Quantifying the ecological and socio-economic implications of a recovery/collapse of South Africa's West Coast rock lobster fishery

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Contents

Abstract

The West Coast rock lobster (WCRL) *Jasus lalandii* fishery is South Africa's third most valuable fishery, but the stock is currently at less than 2% of its pristine biomass. Scientists are warning that if no measures are taken, the WCRL could face commercial extinction. The necessary reductions in the global Total allowable Catch (TAC) seen in past years have had large economic implications for the WCRL value chain, but research into the socio-economic aspects of this fishery is limited. This study, therefore, aims to establish an overview of the economic revenue over the seasons 2016/17 – 2018/19 by exploring changes and trends in the net seasonal income (NSI) for the fishery, sectors within the fishery and different stakeholders. It also investigates the prospects for the sectors and different actors in this fishery over the seasons 2019/2020 - 2030/31 through analysis of the net present value (NPV) under three proposed global TAC management scenarios (global TAC of 640 tonnes, 1084 tonnes and 1280 tonnes).

Data concerning costs and incomes as well as dynamics, mechanisms and concerns surrounding the fishery were collected from stakeholders in the different sectors through interviews and surveys. Further, official records from DEFF (catches, actors, vessels and quotas) and projections made by the Marine Resource Assessment (MARAM) team at the University of Cape Town (rates of recovery of the resource and future catches under the different TAC scenarios) were obtained and analysed. Cost and income data were summarised and models characterising the economic flows within the fishery were created. Calculations regarding the NSI and NPV were made using Monte Carlo simulations to account for the uncertainty surrounding many of the input variables.

Results show that while the fishery as a whole made economic profits for the three seasons, the decreasing quotas in 2018/19 had a disproportionately negative impact on some of the representative individuals examined within the different sectors. The projections indicate that while each of the sectors as a whole would continue to make profits largely proportional to their allocation under the different TAC scenarios, many vessel owners in the fishery are likely to face economic losses or very marginal gains under the lower quota options, while the NPV for quota holders who outsource the catching of their quota are likely to be proportionally less affected by the changes in global TAC.

This dynamic is important to consider for the future of this fishery. If the resource is to recover, and fishing activity is to continue equitably under the decreased quotas that the recovery of the biomass necessitates, the socio-economic context and the dynamics within which the fishers operate must be considered and studied more extensively and socio-economic consequences of a lower global TAC mitigated while improving the ecological status of the resource.

Keywords: marine; fisheries; West Coast rock lobster; socio-economic; management; value chain analysis

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Ethics

The interviews, surveys and general participant engagement for this study were conducted in line with the Ethics guidelines for Rhodes University. The ethics application was submitted and approved in 2019. The data used here from the Department of Environment, Forestry and Fisheries was obtained following the submission and approval of a formal PAIA request.

Apart from the master's thesis submitted here, the findings from this research are expected to be published in the form of a report by WWF-SA.

List of acronyms

BEE	Black Economic Empowerment
CL	Carapace length
CPT	Catch per Trip
CPUE	Catch per Unit Effort
DEFF	Department of Environment, Forestry and Fisheries
EAF	Ecosystem based approach to fisheries management
FAO	Food and Agriculture Organisation of the United Nations
FIMS	Fishery-independent monitoring surveys
FRAP	Fishing rights allocation process
GLM	General Linear Model
IRP	Interim Relief Permit
IUU	Illegal, unreported and unregulated
MARAM	Marine Resource Assessment
MLRA	Marine Living Resources Act
MPA	Marine Protection Area
NC	Nearshore commercial
NEMA	National Environmental Management Act
NGO	Non-governmental Organisation
NPV	Net Present Value
NQ	Nearshore Quota
NSI	Nest Seasonal Income
NVQ	Non – vessel owning quota holder
OC	Offshore commercial
OMP	Operational Management Procedure
OQ	Offshore Quota
PMC	Processing and Marketing Company
RFA	Responsible Fisheries Alliance
SA	Super-area

SAMSA	South African Maritime Safety Authority
SS	Small-scale
SSFP	Policy for the Small-Scale Fisheries Sector
TAC	Total allowable catch
TAE	Total allowable effort
UCT	University of Cape Town
VO-CO	Vessel owner whose entire catch is for someone else's quota
VQ	Vessel owning quota holder
VQ-50/50	Vessel owning quota holder whose total catch is half for their own and half for someone else's quota
VQ-CS	Vessel owning quota holder whose entire catch is only for their own quota
VQ+2	Vessel owning quota holder who is catching their own quota in addition to that of two other quota holders from their super-area
VQ+5	Vessel owning quota holder who is catching their own quota in addition to that of five other quota holders from their zone
WCRL	West Coast rock lobster
WCRLA	West Coast Rock Lobster Association
WWF	World Wide Fund for Nature

List of figure captions

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[1]

2013/14: https://www.gov.za/west-coast-rock-lobster-total-allowable-catch-tac-announced
2014/15 & 2015/16: https://www.gov.za/speeches/daff-announces-201516-west-coast-rock-lobster-tac-and-recreational-fishing-season-9-nov
2016/17 & 2017/18: https://www.gov.za/speeches/agriculture-forestry-and-fisheries-announces-201718-west-coast-rock-lobster-tac-and
2018/19 and 2019/20: https://www.daff.gov.za/docs/media/190926%20Media%20Statement%20TAC%20determined%20for%20the%202019-2020%20WCRL%20TAC%20Fishing%20Season.pdf
2019/2020: https://www.environment.gov.za/mediarelease/westcoastrocklobster_totalallowablecatch_recreationalfishingseason
2020/21: https://www.environment.gov.za/mediarelease/westcoastrocklobster_totalallowablecatch_recreationalfishingseason
(all accessed on 10.3.2021)

List of table captions

[2] https://www.ofx.com/en-au/forex-news/historical-exchange-rates/yearly-average-rates/ (accessed on 14.3.2021)

Chapter 1: Introduction

Since the commercial harvesting of the West Coast rock lobster (WCRL), *Jasus lalandii,* began in South Africa in the early 1900s, the biomass has declined to extremely low levels (Johnston and Butterworth 2018a). Despite being the country's third most valuable fishery, it is estimated that the male WCRL biomass is at about 1.9% of its pristine biomass which makes regulations encouraging recovery of the stock crucial (DAFF, 2016; WWF 2018b). The global total allowable catch (TAC) of the WCRL fishery has therefore been decreased over the past seasons, with further reductions being recommended by best scientific advice (Butterworth 2018). Due to the WCRLs critical state and the dependency by fishers on this resource, there is an urgent need to further improve the management of this fishery to balance the conflicting interests of sustainability and economic goals in accordance with the principles of the Ecosystem-based approach to fisheries (Food and Agriculture Organization of the United Nations 2003) and South African law. The WCRL fishery is currently fished by four main highly diverse sectors: the offshore commercial (OC), the nearshore commercial (NC), and the small-scale fishers, divided into the officially recognized small-scale co-operatives (SS) and communities fishing under interim relief permits (IRP). In addition, there is a small recreational sector. While there is good knowledge of the biological aspects of this fishery (Pollock et al. 2000, Cockcroft and Payne 1999, Johnston and Butterworth 2018a), there is a lack of recent data concerning the socio-economic aspects of the WCRL fishery, which has been found to negatively impact the ability of the management authority to critically consider these aspects in management decisions (Cochrane et al. 2020).

The primary legal instrument governing the management of South Africa's fisheries is the 1998 Marine Living Resources Act (MLRA), which was amended in 2014 to be compatible with the objectives of the Policy for Small-Scale Fisheries Sector (SSFP) written into policy in 2012 (RSA 2012, 2014). While the MLRA has some shortcomings in its comprehensiveness as an instrument of fisheries governance by international standards, it has been found to largely incorporate the major tenets of holistic fisheries management (Cochrane et al. 2015). It's stated objectives include, inter alia, the sustainable and optimal harvest of fisheries' resources, the preservation of these resources for future generations, the promotion of socio-economic transformation and equity through increased focus on rectifying injustices towards groups of previously disadvantaged people and communities and the creation of development and employment, which are largely in line with the Ecosystem based Approach to Fisheries management (EAF). The EAF, promulgated by a number of international fisheries panels, including the Food and Agriculture Organisation of the United Nations (FAO), and commonly accepted as best-practice (Pikitch 2004), highlights the importance of managing a fishery not through a focus on the target species alone, but through accounting for the effects of the ecosystem, including the social and economic well-being of the dependent fishing communities, in formulating management advice (FAO 2003). However, the interdisciplinary approach required to examine the links between ecological and socio-economic aspects of ecosystems and restoration efforts is relatively young (Westman 1977). It has been shown that socio-economic rewards of effective conservation measures include long-term resource sustainability and use of natural resources, as well as job creation and improved livelihoods (Woodworth 2006, Jentoft 2007, Garcia and Charles 2008, Worm et al. 2009) but only in the 1990s, was a real dialogue between scientists from the different disciplines established (Aronson et al. 2010). While the importance of amalgamating knowledge across disciplinary bounds is well known, it is not often implemented. A recent paper assessing articles concerned with ecological restoration (of all types of ecosystems) found that only a small fraction involved the human component of the ecosystem and that only 3% made use of interviews with the people linked to the ecosystem (Aronson et al. 2010).

The separation of biological and social sciences can be extremely problematic in a multidisciplinary field such as fisheries management (Khan and Neis 2010). Cost-benefit analysis of the recovery of fish stocks versus continued exploitation for short term socio-economic gains often neglect intergenerational considerations and lasting remunerations (Sumaila 2004). Research has long confirmed the interactions between overfishing and ecological, economic and social aspects of fishing communities, and established that resource recovery is intertwined with the understanding of the socio-economic aspects of the fisher's lives (Cochrane et al. 2009, Symes and Phillipson 2009, Aronson et al. 2010, Garcia and Rosenberg 2010). An attempt to solve problems related to overfishing must address socio-economic issues through unification, stakeholder engagement, capacity building, diversification, policy processes, rural development and conservation incentives (Worm et al. 2009). This study attempts to create a profile that captures the economic parameters within which stakeholders of the WCRL fishery exist and examines the ecological, economic and socio-political landscape of this fishery through analysis of the potential sensitivity of the different sectors and groups to the recommended changes to the TAC.

In the analysis the differences in the characteristics and dynamics of the different sectors are important to consider. The offshore commercial sector is highly vertically integrated, requires a high initial investment and is therefore quite exclusive, while the IRP and small-scale sectors reflect common dynamics observed in other small-scale fisheries, as fishing operations occur close to shore, only necessitate a moderate financial investment and in most cases involve entire communities (Isaacs 2015). The nearshore commercial sector combines elements of the two, in that rights are allocated to individuals on a long-term basis (as in the offshore commercial sector) but the profile of the quota holders, their assets and background are much more similar to the IRP and small-scale sector, with significant interchange occurring between the two (Nthane 2015). The value of the fishery and exports, the diversity of the fishers and their operations and the perilous nature of the resource make this fishery a very important and emblematic one to study. While several publications are concerned, in particular, with the social dimensions governing the lives of small-scale fishers in this fishery (Isaacs 2015, Jordan 2016, Schultz 2017, Wentink et al. 2017), there is little recent data concerning the social and economic aspects of the offshore commercial sector, the economic dimensions of the different sectors and intersectoral comparisons, relations and dynamics.

1.1 Aims of this study and research question

The urgency for actions promoting the recovery of the WCRL stock has necessitated the substantial reduction in the recent TACs allocated to the different sectors, but the lack of a contemporary and comprehensive analyses of the human dimension of the WCRL fishery means that the consequences that these developments might have for the fishers, quota holders, employees and others dependent on this fishery are poorly understood. In addressing this gap, this research aims to contribute to the current discourse by first conducting a comprehensive literature review of the publications relaying information related to this fishery to date, and secondly by asking two main research questions:

1. What was the net seasonal income (NSI) on a national, sectoral[3] and individual fisher's scale for the seasons 2016/17 –2018/19 and what were the main variables that drove seasonal/ area or role specific differences?
2. What is the net present value (NPV) of the fishery as a whole, the sectors and individual fishers for the timeframe 2018/19-2030/31, and how might the profitability of the different scales of operation be affected by different exemplary global TAC options and their resulting different rates of biomass recovery?

