REPORT OF THE INTERNATIONAL REVIEW PANEL REGARDING FISHING CLOSURES ADJACENT TO SOUTH AFRICA'S AFRICAN PENGUIN BREEDING COLONIES AND DECLINES IN THE PENGUIN POPULATION

forestry, fisheries
& the environment

Department:
Forestry, Fisheries and the Environment
**REPUBLIC OF SOUTH AFRICA**

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Terms of Reference

a) Review the quantitative scientific analyses of the Island Closure Experiment and subsequent publications to evaluate whether the scientific evidence from ICE indicates that limiting small pelagic fishing around colonies provides a meaningful improvement to penguin parameters that have a known scientific link to population demography in the context of the present rate of population decline.

b) Assess the cost-benefit trade-off of 1) costs to fisheries, versus 2) the proportion of penguin foraging range protected during the breeding season, for different fisheries exclusion scenarios.

c) Evaluate the evidence supporting the benefits of fishery restrictions around African Penguin colonies to adopt precautionary measures by implementing long-term fishery restrictions.

d) Recommend a trade-off mechanism as a basis for setting fishing limitations and mapping if closures or fishing limitations are viewed to contribute positively to the support of the African Penguin population.

e) Provide recommendations on the scientific work that is required to evaluate the effectiveness of such no-take areas.

f) Provide recommendations about what scientific work is appropriate in the short term to determine the dominant causes of the rapid and concerning rate of decline of the penguin population.

Panel

André Punt (U of Washington, USA, chair)
Robert Furness (MacArthur Green Glasgow, UK)
Ana Parma (National Scientific and Technological Research Council of Argentina)
Éva Plagányi (CSIRO Environment, Australia)
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# Current status of African Penguins in South Africa
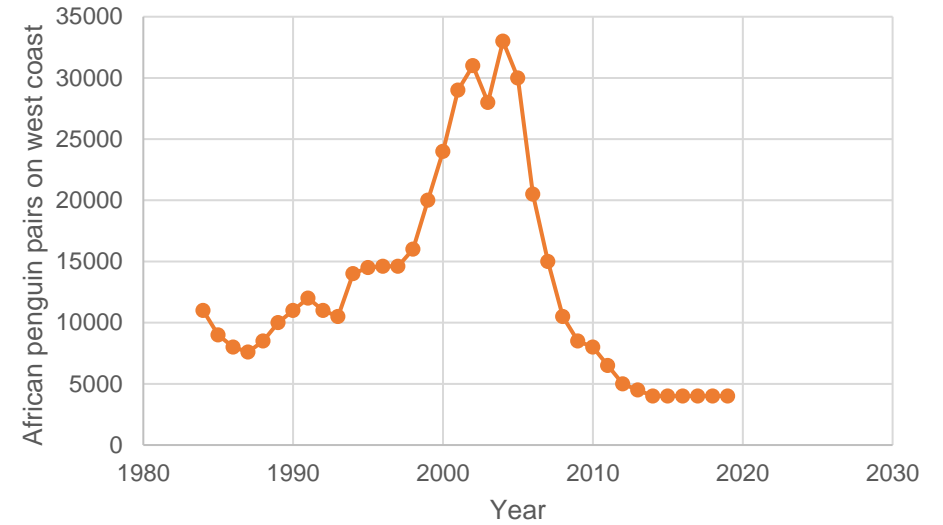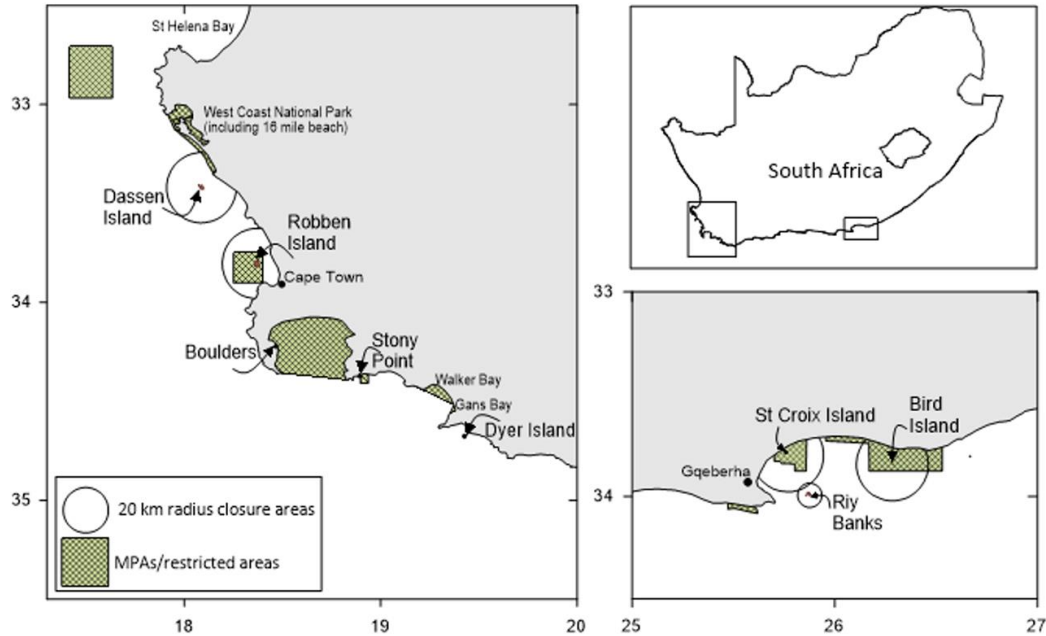
The population of African penguins breeding in South Africa has been declining rapidly (approximately 8% per annum since 2005) and is consequently at a high risk of extinction in the coming decades. It is broadly recognized that it is essential to understand and mitigate the primary factors leading to this decline.

