed record of a vessel strike as the cause of death of a southern right whale in this area (Figueiredo et al., 2017).

In Argentina, 6% of whales identified in Golfo Nuevo showed evidence of vessel interactions via scarring (Harcourt et al., 2019), and there have been increases in the risk of collisions between whales and boats. In 2008, an accident near one of the piers of the Puerto Madryn harbor resulted in mortality of a southern right whale juvenile during the maneuver of an Argentine navy ship (Argüelles, Fazio, et al., 2016). Southern right whales regularly use the area of Golfo Nuevo for feeding, but since the deep waters of Golfo Nuevo are regularly used by ships and vessels as a route to enter the port, the increase in the probability of collisions between southern right whales and ships is expected (Argüelles, Fazio, et al., 2016). In Peninsula Valdes, evidence of blunt force trauma or lacerations (possibly caused by entanglement) was also reported in an additional 5 calves in 2003 and 2012 (McAloose et al., 2016).

In Australia, ship strikes are not considered a substantial problem, but some mortality has been reported in the region that can be tied to ship strikes. In August 2013, the body of an adult female southern right whale was sighted in a subtropical wintering ground in southeast Queensland, with the skull showing breakages at the base of the rostrum and through the back of the skull and the trauma to the posterior skull was a straight slice through the bone, indicating that this impact injury was from a large propeller blade (Lanyon et al., 2016). In August 2014, two more southern right whales were reported struck by a west-bound passenger ferry in Moreton Bay, resulting in the death of one of the individuals (possibly a juvenile) (Lanyon et al., 2016). While the number of vessel collisions with right whales in Australian waters remains small compared to populations elsewhere, if whales repopulate the southeastern coastline of Australia, where shipping traffic is more prevalent than other areas of the country, incidents are likely to increase (NMFS, 2015). Additionally, ship strikes and entanglement poses a greater risk for southern right whales when they are in the coastal zone of Australia due to the higher probability of encountering vessels. It is likely that this risk will increase as shipping traffic grows and the impact on an individual, especially in southeast Australia, is likely to have a significant, potentially population-scale effect (Australia, 2012). Furthermore, the potential for increased negative interactions between recovering right whale populations and increased human development has been identified as an issue of concern in Brazil, New Zealand, and eastern Australia (E. L. Carroll et al., 2015; Figueiredo et al., 2017).

Anthropogenic Noise

Humans have introduced sound intentionally and unintentionally into the marine environment for many purposes, including oil exploration, navigation, and research. Noise exposure can result in a multitude of effects, ranging from little or no effect to those being potentially severe, depending on source level and on various other factors. Marine mammal response to noise varies due to many factors, including type and characteristics of the noise source, distance between the source and the receptor, receptor characteristics (e.g., sensitivity, behavioral context, age, sex, and previous experience with sound source) and time of the day or season. Noise may be intermittent or continuous, steady or pulsatile, and may be generated by stationary or transient

sources. As one of the potential stressors to marine mammal populations, noise may disrupt marine mammal communication, navigational ability, and social behavior. Marine mammals use sound, both passively (i.e., listening) and actively (i.e., sound generation), to communicate, navigate, locate prey, and sense their environment (NMFS, 2015). Both anthropogenic and natural sounds may cause interference with these functions.

In Australia, Christiansen et al. (2020) assessed the potential behavioral response of southern right whale mother-calf pairs to UAVs which are used increasingly for wildlife research and monitoring. The study tracked the movement and breathing patterns of southern right whales before and during UAV approaches on a breeding ground in Australia (F. Christiansen et al., 2020). The researchers also measured the received noise level of the UAV on whales equipped with acoustic tags (DTAGs), to evaluate the likelihood of southern right whales perceiving the noise emitted by the UAV. No behavioral response to the UAV was observed, which provides support for UAVs as a noninvasive tool to study baleen whale behavior and ecophysiology (F. Christiansen et al., 2020).

In South Africa, researchers compared the effect of recent port developments on southern right whale mother-calf pairs in a nursing area on the Eastern Cape Coast (Koper et al., 2016). Soundscape contributors and sound levels of two neighboring nursing bays, St. Francis Bay (one recreational port) and Algoa Bay (two commercial ports), were compared. Wind, fish, snapping shrimp, and close vessels were contributing to noise levels in both bays (Koper et al., 2016). Additional sound sources in Algoa Bay were surf-zone noise, dolphins, and distant vessels. The overall sound levels in Algoa Bay were 5-25 dB re 1 µPa2 /Hz higher (Koper et al., 2016). However, mother-calf pair sightings per unit effort was 0.99 (St. Francis Bay) against 1.11 (Algoa Bay), resulting in a lack of evidence that mothers prefer quieter bays or bays with less frequent anthropogenic sound sources to nurse their calves (Koper et al., 2016). Thus further research is required to assess the importance and range of each sound source within the soundscape.