[3] Sectoral is used in this study to refer to the different categories of fishing recognised within the WCRL fishery as a whole, namely the offshore commercial, nearshore commercial, interim relief (IRP). small-scale and recreational sectors.

Chapter 2: Literature review

The West Coast rock lobster fishery of South Africa is an extremely valuable fishery and provides an income and employment to a large number of people due to the resource's high value and easy accessibility (DAFF 2016). The decline in the biomass and subsequent necessary decrease of the total allowable catch (TAC) made available to the fishers have resulted in significant changes in the perception of the fishery by stakeholders and dynamics of the value chain.

2.1 The West Coast rock lobster resource

2.1.1 Distribution and life history

The West Coast rock lobster *Jasus lalandii* is a nearshore spiny lobster that is found in the temperate waters of Southern Africa's west and south coast. Although the animal is found from just north of Walvis Bay, Namibia, to about East London, South Africa, its biomass is only deemed commercially viable from about 25 degrees south in Namibia to South Africa's Cape of Good Hope (Pollock and Beyers 1981).

J.lalandii are mainly nocturnal foragers, feeding on a range of benthic and non-benthic organisms including crustaceans, molluscs and echinoids, and have been found to have significant ecological impacts through depletion of herbivores on these temperate eco-systems following an invasion (Mayfield et al. 2000, Blamey et al. 2010, Haley et al. 2011). Cannibalism may occur during moulting or periods of stress (Heydorn et al. 1969).

The annual moulting and reproductive cycles in *J. lalandii* are closely coupled as mating occurs when females are soft-shelled and males are in a hard-shelled state (Cockcroft and Goosen 1995). Juveniles moult several times per year and grow relatively fast to the size at which sexual maturity is reached, but after reaching maturity, most *Jasus* species only moult once annually (Booth 2013). As their growth after moulting is restricted by energy diversion from growth towards reproductive output, female WCRL generally have slower growth than males (Pollock et al. 1997). Female *J. lalandii* reach sexual maturity at sizes between 56 – 66 mm carapace length (CL), depending on locality and environmental conditions, while males attain a larger carapace length (Johnston and

Butterworth 2018a). These differences were applied to fishery output control measures through a size limit of 75 mm CL (Pollock 1986), thus protecting the vast majority of females, while males make up 90-99% of the legal catch (Johnston and Butterworth 2018a). Seasonal inshore and offshore movements of lobsters are associated with moulting and breeding (Atkinson et al. 2005).

2.1.2 Recent changes: shift in distribution, walkouts, somatic growth reduction

Since the 1980's the WCRL fishery has been affected by three critical life-history developments: an overall reduction in animal size and growth rates, increased walkouts and a shift of the centre of the biomass distribution eastwards.

Reduced or negative growth in adult lobsters as measured in reductions in post-ecdysis growth increments had a critical effect on the management of the fishery. While growth of around 4 mm CL was common prior to the 1990s, studies of that time revealed that growth of less than 2 mm CL per year was occurring widely along the WCRL's biological range in the late 1980s and early 1990s. Changes in growth patterns did not appear to be restricted to particular areas, sex or stage of development (Cockcroft and Goosen 1995, Pollock et al. 1997, 2000, Melville-Smith et al. 2008). Slower growth and smaller sizes of *J.lalandii* studied across the fishing area have been linked to decreased fecundity (Beyers and Goosen 1987) and while zero or negative growth increments after a moulting event can occur naturally in some crustacean species it is generally associated with unfavourable environmental conditions (Hartnoll 2001). It is not understood what caused this trend but the consequence of the decrease in somatic growth rate was poor recruitment, and led reduced productivity for the fishery as fewer lobsters caught in that period were above the minimum size limit (89mm CL at the time). The decrease in the fishers' catches and increase in post-release mortality of the undersized lobsters, led to a subsequent reduction of the minimum size limit to 75 mm CL and a decreased TAC until some recovery was observed in the early 2000s (Cockcroft and Payne 1999, Brandão et al. 2004).

The 1990s also saw an increase in the frequency and severity of lobster "walk-outs". During walk-outs lobsters move out of the ocean to perish on the beach, most likely due to hypoxic conditions resulting from local red tide developments (Cockcroft 2001). The year 1997 saw the worst lobster walk-outs experienced in South African recorded history when an estimated total of 2000 tonnes was recorded stranded (Cockcroft and Payne 1999).

In addition to slowing growth, and increased walk-outs a distinct shift in the WCRL centre of abundance towards the east was observed in the late ’90s. Differences in the phenology, such as timing of breeding and moulting, divide the WCRL population into two broad regions (see section 2.2.2): the “West Coast” (Fishing Zones A-C) and the “South Coast” (Area 8, Area 11 and Zone F), which are separated by Area 7 (Dassen Island). As was reported in Cockroft et al (2008) the proportion of catches in the late 1980s and early 1990s was higher in the “West Coast” region contributing to around 60% of overall catches while the southern region only yielded about 18% of total catches. Around the turn of the century, this balance shifted significantly as the catches in the western region dropped to around 10% and those in the southern region rose to around 60 % of the overall catches, with the remaining percentages caught at Dassen Island (Cockcroft et al. 2008). The dynamics causing this shift are not well understood but were most likely linked to a migration from offshore to closer inshore in the southern region and a disproportionate decrease in biomass in the western region due to the aforementioned phenomena, rather than to a eastward migration of the biomass (Cockcroft 2001). The shift in biomass abundance had implications for the management of the fishery reflected in the management strategy as Zone F, the most eastern fishing region, was opened in 1999, where the WCRL abundance had previously not been deemed commercially exploitable (Melville-Smith and Van Sittert 2005).

2.1.3 Resource status

Since the beginning of the fishery, the WCRL biomass has been heavily depleted (Figure 1.) and is at present estimated to be at 1.9% of pristine levels (WWF 2018a). The stock assessments presented here concern the male biomass of individuals above 75 mm, as these constitute the bulk of catches in the fishery (Figure 1.1). In 2008 when the abalone fishery was closed, the Marine Resource Assessment (MARAM) team estimated the remaining inshore and offshore biomass of *Haliotis midae* to be at 4% of the pre-exploitation biomass in the most heavily fished area (Plagányi 2008), highlighting the urgency of addressing the threat of commercial extinction in the WCRL fishery promptly, if the fishery is to remain open and viable.

Figure 1.1 A) shows that the heaviest exploitation occurred from the beginning of the fishery up to the 1960s, as there were little oversight and resource management at this time (see section 2.2.2). In Figure 1.1B) the more recent trends are shown in more detail and the drop in biomass caused by the combination of fishing activities, the somatic growth decrease and walkout can be seen over the 1980s and 1990s. After a brief recovery around the turn of the century, the biomass has shown further decreases, most likely due to unsustainable catching and IUU fishing (Johnston and Butterworth 2018a).

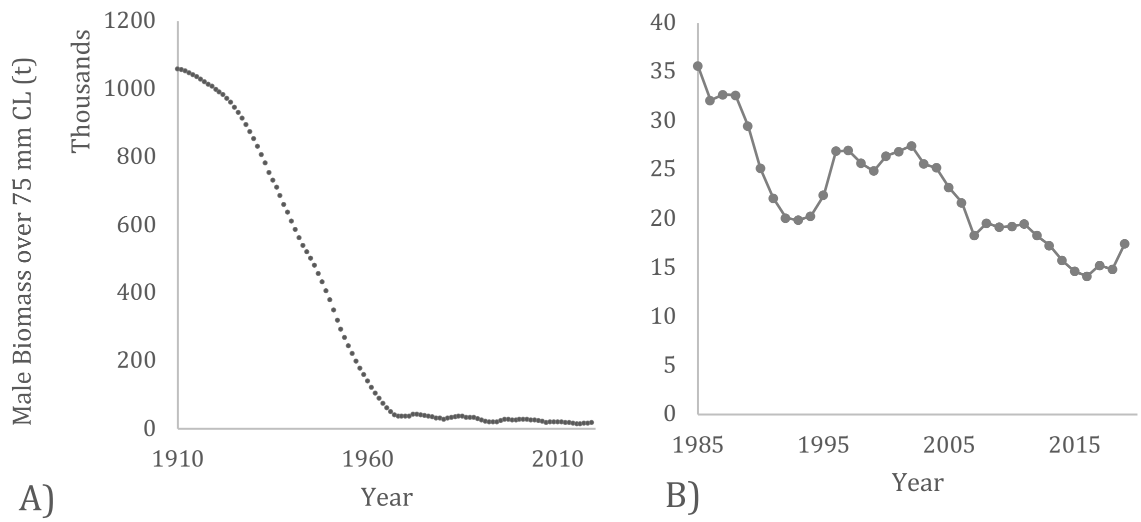


Figure 1.1 The West Coast rock lobster biomass (tonnes) for the years 1910- 2018 (A) and 1985-2018 (B) (MARAM pers. comm. 2019). Note the more than 10-fold difference in y-axis scales between the two.

2.2 Governance

2.2.1 Legislation and policies

The main legal instrument governing fisheries in South Africa is the Marine Living Resources Act (MLRA), implemented in 1998 (Act 18 1998) (RSA 1998). The MLRA is internationally regarded as an overall effective legislative framework that addresses the three pillars of an ecosystem-based approach to fisheries management through legislation promoting the sustainable exploitation of the stock, economic growth, human and socio-economic resource development and the alleviation of poverty (Cochrane et al. 2015). The balance between the different principles and objectives, has to be achieved in consideration of their long-term goals, an issue that was highlighted in the court case led by WWF against DAFF, wherein the judge emphasized in his decision that the reasoning of promoting short-term socio-economic relief to fishers by failing to reduce the year's TAC was unconstitutional in light of its long-term consequences, for both the ecological objectives and future generations of fishers, given the imminent threat of the resource's commercial extinction (Rogers 2018).

The narrow definition of- and the limited rights offered to small-scale and subsistence fishers in the MLRA, have been criticised, due to perceived inconsistencies of the act's objectives and the practical mechanisms through which alleviation of poverty, increase in food security and promotion of equity would be achieved (Kleinschmidt et al. 2003, Sowman 2011, Cochrane et al. 2015, Isaacs and Witbooi 2019). Due to inadequate reforms initiated by the government to increase small-scale fishers' recognition, several organizations (Small-scale Fishery Association, Masifundise, Development Trust and Legal Resources Centre) launched a class-action lawsuit in 2005, to gain formal recognition of former subsistence fishers through small-scale commercial fishing rights. The case was settled out of court in 2007 with the court order mandating that a "new policy and legislative process needed to be developed by all parties concerned, that would include all traditional fishers in South Africa and accommodate the socio-economic rights of these fishers[4]". A national task team was appointed with the responsibility of allocating 1000 interim relief permits (IRP) to former subsistence fishers while developing a new policy for small-scale fisheries that would provide a legal basis for small-scale fishers to access long term rights (such as the quotas allocated to commercial fisheries every 15 years) and to facilitate interactions with domestic and export value chains (Isaacs and Witbooi 2019). The New Policy for Small-Scale Fisheries (SSFP) was introduced in 2012 with key objectives of the SSFP including the encouragement of community-oriented management, as well as increasing co-management, securing the well-being of small-scale fishing communities and promoting the interests of vulnerable groups such as single women, disabled or child-headed households (RSA 2012, Isaacs 2015).