Primary hypotheses related to causes of the decline of African penguins

Fishery-related hypotheses (resource competition)
- Reductions in local prey biomass.
- Disruption of the prey field so that preferred foraging opportunities are diminished.
- The rates by which local prey are replaced via regional advection or directional movement of prey and diurnal prey migrations contributes to potential resource competition.

Robinson et al. 2015
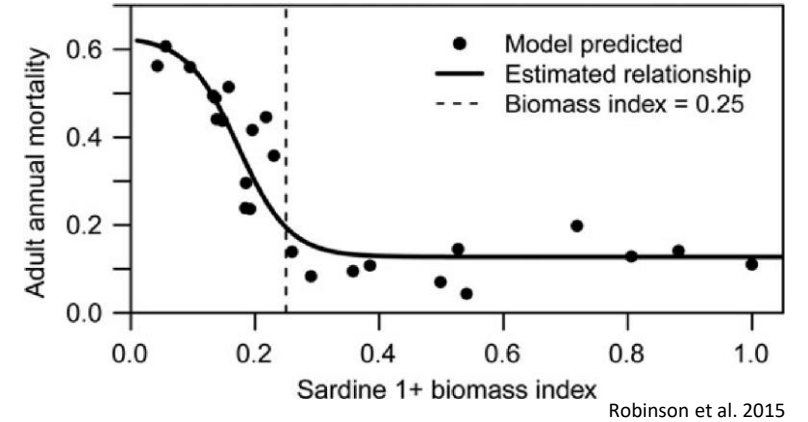
Other hypotheses
- The effect of lower prey biomass on survival (effects of sardine biomass on penguin survival have been found for Robben Island) due to fishery/environmental effects.
- Egg collection (now ceased).
- Loss of nesting habitat as a result of guano harvesting leading to breeding in sub-optimal locations.
- Predation by, and competition with, other predators (especially due to Cape fur seals).
- Increased shipping noise.
- Oil pollution.
- Effects of climate change.

The Island Closure Experiment-I

The Island Closure Experiment (ICE) was established to provide a scientific basis to assess whether closures to pelagic fishing in the neighbourhood of penguin breeding islands might provide a meaningful improvement to penguin reproductive success.

The ICE comprised two parts:
- a feasibility study during which purse-seine fishing was prohibited around two pairs of penguin breeding islands: Dassen and Robben islands on the West Coast and St Croix and Bird islands in the Eastern Cape.
- an experimental phase.

The penguin parameters that were measured were:
- chick condition, and measures of foraging behaviour (all colonies).
- Survival, growth, fledging success (western colonies only).
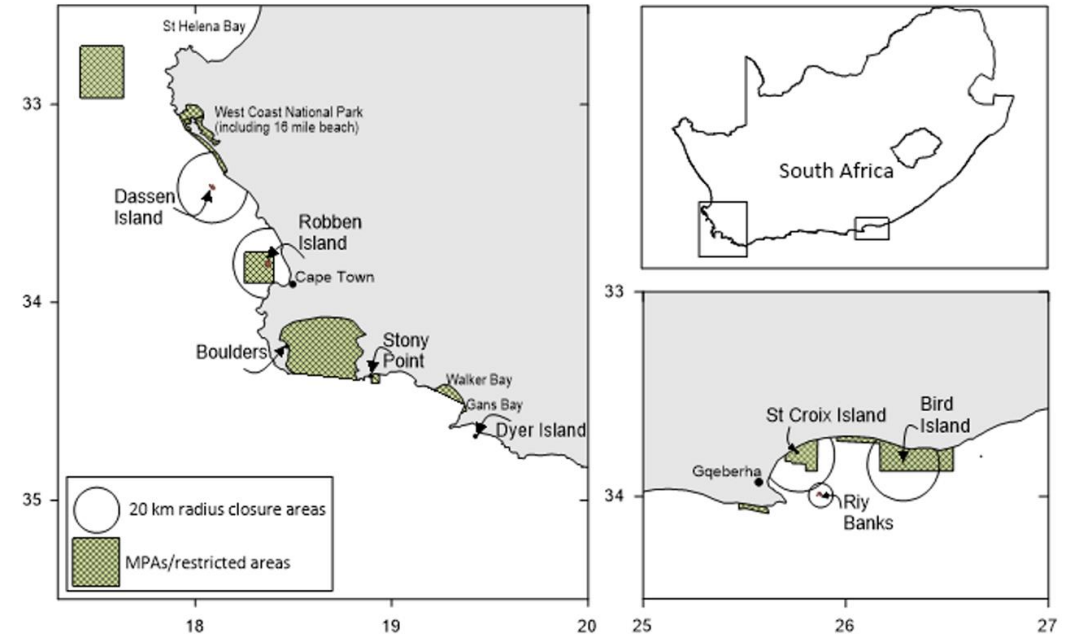
Island	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Dassen Island	X	X					X	X	X				X	x
Robben Island				X	X	X				X	X	X		x
St Croix Island		X	X	X				X	X	X				x
Bird Island					X	X	X				X	X	X	

The Island Closure Experiment-II

Analysis approach

- Analyse the impacts of fishing closures on the response variables monitored using generalized linear mixed-effects models.

- Convert the changes in the monitored reproductive parameters into changes in population growth rate.

- "Integrate" the results for the various reproductive parameters into an overall effect and compare the results to the estimated rate of decline.

Only the predictions for Dassen and Robben islands were used by the Panel to draw final quantitative conclusions about the effect of closures on penguin population growth rate. Results for the east colonies were more uncertain and difficult to interpret given that St Croix and Bird islands did not provide the anticipated contrast, as Bird Island was almost unfished, and given the concerns regarding the use of foraging-related variables and the fact that only estimates based on chick condition were available for these colonies.