Climate Change

Southern right whales are both cool-and warm-water limited, and primarily feed on copepods and krill along the shelf waters of the eastern Tropical Pacific, which are characteristics that put the species at a high risk of being negatively impacted by warming ocean temperatures due to climate change (Macleod, 2009). As water temperatures increase due to climate change, the geographic range of the southern right whale may contract due to thermoregulation, and climatically driven changes in the abundance of southern right whale's main species, krill (*Euphausia superba*) may be affected (E. Seyboth et al., 2016). In waters around South Georgia, krill abundance declined when sea surface temperature was higher than normal, in association with El Nino events. This decline was attributed to the negative impact of warmer water on krill recruitment. As a consequence of the reduction in krill abundance the reproductive performance of many krill-dependent marine mammals and seabirds was dramatically reduced (E. Seyboth et al., 2016).

In southeastern Brazil, Seyboth et al. (2016) compiled annual data on southern right whale calving numbers obtained from aerial surveys between 1997 and 2013 in, where the southern right whales concentrate during their breeding season. Using a cross-correlation analysis, the

researchers examined the response of the species to climate anomalies and krill densities and found significant correlations with krill densities, Oceanic Nino Index, Antarctic Oscillation, and Antarctic sea ice area (E. Seyboth et al., 2016). The results from this study suggest that global climate indices influence southern right whale breeding success in southern Brazil by determining variation in food (krill) availability for the species (E. Seyboth et al., 2016). Therefore, increased frequency of years with reduced krill abundance, due to global warming, is likely to reduce the current rate of recovery of southern right whales from historical overexploitation.

As noted in 2.3.2.1, HAB events have been increasing in strength and intensity in the Southern Hemisphere contributing the heightening of favorable conditions for HAB events, making toxins a growing concern for marine species and their prey (Häussermann et al., 2017). Within the southern right whale calving ground of Peninsula Valdes, Argentina, satellite data show that phytoplankton dynamics have changed in the region since the 1990s, with the magnitude of the spring phytoplankton bloom increasing considerably (Wilson et al., 2016). This resulted in a positive correlation between *Pseudo-nitzschia* densities and calf deaths at Peninsula Valdes, Argentina, suggesting that HAB events in the region may be directly contributing to calf deaths in the region. Additionally, *Pseudo-nitzschia* were found in fecal samples of two live and three stranded whales in 2004, 2005, and 2010 suggesting that southern right whales could be exposed to domoic acid in their calving ground (D'Agostino et al., 2015), and a more recent study found that for the first time southern right whales were directly exposed to domoic acid via copepods as vectors during the calving season in the gulfs of Peninsula Valdes (V. C. D'Agostino et al., 2017). However, the health impacts of domoic acid to adults and calves remain unknown. This study highlights the need for understanding the transfer of phycotoxins from mothers to calves. Therefore, future studies should continue to analyze domoic acid in both living and dead right whales including the simultaneous sampling of feces from mother-calf pairs.

Contaminants and Pollutants

Information on contaminant loads in southern right whales is scarce. Southern right whales may be exposed to pollution and high nutrient loads both during their time in coastal waters throughout their range and on their feeding grounds, although the extent and implications of this exposure remain largely unknown. However, given that southern right whales feed primarily in the mid-high latitudes waters of the southern ocean, the impact of toxins from chemical discharge is likely to be low (Australia, 2012).

While in coastal waters, southern right whales may encounter chemical pollution in the form of sewage and industrial discharges, and run off from onshore activities such as agriculture. This is most likely to create impacts in coastal aggregation areas. In their feeding grounds they are most at risk from bioaccumulation of human-made chemicals such as organochlorines most commonly from herbicides and pesticides and industries such as dry cleaning, tanneries and electrical equipment (Australia, 2012).

Torres et al. (2015) assessed Organochlorine pesticides (OCPs) and polychlorinated biphenyls (PCBs) in blubber from 35 dead southern right whales stranded at Peninsula Valdes, Argentina. Although all these organochlorine compounds are forbidden they had bioaccumulated in the blubber of southern right whales with a predominance of endosulfans, the more recently used

pesticide (L. G. Torres et al., 2017). This is the first study on levels, compositional patterns, and organochlorine sources in southern right whales. However, the absence of data on chemical pollutants in stranded dead whales should be a priority for research. Moreover, more research on other tissues/organs and milk is recommended since the specimens in this study were mostly calves, and pollutants are likely transferred from the mother during pregnancy and nursing (P. Torres et al., 2015).