[4] Kenneth George, Masifundise Development Trust, John Spami Nkunzana, Japie Britz, Norton Dowries, Peter Coraizin, Artisanal Fishers Association versus. The Minister of Environmental Affairs ver Tourism Maritinus van Schakwyk (2007). In the Equality Court Held at the High Court Of South Africa (Cape Of Good Hope Provincial Division) FILE NO: EC 1/2005 (accessed on 10.3.2021)

In September 2018 two communities in the Northern Cape, Hondeklipbaai and Port Nolloth were the first to be granted official small-scale fishing rights, as part of the implementation of the SSFP, allowing them access to line fish and WCRL and some other marine resources. However, the implementation of the SSFP in the Western Cape has been repeatedly delayed, with the capacity of the Directorate for Small-Scale Fisheries being noted as a crucial bottleneck, as there are currently only 7 people and only 3 permanent employees engaged nationwide (PLAAS 2017). An internal audit in 2019 revealed substantial short-comings and inconsistencies in the verification process applied to the applicants for small-scale rights in the Western Cape, and in 2021, the Minister of DEFF approached the court for a complete revision of the process, which is expected to delay the finalization of rights allocations by at least another year [5].

2.2.2 Government Authority

From 2010 to 2019, the governing body responsible for managing the nation's fisheries in South Africa was the Fisheries branch of the Department of Agriculture, Forestry and Fisheries (DAFF) (Cochrane et al. 2015), but since 2019, the Fisheries Branch falls under the Department of Environment, Forestry and Fisheries (DEFF). The different denominations will be used according to under which name the authority was operating at the time of the mention. The internal structure of the Fisheries branch has stayed the same, divided into a number of directorates fulfilling different functions related to fisheries management related objectives, including conducting biomass surveys, allocating quotas, issuing permits and monitoring and enforcing rules and regulations (Cochrane et al. 2020). MARAM (UCT) is mandated by the scientific working group (SWG) within DEFF to do the required stock assessment of the resource, from which scientific advice is then formulated by the SWG after due consideration of the stock assessment inputs.

[5] https://www.gov.za/speeches/minister-barbara-creecy-asks-courts-review-small-scale-fishing-rights-process-western-cape (accessed on 10.3.2021)

2.2.3 History of the fishery and management measures

As indicated by dietary remains found in Khoi-San caves dating back to at least 10 000 years ago, WCRL appears to have been consumed on South African shores since the settlement of the first people (Cockcroft and Payne 1999). By the time the white settlers arrived in the Western Cape, the fishery for this resource was characterized by high abundance and considered “food for the poor” (Melville-Smith and Van Sittert 2005). The first commercial WCRL fishery opened in 1875 when a processing plant started exporting WCRL as a cheap substitute for the northern hemisphere *Homarus americanus* lobster to Europe, with more factories opening up along the coast as demand grew during World War 1 and 2 (Melville-Smith and Van Sittert 2005).

The first management measure taken in this fishery was a minimum size limit of 89mm carapace length (CL) in 1933, which aimed to protect the slower-growing females in the population (DAFF 2016), followed by the first production ceiling, introduced in 1946, to control the export market (Melville-Smith and Van Sittert 2005). As the industry grew and sustained catches above 10 000 tonnes from 1950 to 1965, management decided that a Total Allowable Catch (TAC) system with catch limits tailored to different regions within the lobsters' distribution would be most effective to reduce the fishing pressure (Cockcroft and Payne 1999, Melville-Smith and Van Sittert 2005). These spatially determined catch limits led to the division of the fishing region into Zones A-D in the early 80s, to which Zone E was added in 1987 and Zone F was added following the eastward shift of WCRL distribution in 1999 (Cockroft et al. 2008) (Figure 1.2).

Figure 1.2 Fishing area divisions for the West Coast rock lobster fishery, from north to south A1+2 (Zone A), A3+4 (Zone B), A5+6 (Zone C) and A8+ (Zone D, E and F) (Bergh 2014).

The fishery stabilized in the 1980s and was considered optimally fished at a yearly landed mass of around 3000 - 4000 tonnes until showing further signs of deterioration in 1989 (Cockcroft and Payne 1999). In the late 1980's South Africa first introduced individual quotas for the WCRL fishery, intended to increase the objectives of transformation, increase oversight and enhance economic efficiency (Isaacs 2015). However, the stock was found to decline further as decreases in somatic growth rate occurred at the end of the 1980's and mass walkouts over the 90s and early 2000s put additional pressure on the already heavily exploited biomass (Cockcroft et al. 2008). TACs during this period were drastically reduced from 3790 tonnes in 1991/1992 to 1500 tonnes in 1995/96 (Cockcroft and Payne 1999).

After the advent of democracy in 1994, the new government sought to make the fisheries sector more equitable and to distribute rights to previously disadvantaged persons (Isaacs 2015). As a result, existing, disproportionally white-owned fishing companies, were required to partner with Black Economic Empowerment (BEE) companies to increase their race and sex diversity in order to maintain their quotas (Isaacs 2015). Furthermore, the government drafted policies which were to permit more equitable access to the fishery, leading to a large number of new entrants in the late 1990s and early 2000s, who, however, often received rights that were not economically viable, in most cases leading to the new entrants leasing their quotas back to the former, established fishing companies (Isaacs 2011).

When the perilous state of the WCRL resource was realized in the mid-1990s, an Operational Management Procedure (OMP) was introduced in 1997 to allow for a more standardized and methodological approach to TAC calculation, and allow optimal fishing pressure while honouring long-term stock recovery targets (DAFF 2016). The OMP, first designed and implemented in 1997 (Johnston and Butterworth 2005), is updated periodically and used to create baseline future stock scenarios which take a number of uncertainties into account. The OMP models three factors: future recruitment, future somatic growth and current abundance using monitoring data, including catch-per-unit-effort (CPUE), fisheries independent monitoring surveys (FIMS) and annual assessments of somatic growth rate as input variables. A detailed overview of the early OMP history can be found in Johnston and Butterworth (2005).

In 2016 it was decided that the management procedure for the WCRL resource fell under the 'exceptional circumstances', which led to the suspension of the OMP due to time constraints faced in redressing and revising the model within the urgent resource context. Until further consultations 'best deterministic assessments' are conducted by the working group to provide best advice on different future recovery scenarios and the setting of TAC masses (Butterworth 2018). The fishing authority has struggled to meet their recovery targets and several years have seen quotas set in contravention of the best available scientific advice (Johnston and Butterworth 2019b). The most recent recovery target is set at 7% above the male biomass in 2006 by 2025 (Johnston and Butterworth 2019b) .

The fishery is essentially a summer fishery, with the timing of the season being defined each year for the different sectors and the different areas. Fishing generally opens around November for the

NC/ IRP sectors. The length of the season has been reduced in recent years, while it remained open until June in 2016/17, it has been closed between February and March in 2019/20 for the different super-areas. While the timing of the season differs in the OC sector, it is similar (November – March) in super-area 3+4, but is shifted towards the winter months in the more southern areas (i.e. January to May in A8+ or June/July for the deep water area in A8[6].

The management measures currently in place are (Johnston and Butterworth 2018a):

- Total Allowable catch (Divided between sectors and areas)
- Closed seasons (varying in length and timing between sectors and localities)
- Sub-division of the fishing area into zones and exclusion of fishing activities from Marine Protected Areas (MPAs)
- A minimum size limit (75mm carapace length for commercial catches and 80mm carapace length for recreational catches)
- Gear restrictions (for example nearshore commercial and IRP can only use hand hauled hoop nets)
- Restrictions on retention of berried females and soft-shelled (moulting) animals

2.2.4 Quota and TAC distribution

Before the advent of democracy, the commercial WCRL TAC was captured by only 39, predominantly white, right-holders, which after the change of government and increased focus on equity and transformation had shifted to 1019 commercial WCRL rights-holders in 2002, of which more than 785 were former subsistence fishers and operated mainly in the nearshore sector. The increase in quota holders and subsequent additional inclusion of the small-scale/IRP sectors meant that while the fishery became more accessible, the individual quota sizes decreased substantially over the years (Sowman 2006, DAFF 2015a)

The rights for the OC and NC sector were renewed and reallocated for 15 years following the 2015 Fisheries Rights Allocation Process (FRAP) according to criteria outlined in the respective policies

[6] 2016/17 & 2017/18: https://www.gov.za/speeches/agriculture-forestry-and-fisheries-announces-201718-west-coast-rock-lobster-tac-and
2019/2020: https://www.environment.gov.za/mediarelease/westcoastrocklobster_totalallowablecatch_recreationalfishingseason

(DAFF 2015a, 2015b). Exclusionary criteria in both commercial sectors included previous acts of non—compliance with fisheries regulations and previous underutilization of rights and previous holding of paper-quotas, however, only in the nearshore rights allocation were proof of intentions and ability to actively participate in harvesting required. Balancing criteria which were applied to both commercial sectors included whether the applicant met the objectives of transformation, job creation, local economic development and access to a suitable vessel. For OC applicants, further emphasis was put on demonstrating how their allocation had empowered previously disadvantaged people (or would do so) through additional clauses seeking information on the BEE score, transformational aspects of their company, compliance with the Employment Equity Act 55 of 1998 and employee share schemes (DAFF 2015a, 2015b).

The criteria set out for fishers applying for community-based small-scale fishing rights are outlined in the Policy for Small-scale Fisheries Sector (SSFP) in South Africa (DAFF 2012). Awaiting the implementation of the policy, annual exemption permits are issued, referred to as "Interim Relief Permits" (IRP). The criteria for these permits included being actively involved in traditional fishing for at least 10 years and/or be totally financially dependent on marine resources. Further, permit holders could not be actively involved with the commercial fisheries, neither through a permit nor as permanent employment as crew, and could not be the recipient of any government grant (with the partial exception of old age grants). Only one member per household was permitted to hold an exemption (IRP) permit (Ngqongwa 2015).

Since the initial introduction of the TAC system, quotas have been allocated according to different areas along the West Coast in proportion to local biomass estimates (DAFF 2016). To the original Zones A-D, the Falsebay Zone E was added in 1987 and the additional Zone F was opened in 1999 after the biomass was perceived to shift eastwards, allowing commercial fishing east of Hangklip (Cockcroft et al. 2008).

The approximate TAC allocation between the OC and nearshore sectors (NC, IRP, small-scale and recreational) is based on the estimated proportion of the resource in the two zones of approximately 80:20. Analysis conducted in 2018 using results from FIMS estimated the proportion of biomass in the nearshore fishing grounds of super-area 3+4 to range from 28%- 42% of the total biomass in that super-area, while the proportion of nearshore biomass for super-area 8+ was estimated to be between 5-25% of the super-area's biomass (Johnston and Butterworth 2018c). The total nearshore (NC, IRP, small-scale and recreational) TAC allocation has been ranging between 32-37% for the TAC allocations with an overall increasing trend between 2012/13 – 2018/19 (Figure 1.3) indicating that the TAC distribution is increasingly exposing the nearshore resource to disproportionate fishing pressure. While the biomass assessment study did not assume any likely inshore migration by offshore lobsters in the event of nearshore depletion and there is little evidence that this migration would occur sufficiently rapidly to offset the loss of nearshore lobster (Johnston and Butterworth 2018c). The two areas studied cannot represent the diversity of the entire WCRL distribution, however, the findings suggest that this might be an area of concern and potential conflict between the different groups accessing the nearshore resource.

Over the last 8 years, the global TAC has decreased by more than 60 % from 2166 t to 837 t (Figure 1.3). While the proportions of allocation between the sectors have remained largely similar, the ongoing efforts to allocate more of the TAC to the IRP/small-scale sector led to changes in proportions after FRAP 2015 (only implemented in 2018/19) where the nearshore resource was divided 50/50 between the IRP and NC sector and 20 % of the offshore commercial quota was reallocated to the newly introduced IRP/SS offshore quota[7].