The Island Closure Experiment - **Conclusions**

- The results of the ICE for Dassen and Robben islands indicate that fishing closures around the breeding colonies are likely to have a positive impact on population growth rates, but that the impacts may be small, in the range 0.71-1.51% (expressed in units of annual population growth rate). These impacts are small relative to the estimated relative reductions in penguin abundance for these two colonies over recent years.
- These changes in population growth rate do not include impacts of island closures on African penguin adult survival or immature survival, which are likely to exist based on evidence for other situations, but cannot be quantified for African penguins.

Closures of forage-fish fishing around penguin colonies would be likely to benefit penguin conservation, but will need to be part of a larger package of conservation measures as such closures alone are unlikely to reverse the current declines.
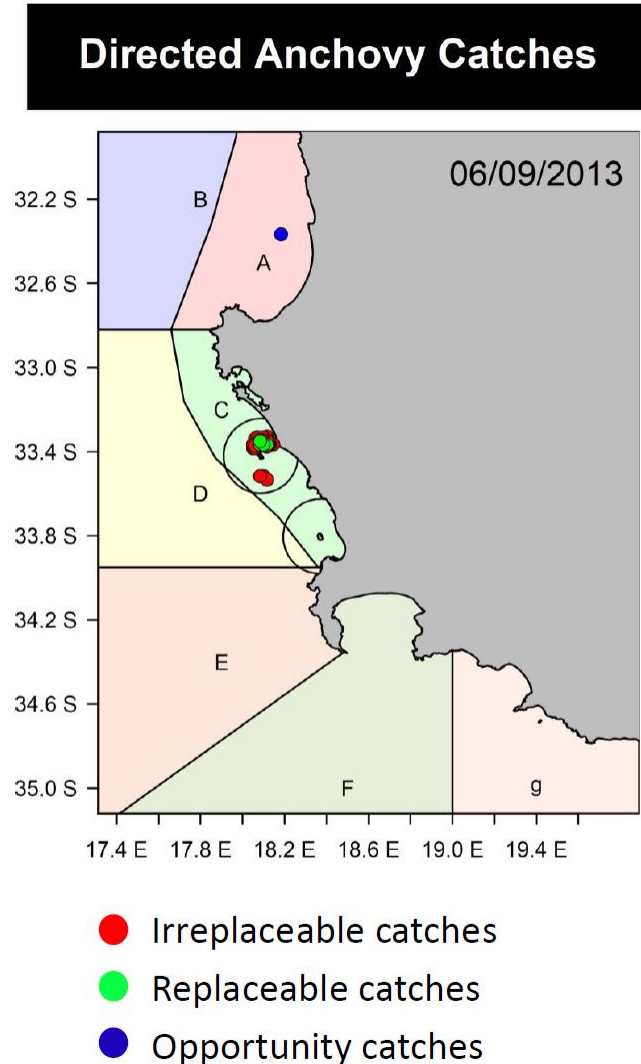
Evaluating the costs to the fishing industry of closure-I

The **Opportunity-Based Model** estimates the impact of closures on catches by the pelagic fisheries targeting anchovy and sardine.

It calculates the average irreplaceable catch stemming from the proposed closures based on catch history and the consequences of having to fish outside the closed area if there is a fishing "opportunity".

Only observed catches taken in a given day outside a closure are assumed to provide potential alternative fishing opportunities for replacing the catches.

The OBM **likely overestimates** the loss in catches due to closures, to an unquantified extent, given its assumptions related to the set of opportunities that are available to replace catches in closures, particularly those considered "irreplaceable" because all of the catch on a given day occurred inside a closure.

Directed Anchovy Catches

● Irreplaceable catches
● Replaceable catches
● Opportunity catches

Evaluating the costs of the fishing industry of closure - **Conclusions**

- Implementing closures will impact the fishing industry and local communities to some extent, but accurately quantifying this is challenging.
- The OBM and Social Accounting Matrix (SAM) model are appropriate methods for estimating costs to the fishery, but their results should be considered primarily in a relative sense and as measures of short-run impacts.

Specifying foraging areas

- Penguin foraging areas should be quantified for trade-off analyses delineating mIBAs using ARS methods