Summary
Ship strikes and entanglement in fishing gear result in southern right whale deaths. Despite current levels of ship strikes and entanglements, most populations continue to grow at ~7% each year (Harcourt et al., 2019). However, the frequency of adverse events will likely increase as nations continue to develop their coastlines and as the southern right whale repopulates sections of its historical range. Little information on anthropogenic noise effects on southern right whales exists, and further research is required to assess the importance and range of ambient sound sources and whether southern right whales change their behavior in the presence of natural or anthropogenic noise. Recent studies from the Argentinian and Brazilian southern right whale subpopulations indicate that climate change may be affecting calf mortality in the Peninsula Valdes region of Argentina and breeding success in southeastern Brazil. Additionally, the possible collapse of krill populations in the South Atlantic due to warming temperatures and loss of sea ice could have major consequences for the southern right whale, which may not be able to switch to other prey species, leading to nutritional stress and lowered reproductive success. New information on OCPs and PCBs in southern right whales, suggests that pesticides may also be stressor for Argentinian southern right whales. For these reasons, threats from other natural or manmade factors may affect the southern right whales' continued existence.

2.4 Synthesis

Southern right whales were hunted extensively via commercial whaling starting in the early 17th century, but especially in the 18th, 19th, and 20th centuries by American and European whalers. Commercial whaling significantly reduced the global population of southern right whales. Prior to whaling, it is estimated that approximately 120,000 southern right whales were found in 12 wintering grounds (Figure 1; Harcourt et al., 2019). Worldwide abundance of the southern right whale is approximately 15,000 individuals across its circumpolar distribution in the Southern Hemisphere, with most populations growing at ~7% per year and some repopulating historical areas. However, although still a fraction of its historic abundance, the abundance reported in this 5-year review (which is the same as what was reported in the 2015 5-year review) is still more than double the abundance reported in the 2007 5-year review (7,000 in 1997). While strong population growth rates have been observed for most populations, there has been evidence for a levelling-off in the population growth rates for some of the major areas, with lower counts since 2015 (i.e. western South Atlantic and western Australia). Two further suspected breeding populations in the southeast Pacific (i.e. Chile and Peru) and southwest Indian Ocean (i.e. Madagascar and Mozambique) remain at very low numbers and show no clear evidence of any increase (Cooke et al., 2018).

The southern right whale continues to face a number of threats throughout its range. Ship strikes, entanglement, coastal development, kelp gull harassment (including infectious disease

transmission), climate change, and possibly contaminants and several potential pathogens identified in the Brazilian and Argentinian subpopulations are threats that could affect the recovery of right whales. Despite these threats, most populations are increasing, which indicates that current threats are not impacting population growth across the species' range. However, at the subpopulation level, recent population declines in southern right whales off South Africa, Peru and Chile, and increased mortality of calves off Peninsula Valdes, Argentina, suggests that these threats may be impacting recovery of southern right whales. Additionally, changes in ocean conditions caused by climate change may pose a significant threat to southern right whales in the future by decreasing prey availability.

Southern right whales are protected and managed under a variety of international, national, provincial, and state laws and policies. Within territorial waters, the level of protection and enforcement varies from extensive in some locations to non-existent in others. While a majority of countries have established federal legislation prohibiting the take of southern right whales, many lack comprehensive management or recovery plans for the conservation of right whales and their habitat. A variety of MPAs have been created in the Southern Hemisphere to protect southern right whales. These include the prime calving grounds around Peninsula Valdes (Argentina), Walker Bay (South Africa), Head of the Bight (South Australia), and the Namibian Islands' Marine Protected Area (Namibia). However, many of the these MPAs lack management plans, adequate staffing, funding and enforcement capabilities and it is difficult to assess whether these areas are effective in conserving and protecting southern right whale habitat. Thus, the best available scientific and commercial information do not indicate that existing measures are sufficient to counter threats to the species across its entire range.