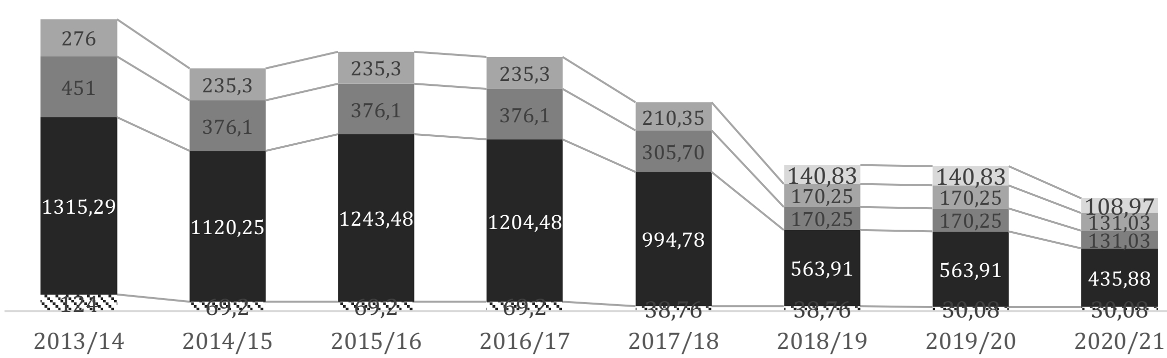


Figure 1.3 Global TAC for 2013/14 – 2020/21 and sectoral divisions indicating the TAC received by the recreational sector (white, patterned), offshore sector (black), nearshore commercial sector (dark grey), IRP/small scale

7 https://www.dalrrd.gov.za/docs/media/THE%20MINISTER'S%20DECISION%20ON%20APPEALS%20FILED%20IN%20THE%20WEST%20COAST%20ROCK%20LOBSTER%20(NEARSHORE)%20ZONE%20F.pdf (accessed on 10.3.2021)

nearshore quota (medium grey), IRP/small-scale offshore quota (light grey). Data from annual media releases from DEFF [8].

The setting of TACs has caused several conflicts over the past 10 years. The failure to reduce the TAC from the previous season's allocation in 2012/13 by DAFF (in contravention to advice from their own scientists) resulted in both WWF SA and the RFA publicly voicing their concerns and demanding justification from the department (RFA 2012, WWF SA 2012). In 2013 the conservation efforts surrounding the WCRL made headlines when WWF threatened to downgrade the lobster from green to red on its sustainable seafood list (SASSI) if management did not adhere to scientific recommendations intended to reduce pressure on and encourage the rebuilding of the stock (Barendse et al. 2018). Social pressure from retailers eventually led DAFF to enter into a compromise despite the strong opposition of many fishers, reducing the TAC in exchange for WCRL to be only listed as orange at the time (Barendse et al. 2018). Due to the continued decrease in the biomass, the WCRL was red-listed in 2016, to raise awareness and demand urgent action from consumers and the government alike[9].

The next major conflict occurred in regards to the setting of the 2017/18 TAC which was left at the same level as the previous season's TAC (1940 t) despite best scientific advice recommending a decrease to 790 t. The substantial reduction, aiming for long- term sustainability of the resource, had approval by a wide range of stakeholders, including government officials, NGOs, scientists and fishers' associations but despite this, the minister overrode these recommendations. The previously mentioned parties in support of the proposed decrease in TAC, led by WWF, took the matter before the High Court (WWF 2018a). It was ordered that the setting of the TAC by DAFF was unlawful and in contradiction of the constitution as well as NEMA (Rogers 2018), as the Minister's given reason of wanting to avoid socio-economic hardship for the stakeholders at present could not justify the long-term damage to the WCRL and to future fishers that would likely

[8]
2013/14: https://www.gov.za/west-coast-rock-lobster-total-allowable-catch-tac-announced
2014/15 & 2015/16: https://www.gov.za/speeches/daff-announces-201516-west-coast-rock-lobster-tac-and-recreational-fishing-season-9-nov
2016/17 & 2017/18: https://www.gov.za/speeches/agriculture-forestry-and-fisheries-announces-201718-west-coast-rock-lobster-tac-and
2018/19 and 2019/20: https://www.daff.gov.za/docs/media/190926%20Media%20Statement%20TAC%20determined%20for%20the%202019-2020%20WCRL%20TAC%20Fishing%20Season.pdf
2019/2020: https://www.environment.gov.za/mediarelease/westcoastrocklobster_totalallowablecatch_recreationalfishingseason
2020/21: https://www.environment.gov.za/mediarelease/westcoastrocklobster_totalallowablecatch_recreationalfishingseason
(all accessed on 10.3.2021)

[9] http://wwfsassi.co.za/west-coast-rock-lobster-is-now-red-listed/ (accessed on 10.3.2021)

be incurred by maintaining the fishing pressure at the levels set. The claim that sustainable fishing could continue at the present legal levels under the presumption that IUU fishing would be reined in was further rejected, as the court ruled that there was not sufficient evidence that the measures taken, preparation and capacity of the department reflected the viability of this proposed trade-off (Rogers 2018). The court's decision thus resulted in a substantial reduction of the TAC for the 2018/19 season, to 1084 t[10], maintained at that level the following season (2019/20)[11] and further reduced to 837 t for the 2020/2021 season[12].

2.3 Value Chain

As the market for food, including fisheries' products, is becoming increasingly global and internationally connected, an extensive understanding of value chain interactions within and across countries and from the fleet to government level, is becoming critical for fisheries managers (Christensen et al. 2011, Hamilton-Hart and Stringer 2016). The nature of interactions within a value-chain also matter as relationships between actors can differ greatly in the management approach required (Bair 2008), and demand and supply dynamics can influence profits at various stages of the value chain (Plagányi et al. 2014).

The various agents must thus be described and defined in their make-up and function. Producers can be described by the sector they engage in, by their role and profile. As the next link in the value chain marketers and processors must be considered in the context of their specific function (marketing and processing can occur in various stages which are not necessarily done by the same enterprise) and further by the nature of links to the fishers and distributors. Sellers often exist in chains from immediate sellers to the final suppliers such as restaurants, but chains can vary in length and can intersect or combine. The last agents in a value chain are the consumers who can buy the produce at any point of the value chain (i.e., ranging from purchasing of the raw product

[10] 2018/19 and 2019/20: https://www.daff.gov.za/docs/media/190926%20Media%20Statement%20TAC%20determined%20for%20the%202019-2020%20WCRL%20TAC%20Fishing%20Season.pdf (accessed on 13.3.2021)

[11] 2019/2020: https://www.environment.gov.za/mediarelease/westcoastrocklobster_totalallowablecatch_recreationalfishingseason
2020/21: https://www.environment.gov.za/mediarelease/westcoastrocklobster_totalallowablecatch_recreationalfishingseason (accessed on 13.3.2021)

[12] https://www.environment.gov.za/mediarelease/westcoastrocklobster_totalallowablecatch_recreationalfishingseason (accessed on 13.3.2021)

directly from fishers to consuming processed, marketed, sold multiple times and prepared lobster in a restaurant in a different country).

2.3.1 Harvesting

2.3.1.1 Fishers

The OC sector utilizes steel traps for capture, which consist of a rectangular metal frame covered by polyethylene netting and a top or side entrance. As the transport and deployment requires the capacity for their weight and volume, they are only used in conjunction with inboard motor vessels between 6- 14 meters in length with power winches (Sauer et al. 2003).

The NC, IRP and Small-scale sectors are restricted to operating no more than one nautical mile offshore and using hoop nets for capturing the WCRL (DAFF 2015b). Vessels in these sectors generally operate with one or two outboard motors and are transported to and from the harbour on trailers.

Quotas in the two commercial sectors are allocated to individuals and for a span of 15 years, while quotas in the IRP sector are allocated annually per community (although final allocation to each community takes the number of permit holding individuals into account) and are envisioned to be handled collectively in a precursor to the establishment of small-scale co-operatives (Isaacs 2011). Further, vessels in the two commercial sectors are generally required to catch for one quota code only per trip, although this can be slightly adjusted under specific circumstances (point 1.13 of the permit conditions)[13].

The increasing numbers of quota holders and decreasing global TACs have resulted in considerably diminished individual quotas across all sectors. Particularly in the NC and the IRP sector, this has resulted in many of the quotas becoming economically unviable, which in concert with a lack of resources for vessels and fishing gear have increased the difficulties for these quota

[13] https://www.nda.agric.za/doaDev/sideMenu/fisheries/21_HotIssues/April2010/FishingPERMITCONDITIONS2010/WCRL%20Nearshore%20Permit%20Conditions%202009_10%20fishing%20seasson%20approved%20on%2011%20Nov%2009.pdf

holders to establish themselves profitably within the value chain (Isaacs 2015, Wentink et al. 2017, Augustyn et al. 2018).

The implementation of the SSFP does not only affect IRP fishers, but also those in the NC sector, as community rights and establishments of co-operatives will attempt to merge the nearshore commercial and IRP holders. Fishers from both groups have disputed this move as it may limit those holding individual rights in the nearshore sector as they would be required to merge access and sales, while the communal handling of affairs is also feared to heighten the potential for elite capture of the fishery (Wentink et al. 2017). The high occurrence of exploitation of power by community representatives has been demonstrated in previous studies (Schultz 2017).

Some recent socio-economic information is available for the IRP/small-scale sector, investigating the viability and economics of small-scale harvesting of WCRL and line fish in Kogelberg (Jordan 2016), the way that the interactions at the value chain level affect the profitability of small-scale fishers (Wentink et al. 2017) and the potential for enhancing the income of small-scale WCRL fishers through a reorganization of the value chain (Botha 2020) while some information regarding the socio-economic situation in the offshore sector was given at the beginning of the millennium (Sauer et al. 2003) and rough estimations are given in the policies for the allocations of rights in the nearshore and offshore commercial sectors (DAFF 2015a, 2015b).

2.3.1.2 Illegal fishing

The high market value, relatively easy accessibility of this resource and overall decreasing TAC allocations are all factors that are thought to contribute to the high occurrence of illegal unregulated and unreported (IUU) fishing in this fishery (Augustyn et al. 2018). While there has been a large informal market historically (Melville-Smith and Van Sittert 2005), the considerable decline in biomass has meant that reducing IUU fishing has been declared a priority for preventing the collapse of the stock (WWF 2018b). While accurate estimates regarding the extent of IUU fishing remain difficult to establish, DEFF contracts MARAM to create models that allow some insight into the unreported catches (DAFF 2016). Two primary data sources are used for creating estimates: A general linear model linking the enforcement effort (and recently more specific enforcement types) from DAFF's Monitoring, Control and Surveillance unit to the number of successful confiscations and data from TRAFFIC comparing the quantity of legal lobster exports to available data on imports of South African WCRL into foreign markets to determine the percentage of imports that had not caught and traded legally (Van Zyl et al. 2017). Although the exact estimates vary there are strong indications that IUU catch exceeded 1000 tonnes in 2017 which would make it similar or higher than the global TAC set for the 2018/19 season (WWF 2018a).

2.3.2 Post Harvest

2.3.2.1 Buyers

As the majority of WCRL is exported, the harvest has to be of high quality and suitable for live export. High levels of organization and coordination between buyers and sellers are required to avoid high mortality rates and loss of revenue (Wentink et al. 2017). As a consequence many buyers have become highly involved with the fishing communities who supply their products, giving feedback and training to improve the quality of the catch, as well as providing certain specialized equipment to increase WCRL catches and survival (Wentink et al. 2017). The dependence of fishers on these 'middle men' can be increased when these actively seek to bind fishers and their communities to their particular service. Although this can present in positive forms such as agents providing help in organizational aspects of the fishery (assisting with boat license requirements and renewals, vehicle supply and insurances) many also offer unregulated credit, which can lead fishers into debt. If fishers fail to repay the debt to their agents, this often results in a vicious cycle whereby the fishers are forced to sell the following year's supply at a lower price making future financial independence more unlikely (Wentink et al. 2017).