mIBA – marine Important Bird Area
ARS – Area-Restricted Search
UD – kernel utilisation distribution
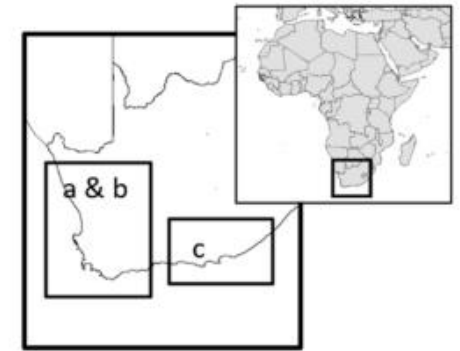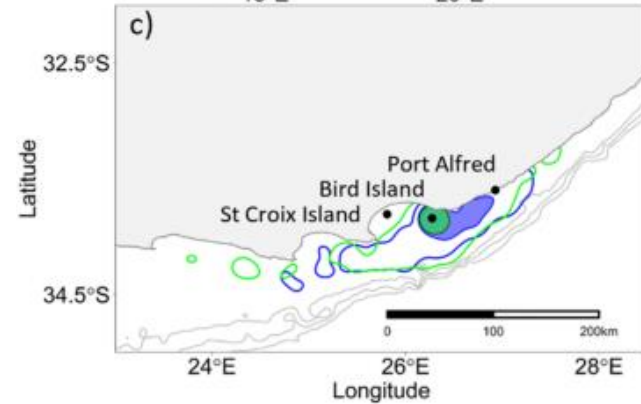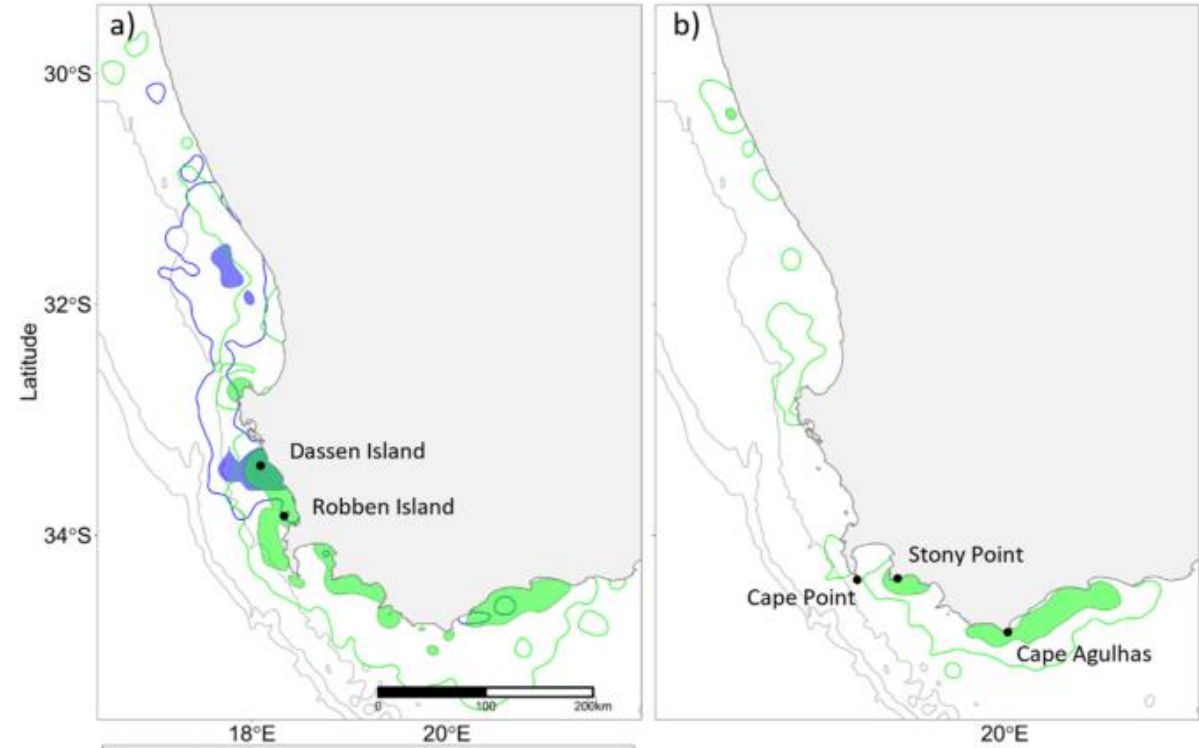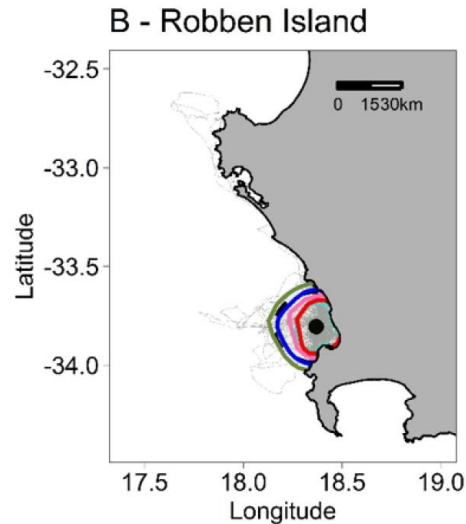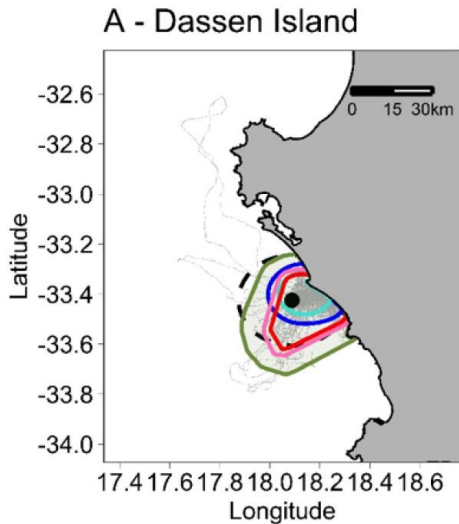
Quantifying trade-offs

- The trade-off among closure options is a policy decision related to conservation, economic and social goals.
- Closed areas to protect penguins during breeding should be year-round, primarily because egg laying and chick provisioning occur year round, and these areas may be important during critical pre- and post-moult periods.
- It is possible to design closures within the overall foraging area to minimize lost catch for any given choice of percentage of penguin foraging area to be protected.
- The trade-offs between costs to the fishery and benefits to penguins in terms of the size of an area closed will differ among islands and among sectors within the fishery.

Reviewing closures

If designated, closed areas to protect penguins should be reviewed at a time when results are available to investigate life-history processes such as juvenile recruitment, adult survival and hence population growth rates. This may be at a time between 6 and 10 years after designation. Other reasons to review such closed areas might include major socioeconomic changes in the fishery and processing, or stock abundance, or similar consequences of prey resource change.

# Using experimental closures to assess effectiveness

The ICE is now considered completed.

While it is not essential that there is an experimental component of any closure regime, if there is :

- It should be focused on parameters such as juvenile recruitment and survival, and adult survival in addition to those related to breeding success monitored during the ICE.

- The western and southern Cape regions should be the focus of any future experimental closure program given data availability and the ability to undertake regular monitoring.

- It is desirable that a power analysis be conducted to identify an appropriate sequence of (possibly alternating open and closed) closures.