In summary, most populations of southern right whales have exhibited increases in abundance and are repopulating historical areas. Given the estimated total population size of 15,000 reported in this 5-year review (which is a 5-10 fold increase in the population since the 1970s and more than double the abundance reported in the 2007 5-year review) the population size is estimated to be larger now than it was three generations ago (87 years, assuming a generation time of 29 years) (Cooke et al., 2018). Thus, this species is not considered under threat across its entire range. The main threat, directed harvest, has been eliminated. Ship strikes, entanglement in fishing gear, coastal development, kelp gull harassment (including infectious disease transmission), climate change, and possibly several potential pathogens and pollutants identified in the Brazilian and Argentinian subpopulations are threats that may affect the long-term recovery of southern right whales at the subpopulation level. However, it is unclear whether these threats are currently affecting population abundance and trends across the species' entire range. For these reasons, we conclude the southern right whale is not currently in danger of extinction throughout all or a significant portion of its range, but is likely to become endangered within the foreseeable future. Consequently, we recommend that the southern right whale be reclassified from endangered to threatened.

3.0 RESULTS

3.1 Recommended Classification

___X__**Downlist to Threatened**
_____**Uplist to Endangered**
_____**Delist** *(Indicate reason for delisting per 50 CFR 424.11):*
_____*Extinction*
_____*Recovery*
_____*Original data for classification in error*
_____**No change is needed**

3.2 New Recovery Priority Number

Not Applicable

3.3 Listing and Reclassification Priority Number

Not Applicable

4.0 RECOMMENDATONS FOR FUTURE ACTIONS

This 5-year review indicates that, based on a review of the best available scientific and commercial information, that the southern right whale should be downlisted from endangered to threatened. If feasible within the context of agency resources and priorities, we recommend the agency commence a rulemaking at some point in the future to reclassify the southern right whale from endangered to threatened.

Overall, insufficient data and knowledge gaps remain for the southern right whale resulting in a lack of an updated population trend for the species. While this 5-year review notes that southern right whales occur and have been sighted in small numbers off the coasts of Tristan da Cunha, South Georgia, South Sandwich Islands, Namibia, Mozambique, Uruguay, Falkland Islands, French Southern Territories, Mozambique, and the east coast of Madagascar, little is known about the whales in these areas relative to other subpopulations described in this 5-year review. NMFS recommends additional research and continuation of long-term monitoring studies including photo-identification and aerial surveys in these data poor areas to better inform overall population demography and distribution trends, as well as dispersal and migratory movements, location of key habitats, and documentation of ongoing reoccupation of historic areas. With the advent of techniques to derive and analyze data, such as satellite telemetry and passive acoustic monitoring, it is now possible to conduct cetacean research more effectively and efficiently in pelagic and coastal habitat.

Furthermore, emerging information relating to disease, contaminants, and pollution should continue to be monitored and assessed to determine whether these issues threaten the southern right whale at the population level and if they are contributing to stranded dead whales observed. Additionally, at the subpopulation level, further research is required to determine whether biotoxin exposure and bacterial and viral infections are causative agents of calf mortality observed at Peninsula Valdes, Argentina. Data is sparse on the effects of anthropogenic noise on southern right whales, and further research is required to assess whether southern right whales change their behavior in the presence of vessels and/or other anthropogenic noise sources. Changes in ocean conditions caused by climate change and increasing coastal development projects may pose a significant threat to southern right whales in the future by decreasing prey availability, thus further research should be done to assess the long-term threat of habitat degradation caused by climate change and coastal/marine development.

Finally, NMFS recommends that nations with jurisdiction over waters where southern right whale populations or habitats are known to occur continue to manage the species under their current regulatory mechanisms, and, where these mechanisms are lacking or inadequate (e.g., increased enforcement of whale watching activities in Argentina; comprehensive conservation plans for Marine Protected Areas in South Africa), take actions to improve the protection of southern right whales within their territorial waters.

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NATIONAL MARINE FISHERIES SERVICE
5-YEAR REVIEW
Eubalaena australis

Current Classification: Endangered

Recommendation resulting from the 5-Year Review

__X__ Downlist to Threatened
____ Uplist to Endangered
____ Delist
____ No change is needed

Review Conducted By: Heather Austin, Office of Protected Resources, Silver Spring, MD.

LEAD OFFICE APPROVAL:

Director, Office of Protected Resources, NOAA Fisheries

Approve WIETING.DONNA.S.1365710607 Digitally signed by WIETING.DONNA.S.1365710607 Date: 2021.03.15 16:40:28 -04'00' Date: _____

HEADQUARTERS APPROVAL:

Assistant Administrator, NOAA Fisheries

DOREMUS.PAUL.N.1365829221 Digitally signed by DOREMUS.PAUL.N.1365829221 Date: 2021.03.24 18:52:57 -04'00' Concur _____ Do Not Concur

Signature_____ Date:_____