The ways and amounts that fishers are paid for their catch vary between different buyers and processing and marketing companies, as some prefer to base their prices on market value at the time, while others maintain a set price for the entire season (Jordan 2016). The government set a minimum price of 200 R/kg in 2014/15 for IRP fishers, with fishers receiving around R250/kg at the beginning of the season (Nov/Dec) and approximately R225/kg at the end of the season (Feb/Mar), while NC fishers were estimated to have been paid between R180 and R270 per kg over that season (Jordan 2016).

2.3.2.2 Processing

In general, all fishers aim to sell their catches on to processing and marketing companies (PMCs) which facilitate arrangements for export or hold export rights. The local processing component is very important to consider when assessing the fishery's contribution to job creation and poverty alleviation. In 2003 it was estimated that approximately 19 companies along the coast employed over 2800 employees, but the decreasing TAC s around the time meant that most of the factories had become multifaceted, allowing processing of different species to enhance their economic viability (Sauer et al. 2003). It was remarked that job losses can critically affect coastal communities in the vicinity of these processing plants as they often provide some of the only viable employment opportunities (Sauer et al. 2003).

The general procedure for exporting lobster after offloading is given on various websites of WCRL PMCs[14][15][16] and includes weighing, transfer to temperature-controlled seawater tanks, in which they are 'purged' for about three days by running, cold seawater. They are then removed from their tanks and graded according to quality (lower quality and damaged lobsters are drowned in fresh water and packaged for whole or tail frozen sale). The live lobsters are packaged according to their weight in 10 or 14 kg polystyrene containers (number of lobsters per container depends on their weight category) and kept cool using ice gel packs. Most big companies have direct access to the airport (exports occur mainly from Cape Town International Airport). The major export markets for *J. lalandii* include the far east, western Europe and the USA (Melville-Smith and Van Sittert 2005).

Many of the large fishing companies have rights in the OC sector of the West Coast rock lobster industry in addition to owning some of the major seafood PMCs (Wentink et al. 2017). Many actively engage and provide assistance to fishing communities in the catching, marketing and processing of their harvest, as well as offering full-time employees benefits such as medical aid, pensions and often set aside a parcel of shares to allocate to staff via trust funds (Oceana group 2019) .

[14] https://premierfishing.co.za/west-coast-lobster/ (accessed on 10.3.2021)
[15] https://www.ij.co.za/all-fish-species/ (accessed on 10.3.2021)
[16] https://www.paternostervissery.co.za (accessed on 10.3.2021)

2.3.2.3 Marketing

In the early 1990s, South Africa amended a law to allow all lobster right- holders essentially free choice as to how and through whom to market their produce, which was a change from the previous marketing monopoly held by only 2 companies in the country (South African Frozen Rock Lobster Packers, SAFROC; and Cape Lobster Exporters Association, CLEA) (Sauer et al. 2003). However, it has been noted that the increase in marketers has led to more potential for some marketers to exploit fishers by forcing unfavourable prices for the lobster, as well as internal price competition and greater variance in the quality of the exports (Wentink et al. 2017).

2.3.3 Consumers

Due to the high market value of the WCRL, it generally is not consumed by fishers themselves as they prefer the economic gain that can be reached through the sale to export market (12-20$ per kg) over the standard local prices (3-4$ each) (prices from 2015). These prices make WCRL one of the most highly sought after marine resources (Isaacs 2015). Caught, traded and exported live for the highest monetary return, value chain aspects are critical in this fishery as those fishers that can achieve the highest survival rate through value chain integration and coordination with exporters profit financially (Wentink et al. 2017).

2.3.3.1 Local markets

As noted in the section on the general history of the fishery, the local market remained uncontrolled for a long time after the first production ceiling was introduced for the export market, and only in the late 1960's the local consumption was deemed high enough to require restrictions (Melville-Smith and Van Sittert 2005).

Due to the large wealth gap in Cape Town, there is a reasonable balance between fishers and wealthy people creating a demand for 'luxury food' like lobsters, but it is in no way competitive with the export prices and demand (Isaacs 2015). A recent development in the South African small-scale fisheries sector has been the introduction of an Information and Communication Technology (ICT) system by ABALOBI, which promotes direct access to high-end local restaurants and retailers for local small-scale fishers. While this has so far been used mainly for the line-fish basket of species allocated to small-scale fishers, it has great potential to influence the way lobster can be sold in the future through an expansion of buyers in the local, and, as has recently been done through an agreement with Oceana, the export market, reduction of middlemen and increased financial revenue to fishers (Petrik and Raemaekers 2018).

2.3.3.2 The export markets and competing products

While South African lobster has historically been exported to markets in Europe, Asia and the Americas (Pereira and Josupeit 2017) the past two decades have seen China becoming the dominant importer of live export *J.lalandii* (Isaacs 2015, Wentink et al. 2017).

On an international scale, lobster prices are increasing (Economic Research Associates Pty Ltd 2015). This is thought to be due to a growth in demand in China that is outweighing the growth of supply (Pereira and Josupeit 2017). The economic liberation of trade in China, in tandem with a rising GDP (Wang et al. 2019), are believed to have increased Chinese citizens' appetite for luxury-type food, such as lobster, leading to China growing into the main importer in the world's seafood market (Fabinyi 2016).

In the international market, the main competitors for South Africa's *Jasus lalandii* are other palinurideaen (spiny and rock lobster species) lobsters, mainly from the genera *Jasus*, *Palinurus* and *Panulirus*. The prices paid for lobster by Chinese importers for lobster from New Zealand and Australia are particularly high (lobster from New Zealand achieves prices of almost USD 90/kg) while Mexican and South African lobster are estimated to generally achieve prices of an average USD 40/kg (Pereira and Josupeit 2017) . Both *Jasus edwardsii* (southern Australian rock lobster) and Australia's west coast rock lobster (*Palunirus cygnus*), are said to be of more sophisticated taste than *J. lalandii* and Indonesian, Mexican or American lobster species (Economic Research Associates Pty Ltd 2015). Variability around quality and transport of *J.lalandii*, has further decreased the confidence of Chinese clients, as the harvest standards are variable and the longer travelling time from South Africa (compared to Australia or New Zealand) can result in higher mortality rates. Further, *J. lalandii* has a larger head to tail ratio than *Panulirus cygnus*, thus resulting in significantly lower tail meat yields (Winzer 2007). Positive attributes of *J. lalandii* against the competing species include their smaller sizes, which allows for cheaper piece pricings and greater menu variations, as well as the fact that it is more similar to the more desired and higher prized *J. edwardsii* than the Mexican or Indonesian variations, making it a more fitting substitute (Winzer 2007). In comparison to another Palinuridae species, for example, *Palinurus argus* from South America, *J. lalandii* is therefore still generally accessing higher market prices (*P. argus* was reported to achieve average market prices of only 12 USD/kg, in exports mainly directed at Japan, Europe and Canada) (Muñoz-Nuñez 2009).

At this point, it cannot be determined to what extent streamlining the value chain and quality optimisation could improve the international market price of *J. lalandii* to match the prices received for the Australian and New Zealand species, or whether the inherent differences in the quality of the meat, size or proportions will cause the prices to reach a plateau. Improvement and enhancement of the value chain however, is highly likely to contribute positively to the international prices received by South African sellers.

2.3.4 The role of the government in the value chain

Access to the value chain and the number of middlemen varies substantially between the different sectors and within a sector. Many of the PMCs are linked to historically large rights holders in the commercial sector who have developed a dominant part in the overall WCRL value chain (Wentink et al. 2017), while the NC, IRP and small-scale fishers most often sell to local agents who then sell the accumulated stock to companies for export (Isaacs 2015).

Government intervention in value chain relations can help in upgrading the value of both national and international product prices, however, mandated minimum prices and other measures can only have long-term benefits if they are implemented together with other measures to enhance community autonomy and co-governance (Wentink et al. 2017). In 2013/14, the government attempted to promote agreements with agents who bought live lobster (and dead lobster at a reduced price) for a minimum price of US$20. Furthermore, these buyers were required to provide established cold chains and tanks to ensure the best possible export prices (Isaacs 2015). However, it was noted by the fishers and buyers alike that this was done without adequate consultation with the various agents within the value-chain and thus necessary amendments to infrastructure dynamics and marketing efforts were not taken, limiting the success of the minimum price initiative, and highlighting the need for an extensive understanding of the different processes involved in the value chain (Wentink et al. 2017).

The governing authority has strongly promoted increased coordination of small-scale fishers to improve long-term relationships between small-scale fishers and buyers further up in the value chain, as envisioned under the SSFP, to enhance product quality and to allow the fishers more bargaining power. However, the implementation of this model has been more complicated than anticipated (Wentink et al. 2017). The successful implementation requires extensive consultation with all actors, ground-level understanding of the value chain and in-depth assessments of all applicants, however, an internal audit in 2019 found the verification process thus far conducted "wholly inadequate" prompting the Minister to seek a review of the complete process thus far prompting further delays of at least another year[17].

2.4 Conclusion

The perilous state of the West Coast rock lobster fishery requires the government to set global TACs that will encourage the recovery of the biomass as per the objectives of the MLRA. The fishery is at a critical juncture, and the timely implementation of effective management strategies, based on sound quantitative data, is going to determine the ecological, social and economic future of this fishery. It is a very diverse system and the complexity apparent in the fishery's stakeholders and value chain arrangements must be understood and mirrored in its governance. The lack of recent data concerning economic and social parameters is a critical limitation in the extent to which management strategies can be developed to address current and specific aspects and interactions of the human dimension of the fishery and value chain.

[17] https://www.gov.za/speeches/minister-barbara-creecy-asks-courts-review-small-scale-fishing-rights-process-western-cape (accessed on 10.3.2021)

Chapter 3: Current economic and social dimensions of the West Coast rock lobster fishery

3.1 Introduction

The human dimension of the West Coast rock lobster fishery is characterised by a great diversity between stakeholders. The three seasons following FRAP 2015 (2016/17, 2017/18 and 2018/19) showed great changes, both in the global TACs allocated and in individual quota sizes. While the socio-economic aspects of the WCRL fishery were a main point of discussion in the exchanges leading up to the setting of the 2017/18 TAC and subsequent lawsuit against DAFF, led by WWF (WWF 2018a), little official data concerning this aspect of the fishery was and is available. In an effort to address this gap, the following chapter attempts to first explore the concrete parameters of the fishery and different sectors over the seasons 2016/17 – 2018/19, including numbers of active actors, their assets and quotas, as well as income and costs, general dynamics and avenues of product and monetary flow from stakeholders, and then to create an overall socio-economic profile for the fishery over these seasons by calculating the approximate net seasonal income (NSI) for the different sectors and representative individuals. The trends and areas of success and concern that emerged from this analysis are then used to discuss the effects of different variables on the socio-economic dimension of this fishery, and to make suggestions and recommendations for future management strategies.

3.2 Methods

3.1.1 Data collection

The data for this study were collected from two main sources. Firstly, available data from organizations holding records related to this fishery were consulted, including the DEFF landing records for the offshore commercial (OC) and nearshore commercial (NC) sectors, export records for the previous seasons and documents about rights allocations within and between the sectors. These records were in part obtained directly from DEFF through a formal request and in part were publicly available. Secondly, economic, and social data and comments on the processes within the fishery were obtained through interviews, surveys and workshops with fishers in the different sectors, representatives of companies involved with the WCRL value chain, retailers, NGO's and government officials.

3.1.1.1 Official records and documents

Landing records for the NC and the OC sectors were extracted from the DEFF database for the seasons 2013/14-2018/19 after acceptance of a PAIA request, as legally required. These catch records were codified (all actors were denominated by anonymous codes) and detailed the following information for each logged catch: the season, the landing date, the vessel code, the quota code, the vessel owner code, the mass caught (quota code specific) the super-area where the catch was caught, and whether the quota code and the vessel owner code refer to the same entity.

The variables detailed in Table 3.1.1 were extracted from the DEFF catch records and governmental releases, and will be referred to as DEFF landing records, DEFF TAC divisions and DEFF export records as appropriate.