Recommendations related to monitoring

Monitoring should take place irrespective of whether there is an experimental (alternating open and closed) component to the closure program

- Continue to conduct counts of breeding numbers of African penguins at as many colonies as possible in as many years as possible.
- Monitor adult survival of penguins using low disturbance methods such as passive implantable transponder (PIT) tags and readers.
- Continue monitoring of breeding success where it can be done without disturbance.
- Use automatic weighbridges to monitor weights of PIT-tagged adult penguins.
- Apply telemetry methods, to examine impacts of vessel noise (including from bunkering).
- Use PIT-tagging of juvenile penguins to understand survival.
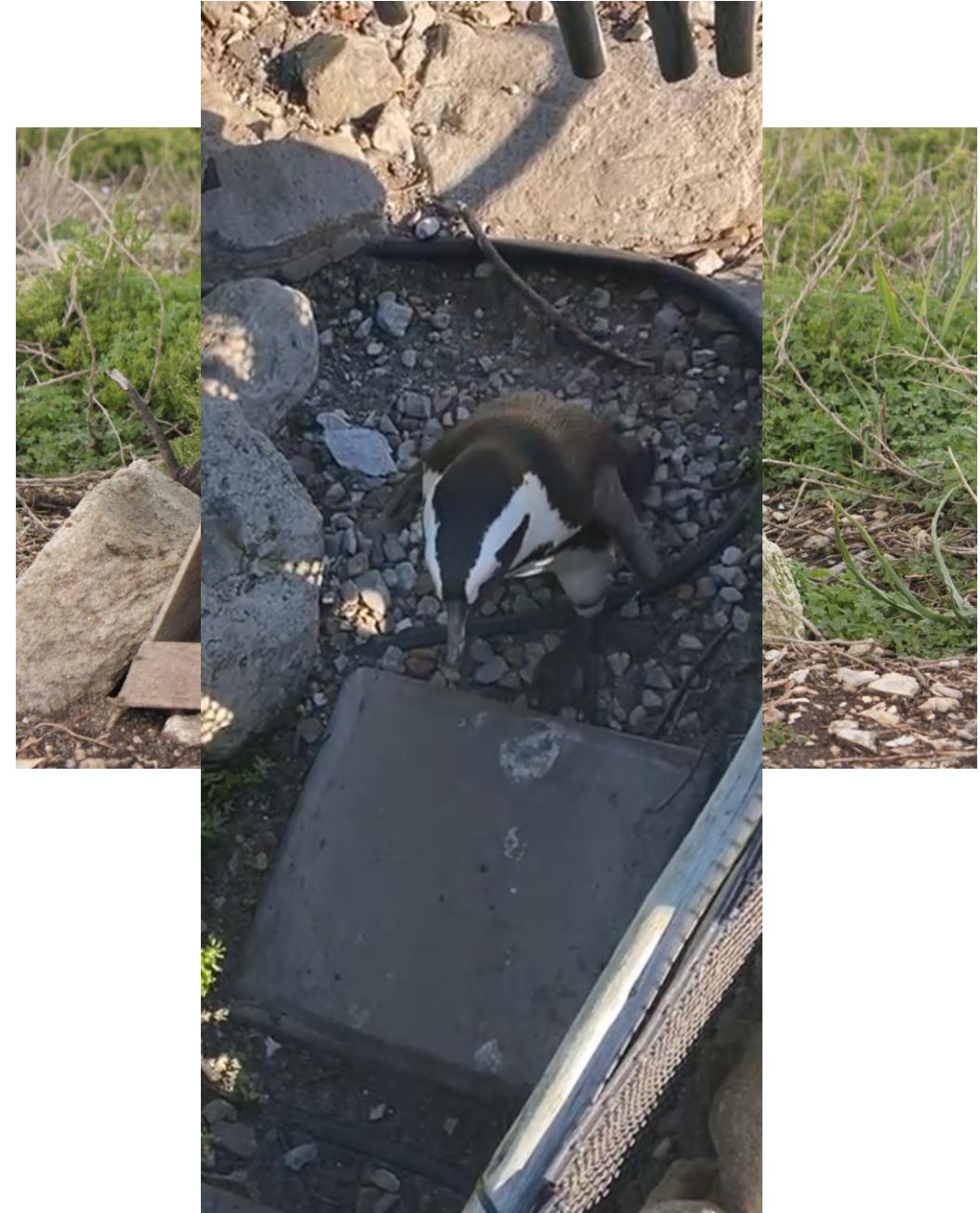
Other high priority research projects-I

Research projects related to fishery costs

- Examine the impact of closures on net revenue as well as changes in catches.
- Examine the long-run socioeconomic impacts to local communities due to the prospective closures and conduct a more in-depth analysis of the SAM results.
- Further examine sensitivity of the SAM results to obtain a better understanding of the range of possible regional outcomes from the prospective closures.
- Apply alternative methods for allocating catches to regions and compare results across the different cases.

Research projects related to defining foraging areas

- Use dive data that provide objective identification of foraging locations, rather than commuting (or travelling) locations to define mIBAs.

Other high priority research projects-II

Other research projects

- Develop a MICE* to explore alternative hypotheses for the decline.

- Test the current OMP to evaluate whether it is adequately precautionary in relation to protecting future recruitment prospects of sardine given that it allows high exploitation at low sardine biomass.

- Continue investigation of the effects of marine noise using, for example, GPS & TDR tags.

- Continue to refine the design of nest boxes.

* MICE - Models of Intermediate Complexity for Ecosystem assessments;
OMP - Operational Management Procedure; TDR - Time-Depth Recorder

Final comments

- Considerable effort has been made by the fishing and conservation sectors in collaboration with government to understand the causes of the decline and how they might be mitigated.
- The ICE has been identified as an example of a best practice for assessing forage fish fisheries – seabird resource competition, but the weaknesses of the design and implementation need to be recognized and their consequences accounted for when interpreting the results.
- Continued communication, collaboration, and transparency of research data and analyses, are strongly encouraged to build trust and strengthen progress towards seeking acceptable solutions. Working collaboratively will further enhance the effectiveness and social acceptability of management measures and decisions aimed at mitigating the decline of the African penguin.

Acknowledgements

Thanks to those who prepared documents for the Panel, made presentations during the workshop stages of the Panel process, and contributed to discussions during the March and June workshops and between meetings of the Panel.

The Island Closure Experiment-III

- The aggregated versus disaggregated data provided similar results when appropriately configured and are generally consistent.
- Negative impacts of fishing, close to the -1% value used as a reference, were generally estimated for Dassen and Robben islands based on chick survival data.
- Most estimated effects based on chick condition were negative but somewhat smaller, ranging from 0.04% to -0.67%.

The results based on analyses of chick growth and foraging-related parameters give little indication of a biologically meaningful impact of the closures.
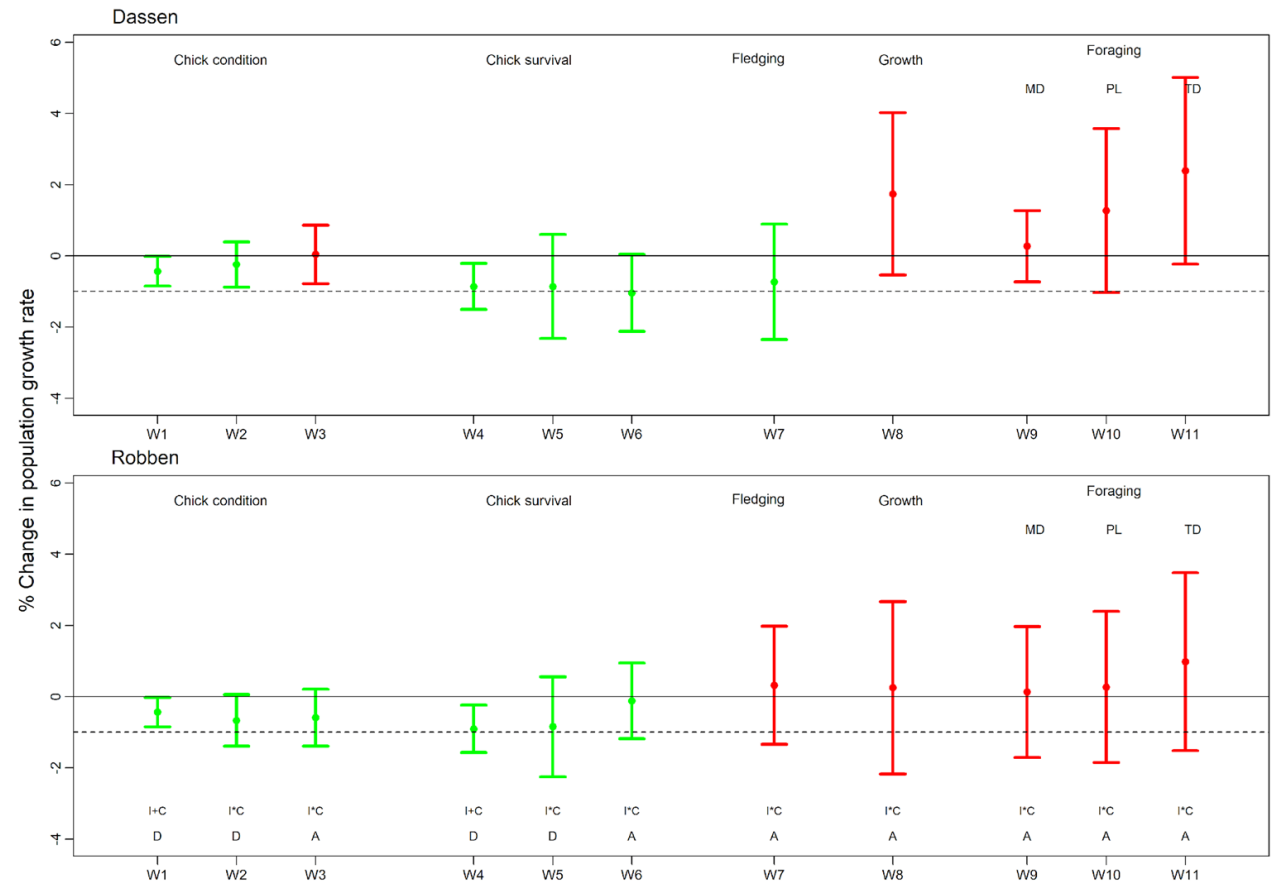
Note: A negative value means that fishing closures benefit penguins.

Evaluating the costs to the fishing industry of closure-II

The **social accounting matrix** (SAM) quantifies community economic impacts of fishery policy changes thus requires understanding how changes in production on the water translate into changes in the production of goods and services shore-side either directly or indirectly.

It models a shock to the regional economy from a reduction in catches due to the closures as calculated by the OBM.

How to interpret the significance of job losses on regional economies and welfare depends on the quality of the local labor markets, whether the losses are seasonal workers, and whether the losses are permanent or temporary.
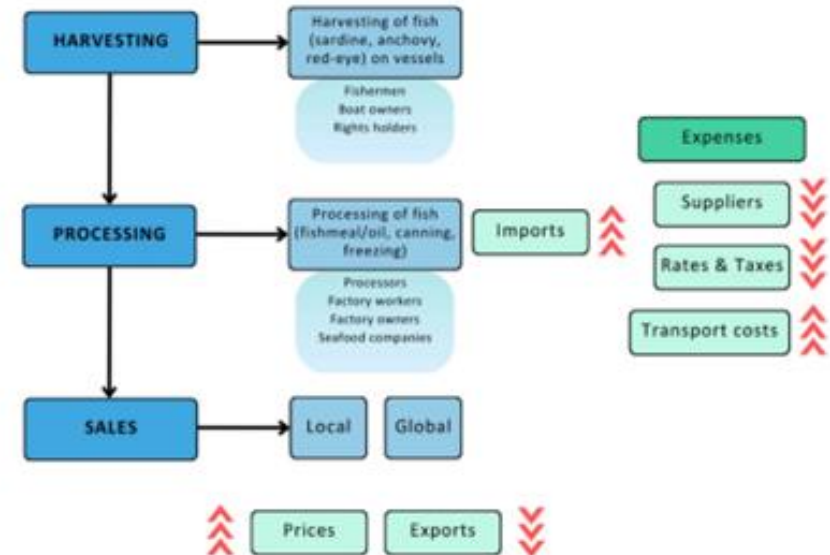
The SAM is a useful tool for creating snapshots of the impacts on regional economies, but the Panel recommends further work on the long-run socioeconomic impacts to local communities.