Table 3.1.1. Input variables for estimating the value of the fishery for the seasons 2016/17-2018/19 sourced from the DEFF landing records, DEFF TAC divisions, DEFF export records or public releases (an x signifies that the information was available for the sector).

For the entire sector:	Offshore commercial	Nearshore commercial	IRP	Small -scale
Total allocation for the sector	X	X	X	X
Total catch for the entire sector	X	X		
Total export for the entire sector	X	X	X	X
Total number of quota holders in the sector	X	X	X	X
Total number of vessel owners in the sector	X	X		
Total number of vessels operating in the sector	X	X	X	
Total number of trips made by each vessel	X	X		
The average catch made per trip	X	X		
For quota holders within the sectors:				
Quota sizes per individual/community	X	X	X	X
Total catches per vessel owner	X	X		
Catches for other quota holders	X	X		

Table 3.1.1 shows that while for both the offshore commercial and the nearshore commercial sectors a lot of the descriptive data is available through the DEFF catch records, the respective data are less available for the IRP and small-scale sector as there are no electronic per-landing

catch records kept for those sectors (Representative of the Directorate for Small-Scale Fisheries, pers. comm. 2019). Even numbers such as numbers of vessels active in the IRP were only given for one of the three seasons upon request from the directorate for small-scale fisheries. This meant that for these sectors some of these variables had to be filled in or estimated from information gained from interviews, while for others the NC data was used as a proxy.

To estimate the value of the fishery to the processing and marketing companies (referred to as PMC hereafter) and exporters, the export records kept by DEFF were analyzed, yielding data on the following aspects of the value chain (DEFF export records 2019):

- Total mass exported by each quota holder, sector, and the entire fishery (for each season 2016/17-2018/19)
- Total number of quota holders linked to one PMC and exporter (for seasons 2016/17-2018/190
- Numbers of PMC working with/ supplying/being directly linked with one exporter (and vice versa) (for 2019)

3.1.1.2 Interview and survey data: Participants and sampling

One of the factors that make this fishery unique and complex is the fact that the West Coast rock lobster quota-holders effectively span the highly variable social and economic range that characterizes South African society as a whole. Participants and Interviewees in this study ranged from small-scale fishers living in remote communities to established representatives of multinational companies.

The political climate within the WCRL fishery can be characterized as a “conflict environment”, as defined by Kriesberg 1998: “A conflict environment is one in which people, whether individuals or groups, perceive their needs, goals or interests to be contradicted by the goals or interests of the other side” (Kriesberg 1998). Participant sampling in conflict environments is often achieved through “snowball sampling” whereby researchers encourage facilitators and participants in the study to help to identify further possible respondents (Cohen and Arieli 2011). This method was appropriate to this study as it helps to navigate distrust and suspicion of researchers by the participants, through the use of referrals by a third-party familiar to the participant.

For this study, engagements with participants were largely facilitated through Abalobi, WWF SA (mainly for the NC and the IRP sector) and the WCRLA (mainly for the OC sector and PMCs) and DEFF (for all sectors and stages of the value chain) as primary references.

A mixed-methods approach was assumed to best accommodate the different needs and preferences of the participants, as methods for engaging with the different stakeholders had to be adapted throughout the study according to suggestions and requests from facilitators or participants. While some questionnaires were returned throughout the study, the majority of information was obtained in interviews and meetings, which allowed greater adaptability to the needs, requirements and expectations of the different participants. This method is more time and money intensive than other methods like surveys, as it necessitates travelling to participants for meetings across a very large active fishing area. However, since this was the most effective way to increase the willingness of stakeholders to engage with the researcher, this was a necessary trade-off. All face-to-face meetings were completed in 2019 before restrictions had to be imposed to try to minimise the spread of COVID-19.

A semi-structured framework and a socio-emotional interviewing style were employed to avoid an exchange that might have been seen as disrespectful, intrusive and threatening. This was shown to increase the respondent's motivation to engage and to view the interview process favourably, two factors that have been linked to increases in the amount and accuracy of information obtained (Dijkstra 1987). All surveys and interviews were conducted in accord with the ethics guidelines set out by Rhodes University, by obtaining the consent of participants before the interaction (Appendix 1.1), disclosing the project's objectives and funders (Appendix 1.2), and ensuring the protection and anonymity of all participants. Interviews followed either the format and content of the questionnaires (selecting questions as relevant to the participant) which (available in Appendix 1.3 and 1.4), or were kept in a conversational style that focused on the participants' main areas of knowledge in cases where the participant in question either had a general knowledge of the fishery (i.e. not a quota holder or directly involved in processing) or when the participant had filled out a questionnaire previously and the meeting was held to discuss the questionnaire answers and more general issues about the fishery.

Interviews have an inherent risk of researcher bias, which is an almost unavoidable source of error and bias in this method of data collection (O'Muircheartaigh and Campanelli 1998). The interviews in this study were conducted by a young, white female, who does not speak Afrikaans (the first language in many fishing communities of the Western Cape). This limitation was mitigated through the help of translators from the local community and by building specific rapport with the participants before, during and after the interviews. This was achieved through transparency (explaining the project, disclosing funding of the project and discussing the participant's role in the study) as well as an assurance of anonymity and confidentiality of any sensitive information, and validating general findings with key respondents before solidifying them, as discussed in Gabarski et al. (2016).

3.1.1.3 Data collection summary

Table 3.1.2 gives an overview of the different types of data collection methods within the different sectors. A total of 30 interviews were conducted, and a total of 19 surveys and questionnaires were collected for this study. These relatively low numbers presented a significant limitation to this study but also attest to the complicated and volatile nature of the fishery at present. Despite the researcher's best efforts and assistance from well-connected facilitators such as the WCRLA, DEFF and Abalobi, the response was generally poor. Stakeholders' suspicion of researchers and political uncertainty are assumed to have played a big role in the general unwillingness to engage. These limitations and sector specific factors will be further discussed in Chapter 5.

Table 3.1.2. Summary of the numbers and roles of respondents who participated in this study and the method by which information was obtained from them.

	Survey	Interview	Survey & Interview
Offshore commercial vessel owner and quota holder	1		1
Offshore commercial quota holder without a vessel	1		
Offshore commercial stakeholder and/or expert		1	
Nearshore commercial vessel owner and quota holder	1	3	1
Nearshore commercial quota holder without a vessel			
Nearshore commercial stakeholder and/or expert		2	
IRP Caretaker		4	
IRP vessel owner and quota holder		3	
IRP quota holder without a vessel	13	4	
IRP stakeholder and/or expert		1	
Small-scale co-operative vessel owner		1	
Small-scale cooperative admin		2	
Small-scale cooperative member without a vessel		1	
PMC (& exporter)	1	2	1
Exporter		1	
Government		2	
Biological and resource management scientists		1	

The" stakeholders and/or expert" refer to individuals with either sector- or function-specific knowledge who gave additional insights that reflected approximations regarding the costs and incomes from a large group of individuals, allowing cross-validation of the findings. The more general and averaged data obtained from these "stakeholders and/or experts" was used to validate and cross-check the findings from individual respondents, and to ensure that, in instances where only a small sample was available, the results matched the general estimations from the experts.

3.1.2 Analysis of data for constructing the economic profile of the sectors

In addition to the diversity within the actors of the WCRL industry, there are also a large number of variations in the way that the different actors are linked, how they interact, and how the money and product flow. The fishers and quota holders in this study, are differentiated by their respective sector: offshore commercial (OC), nearshore commercial (NC), Interim Relief Permit holders (IRP) and members of the small-scale sector organized into co-operatives in accordance with the SSFP. They are also categorised by their functional group and by the super-area or zone within which they are active (in the case of the NC and IRP sector respectively). Table 3.1.3 outlines the numbers of concrete variables estimates that were obtained for the costs and income categories for the different sectors and value chain components.

Costs and revenues of each participant were estimated from the information obtained from participants (Table 3.1.3), which were then used as inputs for the model to calculate gains and losses at each step of the value chain to provide an approximate picture of the dynamics therein following a standard approach. Due to the limited nature of the information obtained for specific variables, the statistical distributions could not be determined reliably. For the purpose of this study, they were therefore assumed to be normally distributed, and means and standard deviations were calculated.

Table 3.1.3. Variables and numbers of individual responses obtained from interviews and surveys. The number of entries is given as each separate response for the variable (for example if one respondent gave estimates for each of the three seasons the number of entries is denoted as 3).

	Offshore commercial (n)	Nearshore (commercial and IRP) (n)	Small-scale (n)	PMC (n)
Income:				
Net price received (R/kg)	3	19	1	n/a
Catching fee (R/kg)	8	14	n/a	n/a
Crew fee (R/kg or R/season)	4 (R/season)	11 (R/kg)	1	n/a
Gross price received (R/kg)				
Cost per trip (R/trip):				
Bait (R/trip)	6	14	n/a	n/a
Fuel (R/trip)	6	14	n/a	n/a
Harbour (R/trip)		7	n/a	n/a
Transport costs (R/trip)		5	n/a	n/a
Oil costs (R/trip)		3	n/a	n/a
Annual costs (R/season):	4			
All maintenance cost (R/season)	3		n/a	n/a
Maintenance vessel (R/year/vessel)		9	n/a	n/a
Maintenance engines (R/year/vessel)		4	n/a	n/a
Maintenance vehicle (R/year/vessel)		6	n/a	n/a
Maintenance trailer (R/year/vessel)		3	n/a	n/a
At sea equipment replacement (R/year/vessel)		9	n/a	n/a
Insurance	3	1	n/a	n/a
Permit quota (R/year/vessel)		official	n/a	n/a
Permit vessel (R/year/vessel)		official	n/a	n/a
Transport for permits (R/year/vessel)		2	n/a	n/a
Telephone bill (R/year/vessel)		2	n/a	n/a

SAMSA (R/year/vessel)		5	n/a	n/a
All capital costs (R):				
Vessel (R)		11	n/a	n/a
At sea equipment (R)		7	n/a	n/a
Vessel + at sea equipment (R)	1	7	n/a	n/a
Vehicle (R)	1	7	n/a	n/a
At-home equipment (R)	n/a	5	n/a	n/a
Trailer (R)	n/a	3	n/a	n/a
PMC employee salaries (R/month):				
Factory worker (R/month)	n/a	n/a	n/a	6
Factory supervisors (R/month)	n/a	n/a	n/a	5
Admin (R/month)	n/a	n/a	n/a	5
Management staff (R/month)	n/a	n/a	n/a	2
Transport (R/month)	n/a	n/a	n/a	1

Further, for the NC and IRP "per-trip" cost category, entries for the seasons 2016/17-2017/18 available in catch records kept by Abalobi for vessel owners in the IRP sector were consulted and numbers of entries for the different categories are given in Table 3.1.4. These were calculated for the different communities for which data was available and then combined across the entire area, weighting the averages by the communities' total catches recorded.

Table 3.1.4. Number of entries for individual cost categories in the Abalobi catch records for the season's 2016/17-2018/19 (Abalobi records, 2019).

Cost category	Number of entries		
	2016/17	2017/18	2018/19
Bait cost per trip (n)	21	14	9
Fuel cost per trip (n)	20	17	12
Oil cost per trip (n)	12	8	8
Transport cost per trip (n)	5	3	4
Harbour cost per trip (n)	3	4	2

3.1.3 Calculation of input variables

The collected data from interviews and surveys were collated in excel sheets. The data were summarised in a different way for the different sectors and value chain components.

3.1.3.1 Calculation of input variables applicable to all sectors

A log-normal distribution is generally assumed for the WCRL CPUE (Johnston and Butterworth 2018b), and this was adopted to characterize the catch per trip distribution as well for the seasons 2016/17-2018/19. Thus, a generalized linear model GLM was conducted in Statistica, to estimate the mean catch per trip for the entire fishing area for the NC and OC sector given the independent categorical factors of season, landing month, as well as super-area in the case of calculating the overall (whole area) mean catch per trip for the entire sector models (Eq 3.1). The same method, including only season and landing month as factors was used for each super-area separately for the NC sector (Eq 3.2.), since this study distinguishes between the areas in the models for representative individuals (in the NC and IRP sector) due to the notable differences in quota sizes and numbers of quota holders between the areas.