Evaluating the costs to the fishing industry of closure-II

- The OBM **likely overestimates** the loss in catches due to closures, to an unquantified extent, given its assumptions related to the limited set of opportunities that are available to replace catches in closures.

- The OBM results are very sensitive to the how often a catch outside a closure can be "re-used". The Panel recommends OBM results should be presented for the 1, 5, and infinity cases.

- The great majority of the estimated catch losses are due to the high fraction of sets classified as irreplaceable under the OBM rules; only a very small fraction of the loss was due to lower average catch rates of replacement sets ("opportunity losses").
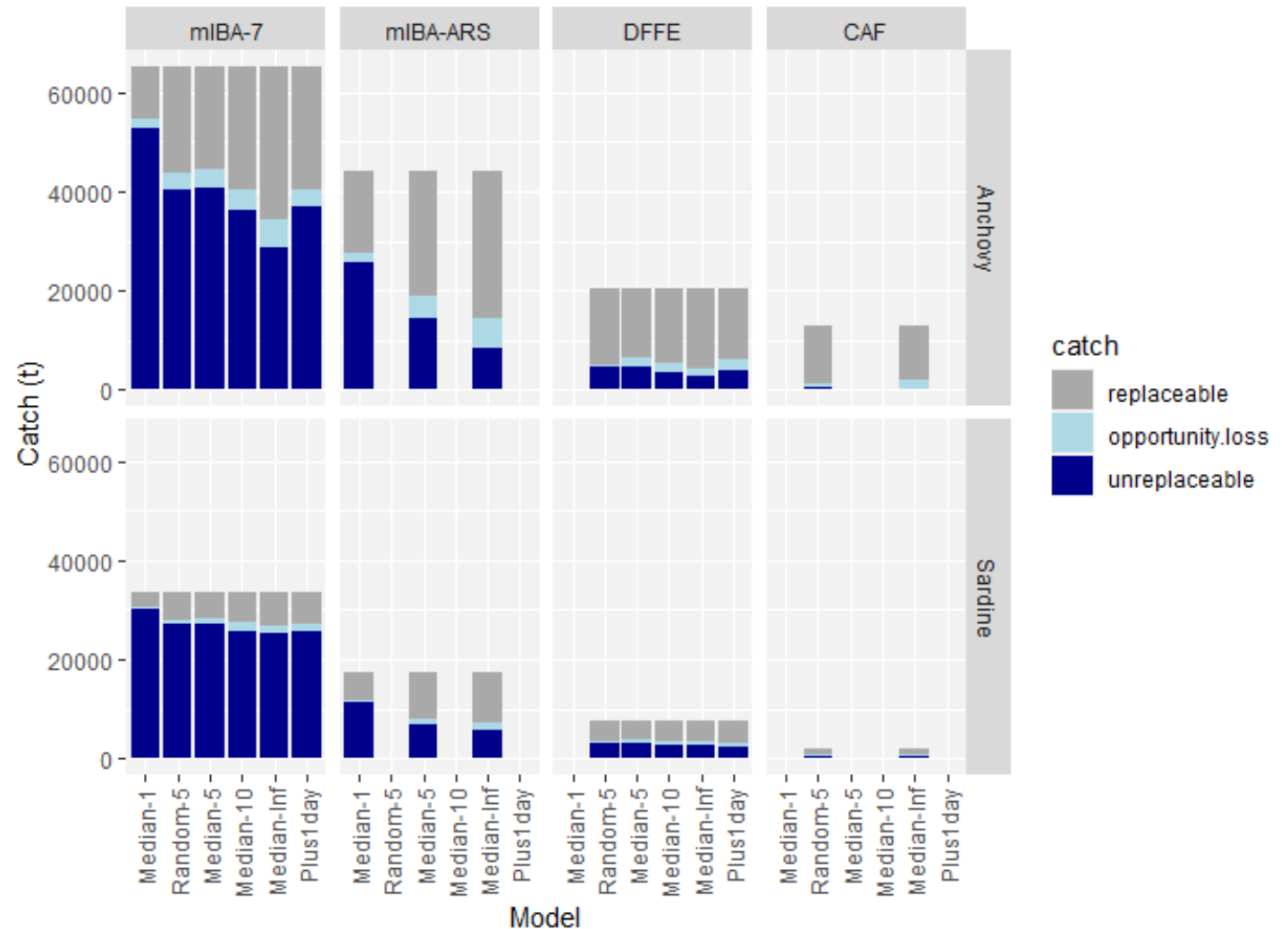
Closure options