Entire sector model:

$$ln\ (CaTr\ season) = \alpha + \ \beta season + \beta month + \ \beta Superarea + \ \varepsilon \qquad \text{Eq.3.1}$$

Per super-area model:

$$ln\ (CaTr\ season_{SA}) = \alpha + \ \beta season_{SA} + \beta month_{SA} + \ \varepsilon \qquad \text{Eq. 3.2}$$

Where: α is the intercept,

$season$ is a factor with 6 levels (2013/14-2018/19) associated with the season (annual) effect.

$month$ is a factor with a maximum of 11 levels (November-September) for the offshore sector and a maximum of 10 levels (October – July) for the nearshore sector associated with the month effect.

$Superarea$ is a factor with 4 levels (A3+4, A5+6, A7, A8+) for the offshore sector and 4 levels (A1+2, A3+4, A5+6, A8+) for the nearshore sector

ε is the error term, assumed to follow a normal distribution

3.1.3.2 Calculation of input variables applicable to individual sectors

Offshore commercial entire sector and representative individuals

The two respondents from the OC sector who filled out surveys and engaged in interviews had quite different assets and capacity, as a result, averages calculated for the costs per vessel were weighted by the number of vessels owned by the respondent for each season.

The offshore sector is strongly vertically integrated, and the division in income between the production (catching) components and the PMC component of right holders in a vertically integrated company is not always clear. However, this study set out to quantify the costs and income of the fishing components of the different sectors, which required attempting to estimate the effective gross and net incomes to vessels fishing for offshore quotas (see section 3.2.1.4 b).

Arrangements between different categories involved in the OC sector were addressed as follows:

- Catching agreements between OC quota holders and vessel owners were not considered in calculations for the entire sector, as the money paid from an OC quota holder to an OC vessel owner remains in the sector and does not affect the total value.
- Agreements between the IRP sector and the offshore vessels catching the offshore quota allocated to the IRP sector in the 2018/19 season were integrated into the calculation to estimate the economic contribution of this arrangement.
- Although preliminary analyses showed that it was not unusual for a quota holding vessel owner to have another vessel owner help catch their quota while also catching some of it themselves, this aspect of the catching agreements was not addressed in the VQ model as the quantity caught in such a manner was largely independent of total catch or quota size, thus creating a large amount of variation and possible combinations.

Equation 3.3 details the process for calculating the net seasonal profit for the entire sector.

NSI_s=($(TC_s \times NPr)$ + $(TCIRPOq_s \times Cfe(OC))$) – ($(nTr_s \times Cstr)$ +$nV_s \times (Csan + Csdp)$)

Eq 3.3.

Where: NSI_s = Net seasonal profit (R/season))

TC_s = Total catch in a given season (kgs/season)

NPr = Net value of one kilogram of lobster (R/kg)

$TCIRPOq_s$= Total catch made for the offshore IRP quota in a given season (kg/season)

$Cfe\ (OC)$ = Catching fee received in the Offshore sector(R/kg)

nTr_s = number of trips made in a given season (trips/season)

$Cstr$ = Cost per trip (R/trip)

nV_s = Number of vessels (n)

$Csan$ = Annual costs (R/season)

$Csdp$ = Depreciation costs (R/season)

Representative individuals in this sector were defined as non-vessel owning quota holders (NVQ), vessel owners catching only for themselves, meaning that all their catch constitutes their own quota (VQ-CS), vessel owners whose total catch was composed to 50% of their own quota and 50% someone else's quota (VQ-50/50) and vessel owners whose entire catch is for someone else's quota (VO-CO). The equations to calculate their NSIs are given in Appendix: 2.4.

Nearshore and IRP sector entire sector and representative individuals

Information from the IRP and the NC vessel owners were combined in the cost analysis. The average costs for a trip were calculated from the figures given in the surveys and interviews. To the data from the interviews and surveys, the averages from the Abalobi catch records, and the resulting averages were crosschecked with experts and stakeholders in the fishery to ensure their reliability. Since the respondents in these sectors had similar assets (each of the respondents having one vessel) and similar (super-area or zone dependent) quotas, averages and standard deviations were calculated giving each respondent equal weight. The vessel owners in both the IRP and NC sector are highly heterogeneous regarding their assets, reflected in the large standard deviations obtained for the different costs in this sector.

There were several specific costs (or cost categories) that were not given by all individual fishers (for various reasons) or were given under different names. Therefore, in estimating total costs per trip, annual or capital costs for fishers, averages were calculated for each distinct cost category and then added to arrive at the total per trip or annual cost. The standard deviation of the totals was calculated following the standard procedure of adding the variance of each distinct cost category and then taking the square root of the combined variances to arrive at the combined standard deviation.

While there are likely to be some differences in costs between the nearshore and IRP sectors and the different localities, due to data limitations and the high variability within both sectors, these differences could not be reliably refined and combined averages are therefore used as an approximation for these models.

The total NSI for the NC and the IRP sectors were calculated according to Equations 3.4 and 3.5 respectively. According to a governmental representative from the Small-Scale directorate within DEFF (pers. comm. 2019), roughly 80 % of the 156 vessels active in the IRP sector do not belong to IRP quota holders but to NC quota holders. As a result, an external catching fee was introduced into the entire sector equations for the nearshore quota in the IRP, to include different effort (trip costs), different numbers of vessels and income/expenditure (catching fee). The model for both sectors was run using two scenarios: Scenario 1 where 20 % of the total IRP NQ quota is caught by IRP fishers using 32 vessels, and the rest is outsourced to NC vessel owners, and scenario 2, assuming that all 156 vessels actively fishing the IRP quota belong to IRP vessel owners, and therefore 100% IRP quota would be caught by IRP vessels.

The NSI for the entire sector model equation NC sector was thus calculated according to Equation 3.4 and the NSI for the entire IRP sector was calculated according to Equation 3.5.

$$NSI_s = ((TC_s \times NPr) + ((PIRP_{NC} \times Qt_{IRP\ NQ}) \times Cfe\ (NC))) - ((nTr_{\ s} \times Cstr) + nV_s \times (Csan + Csdp)) \qquad \text{Eq 3.4.}$$

Where: $PIRP_{NC}$ = Proportion of IRP total TAC caught by NC vessels

$Qt_{IRP\ NQ}$ = Total IRP nearshore TAC (kgs)

$Cfe\ (NC)$ = Catching fee received by the nearshore sector (R/kg)

Terms used here and given in previous equations are not repeated here.

NSI_s= $(((Qt_{IRP\ NQ} \times PIRP_{IRP}) \quad \times NPr) + ((Qt_{IRP\ NQ} \times PIRP_{NC}) \times (Npr - Cfe(NC)) + (TCIRPOq_s \times (Npr - Cfe(OC))) - ((nTr_s \times Cstr) + nV_s \times (Csan + Csdp))$

Eq 3.5.

Where: $PIRP_{IRP}$ = Proportion of IRP total TAC caught by IRP vessels

Terms used here and given in previous equations are not repeated here.

Representative individuals in the two sectors were defined as non-vessel owning quota holders (NVQ), and vessel owning quota holders. For vessel owning quota holders a further two categories were explored: vessel owners who only catch their own quota (VQ-CS) and vessel owners who also catch for other quota holders from their super-area/zone, with the scenarios of a NC vessel owner assumed to catch for an additional two quota holders (VQ+2) and an IRP vessel owner assumed to catch for an additional five quota holders (VQ+5). The equations for the calculation of the NSI for the different representative individuals from the NC and IRP sector are given in Appendix 2.5, 2.6 and 2.7 respectively.

Small-scale sector entire sector and representative individuals

At the point of this study (2019), only two communities in Zone A (Hondeklipbaai and Port Nolloth) had been accorded rights for WCRL under the small-scale fishing status for their cooperatives. Both cooperatives were visited and contact with primary representatives was facilitated by DEFF's department for small-scale fisheries. In Hondeklipbaai only one individual was available for an interview, while in Port Nolloth a representative of the cooperative agreed to a meeting and further facilitated (and translated) interviews with admin personnel and two members in addition to one individual involved in the processing of fish and future capacity for processing lobster, allowing a more complete picture of the economics, developments and social dynamics of this co-operative.

Due to the differences both in quantity and quality of data obtained and the differences in dynamics and functionality between the two cooperatives operating at the point of the study, quantitative results are presented for Port Nolloth only. Hondeklipbaai and the difference between the co-ops, and their differences to the extant IRP sector are discussed in a primarily qualitative manner.
Since the co-operative in Port Nolloth reported that they received wholesale per kilogram prices for the lobster that did not change throughout the year and that the PMCs that they worked with covered their fishing costs as part of the arrangement, their NSI is calculated following Equation 3.6.

$$NSI_s = (Qt_{PN\,s}(NQ) \times Npr(NQ)) + (Qt_{PN}\, s(OQ) \times Npr(OQ)) - (nV_s \times (Csan + Csdp))$$

Eq 3.6.

Where: $Qt_{PN\,s}(NQ)$ = The nearshore quota that Port Nolloth receives (kgs/season)

$Npr(NQ)$ = The net amount of money received per kilogram of their nearshore quota (R/kg)

$Qt_{PN}\, s(OQ)$ = The offshore quota that Port Nolloth receives (kgs/season)

$Npr(OQ))$ = The net amount of money received per kilogram of their offshore quota (R/kg)

Terms given in previous equations remain as given above

Further, given the arrangement of dividing the income per kilogram of lobster of the nearshore quota between members of the co-operative according to their roles (sea-going individuals, pensioners, admin) their NSI can be approximated given Equations 3.7 and 3.8.

$$NSI(seagoing) = \frac{TC\ (NQ)_s}{nsg} \times Sasg + \frac{TC\ (OQ) \times NPr(OQ)}{ncoop}$$ Eq 3.7.

$$NSI(pension) = \frac{TC\ (NQ)_s}{npens} \times Sap + \frac{TC\ (OQ) \times NPr(OQ)}{ncoop}$$ Eq 3.8.

Where: $ncoop$ = number of individuals in the co-operative

$npens$ = number of individuals in the co-operative who are on a pension (women, disabled and old)

nsg = number of sea-going individuals (technically $nsg = ncoop - npens$)

$Sasg$ = Salary received by sea-going individuals (R/kg)

Sap = Contribution received by pensioners (R/kg)

Processing, marketing and exporting

High resolution information was obtained on international market prices and volumes handled, which means gross income from all exports could be determined with reasonable confidence. The totals and interquartile ranges concerning the total mass of WCRL processed for all entities and mass per PMC and exported per Exporter were sourced from the DEFF exporter and marketer database. However, the diversity of the total mass of WCRL processed in the different companies who were engaged in this study (n:4, ranging from total mass processed in a season from 40 t to 371 t) made it very difficult to arrive at representative cost estimates that could be scaled up for the sub-sector as a whole. In addition, the PMCs consulted displayed different degrees of dependence on West coast rock lobster as a product, further complicating such calculations. The interviews and surveys also yielded large variations in the number of positions and roles for employees in the PMC facilities.

Due to these factors, it was decided to describe the processes occurring at the Marketing, Processing and Exporting levels in a mostly qualitative manner, giving some quantitative examples and ranges and presenting some analyses of the economic flow at that stage of the value chain, without making calculations that would require too many assumptions and might produce unreliable results. Gross income for the entire fishery from exports was calculated according to Equation 3.9.

$$GSIr_s = Texp_s \times Int\ Mpr_s \qquad \text{Eq 3.9.}$$

Where: GSI_s = Gross seasonal income (R)

$Texp_s$ = Total export in a season (kgs)

$Int\ Mpr_s$ = International market price per season (R/kg)

The international market price for each season that is used for these calculations is weighted by the time of catching (as different months had different total catches and received different average prices), and according to the estimated proportions of different products (live, frozen, tails etc.) and their associated price discounts (elaborated on in Appendix 4).