- Closed areas to protect penguins during breeding should be year-round, primarily because egg laying and chick provisioning occur year round, and these areas may be important during critical pre- and post-moult periods.
- It is possible to design closures within the overall foraging area to minimize lost catch for any given choice of percentage of penguin foraging area to be protected.
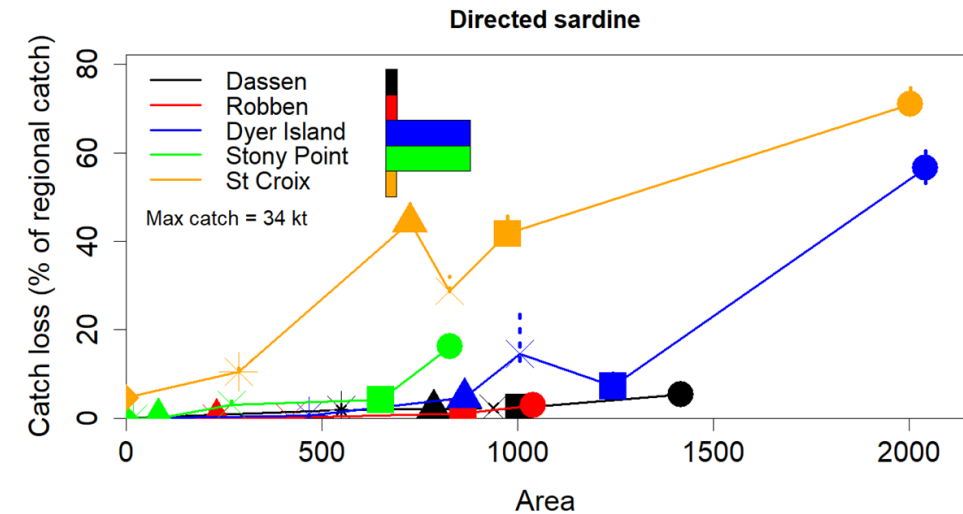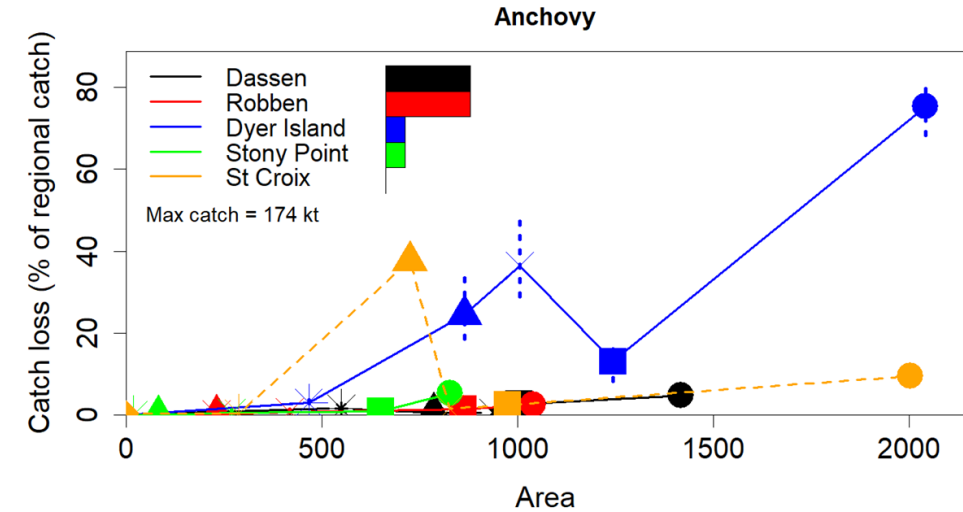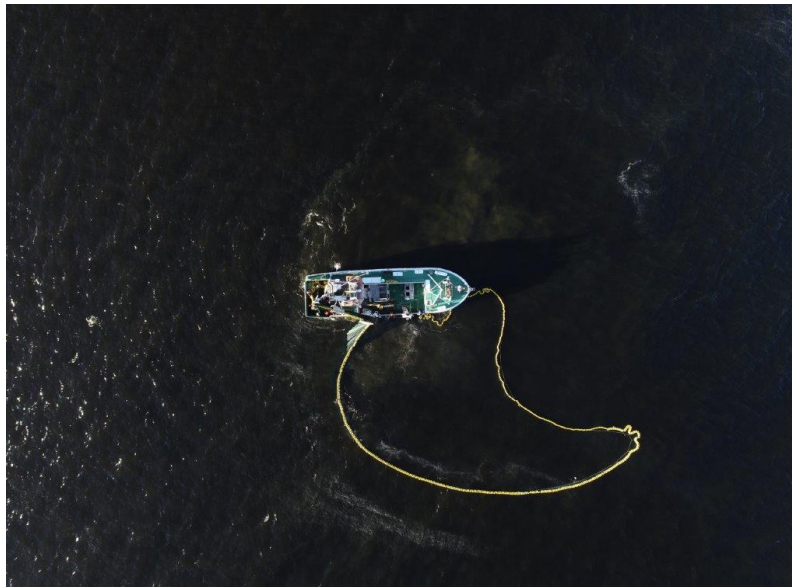
Other high priority research projects-II

A proposed MICE model focused on African penguin

- Use a structured, step-wise approach to conduct objective evaluation of the extent to which alternative hypotheses are consistent with, and able to explain, the available data
- Start with a regional model (i.e., separate western, eastern and southern regions) due to changes in prey composition and availability spatially.
- Include African penguins, sardine, anchovy and Cape fur seals.
- Allow for the effects of past removal of guano on nesting habitat.
- Add other available environmental and climate data to explore to what extent spatio-temporal changes in the environment may be contributing to the decline in penguins.

MICE are recognised as an appropriate tool to address complex science and management issues such as assessing the status of both fisheries and other non-targeted species.

Quantifying trade-offs

- The trade-off among closure options is a policy decision related to conservation, economic and social goals.
- The following considerations are relevant to designing a framework to help decision makers select closed areas (if any):
  - The trade-offs between costs to the fishery and benefits to penguins in terms of the size of an area closed will differ among islands and among sectors within the fishery. Consequently, the benefits to penguins and costs to industry should be considered by island and not simply at the national level.
  - The results of the OBM and hence the SAM model should be considered primarily in a relative sense and hence used for ranking closure options.
  - The economic analyses are only able to quantify the social effects of closures in terms of job losses, and future work should consider broader social consequences of reduced catches.
  - Changes to catch distribution will have regional economic and social effects.