The number of individuals employed in post-harvest activities given the masses exported over the seasons 2016/17-2018/19 was approximated using the data given in the surveys and interviews to estimate the number of employees in different broad role categories ("Factory workers" and "Management, Admin and Support staff"). Since there was such great variation between the PMCs studied, but they together represented a sizeable portion of the total mass processed, the total number of employees from the four companies for which data was available (2018/19) were scaled up to the total mass processed in the three seasons, by first calculating the relationship of employees and the total mass processed (n/kg) across the four companies (Equation 3.10) and using these proportions for the two employment categories to make some broad approximations regarding the total numbers of employees for the fishery in the different seasons (Equation 3.11) as well as to give some estimations regarding the total salaries paid towards workers.

$$pEempl_{PMC\ Cat} = \frac{nEmpl_{PMC\ Cat}}{Texp_{PMC}}$$

Eq 3.10.

Where:

$pEempl_{PMC\ C}$= the proportion of employees at the PMCs in a category per kg of export (n/kg)

$nEmpl_{PMC\ C}$ = the total number of employees in a category in the PMCs interviewed (n)

$Texp_{PMC}$ = the total export of the PMCs interviewed (kgs)

$$nEmpl_{Tot\ Cat} = pEempl_{Tot\ Cat} \times Texp_{Tot}$$

Eq 3.11.

For calculating average salaries, it was noted that factory workers were either paid a monthly salary or wages, depending on their role, the facility that they work in and whether they are employed on a permanent or seasonal basis. For the calculation of the average salary in these instances, hourly wages were scaled up assuming 21 workdays of 8 hours per month to combine them with the monthly salaries for the averages.

3.1.3.3 Estimating the overall value of the fishery for the different sectors

Net income for the seasons 2016/17-2018/19 for the different sectors and actors engaged in fishing, and gross income to the whole fishery was calculated according to the equations detailed above, with individual input values summarized in Appendix 3.

The NSI for all sectors and representative individuals were calculated using Monte Carlo simulations, conducted in XL STAT 2020.3, a statistical software add-in for Microsoft Excel (Microsoft Office Professional Plus 2019). Monte Carlo simulations serve to recombine random values for the input variables within their designated ranges and distributions to present the probability of different NSI outcomes for the different seasons, sectors and individuals. Monte Carlo simulations are a common tool used in economic and fisheries management analyses (Hilborn 1992) and this approach was chosen to account for the uncertainty surrounding the interview and survey derived input variables. For each model 5000 simulations were conducted.

The variables derived from the DEFF data for the seasons 2016/17-2018/19 were assumed to be complete and true and thus did not include any uncertainty when applied. These variables were explored in Table 3.1.1.

3.2 Results Part 1: DEFF record analysis, surveys, and interviews

Major changes that occurred over the three seasons studied (2016/17- 2018/19) were a result of the overall reduction in the global TAC necessary to preserve the resource, as well as the allocation of a higher proportion to the IRP sector and the Small-scale sector. While official releases give the global TAC as 1924,08 t for the seasons 2016/17 and 2017/18, these figures did not reflect the final allocation for the two seasons, as in 2016/17, 39 tonnes were diverted from the offshore commercial sector towards the "Small-Scale fishing sector" which was not utilized in that season due to the delayed official registration of those co-operatives (PLAAS 2017). A similar issue occurred in 2017/18, where 20 % was deducted from the OC sector (from the 2015/16 quota) to be allocated to the small-scale sector, which again was not utilized, thus making the actual global TAC of that season 1579.91 t (Johnston 2018). In the 2018/19 season after two co-operatives were registered, the 20% allocation from the OC sector was maintained, in addition to splitting the TAC for the entire nearshore resource (which is fished by the NC sector, the IRP and the SS) to a roughly 50/50 partition for the NC and the IRP/SS sector (although this division differs slightly in the different super-areas) (Table 3.2.1). The allocations to the IRP sector further differ slightly between the official releases and the community allocations received from DEFF as part of the data collection. For this study, the totals from the community allocations for the seasons 2016/17 – 2018/19 (DEFF IRP allocations 2019) were used, and are the figures given in Table 3.2.1.

Table 3.2.1 Percentages of the global TAC and the total global TAC (t) allocated to the different sectors over the seasons 2016/17 – 2018/19 ((DEFF TAC divisions, 2019) (Johnston 2018) (IRP community allocations 2019).

Sector	2016/17	2017/18	2018/19
Offshore commercial	1204.48 t 63.9 %	994.78 t 62.5%	563,91 t 53.5 %
Nearshore commercial	376.1 t 20.0 %	305.7 t 19.3 %	170.25 t 16.1%
IRP +Small-scale Nearshore allocation	235.3 t 12.3%	210.23 t 13.9%	140.03 t 13.3 %
IRP +Small-scale Offshore allocation			140.83 13.3 %
Recreational	69.2 3.6%	69.2 3.6%	38.76 t 3.6%
Actual global TAC (t)	**1883.09 t**	**1590.29 t**	**1054 t**
Announced TAC (t)	**1924.08**	**1924.08**	**1084**

3.2.1 Offshore commercial

3.2.1.1 Actors and assets

During the period of 2016/17 – 2018/19 the total number of active quota holders has remained largely stable, while vessel owners and vessel numbers showed steeper declines (from 47 to 42 and from 64 to 52 respectively) (Table 3.2.1.1).

Table 3.2.1.1 Summary of the actors and vessels active in the offshore commercial sector for the seasons 2016/17 - 2018/19 (DEFF landing records 2019).

	Total number of quota holders				Total number of vessels active				Total number of vessel owners active		
	16/17	17/18	18/19		16/17	17/18	18/19		16/17	17/18	18/19
				V-CO				V-CO			
NVQ	195	181	203		31	31	28		26	28	25
VQ	19	19	17	VQ	33	29	24	VQ	21	19	17
Total	214	200	220		64	60	52		47	47	42

The ratio of vessel owners who have quotas (VQ) to quota holders who do not own vessels (NVQ) is substantially lower in the OC sector than in the NC sector, with about 1 vessel owner for every 4 quota holders. Furthermore, the offshore sector has a considerable number of vessel owners that are recorded as only catching for quotas not directly linked to them (V-CO), something that is not recorded in the nearshore commercial sector.

The number of quota holders who had their quota caught for them by a single vessel followed a positively skewed distribution, ranging from 1 to 37 quota holders caught for by a single vessel owner with a median of 4 quota holders caught for by a single vessel across all seasons. The permits require that each landing is made for only one quota code, a regulation that the catch records indicate to have been observed. Since the quota sizes vary considerably among quota holders in this sector (as will be elaborated on in the next section (3.2.1.2), the total mass caught by the vessel owner against their own quota and the total mass caught for other quota holders were used as more indicative measures of net income.

The vast majority of vessel owners owned and fished with a single vessel over the six seasons examined, with this category making up 85.1 % (2016/17) to 89.3 % (2017/18) of all vessel owners. Over the seasons, 2- 4 vessel owners (3.7% to 8.5% of vessel owners) owned 2 vessels, and less than 7 % of the vessel owners owned and used more than two vessels in the seasons. The maximum number of vessels owned by a single vessel owner was 9 vessels in 2016/17 and 2017/18 and 6 vessels in 2018/19 (DEFF catching records 2019).

As the use of a single vessel per vessel owner was by far the most common practice, this was assumed in the current study.

3.2.1.2 Quota sizes

The OC sector receives the largest proportion of the global TAC (62.6%, 51.7 % and 52% of the global TAC for the seasons 2016/17-2018/19 respectively). Table 3.2.1.2. gives the difference between the OC sector allocation for the years in the available catch records and what was caught.

Table 3.2.1.2 The total allocation (t) and the actual total catch (t) recorded, as well as the percentage of the TAC caught per season for the offshore commercial sector for the seasons 2016/7-2018/19 (DEFF TAC divisions and landing records 2019).

	2016/17	2017/18	2018/19	
	OC	OC	OC	IRP OQ
TAC (t)	1204.48	994.78	563.91	140.83
Total catch (t)	941.92	872.36	459.849	110.29
Percentage of TAC caught	78.2 %	87.7 %	81.5 %	78.3 %

The individual quotas in the OC sector are calculated as percentages of the global TAC. The size of individual quotas ranges widely, from the smallest quota of 0.020% in 2016/17 and 0.039% in 2018/19 to the largest of 11.65 % in 2016/17 and 7.904% in 2018/19. The distribution of quota sizes is positively skewed (Figure 3.2.1.1).

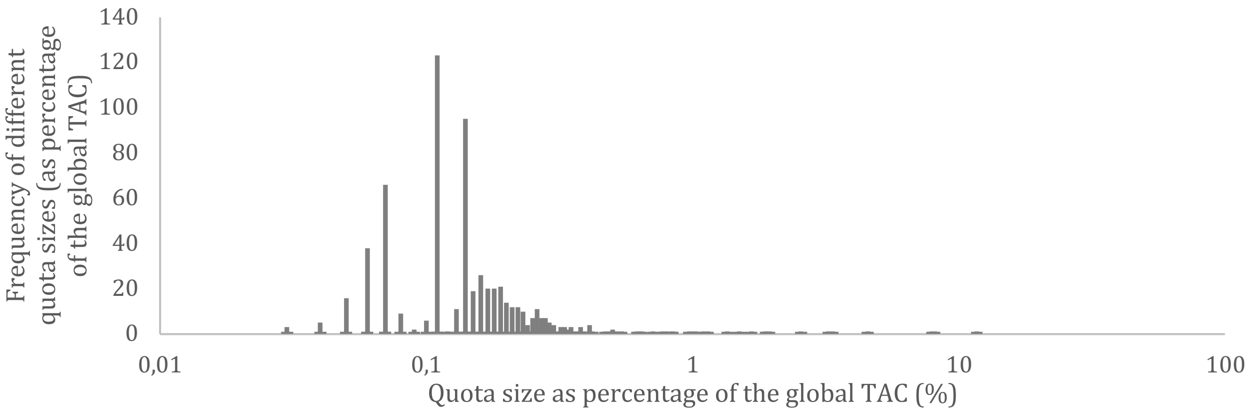


Figure 3.2.1.1. Frequency of quota sizes as percentages of the global TAC for quota holders in the offshore commercial sector for the seasons 2016/17 - 2018/19 (logarithmic scale) (DEFF landing records 2019). Note that x-axis is on a log scale.

The interquartile ranges differed between those quota holders that were an active vessel owner in the seasons and those who were registered as quota holders without an active vessel. Generally, those quota holders who own a vessel had larger quotas than individuals without a vessel (Table 3.2.1.3).

Table 3.2.1.3. Sizes of individual quota as total mass (kgs) for vessel owning quota holders (VQ) and non-vessel owning quota holders (NVQ) in the offshore commercial sector for the seasons 2016/17-2018/19 (DEFF landing records 2019).

	VQ			NVQ		
	2016/17	2017/18	2018/19	2016/17	2017/18	2018/19
Minimum	1389.94	1989.57	749.7	403.8	1989.57	601.2
First quartile	3838.56	3048.99	1744.07	1051.9	1989.57	749.7
Median	4899.18	4002.71	2360.45	2603.60	2581.98	1170.71
Third quartile	7241.74	5812.73	3378.05	4172.49	2920.04	1662.94
Maximum	224223.2	155656	85683.15	48967.57	37180.23	20298.74
N	19	19	17	195	181	203

The quotas changed considerably over the three seasons examined here, as FRAP 2015 was adjusted over these seasons due to new entrants' successful appeals and the integration of the small-scale quota which was achieved in the season 2018/19 by allocating 20% of the offshore quota to the small-scale / IRP sector, through collective deduction from the OC quota holders for that season[18].

[18] https://www.gov.za/speeches/minister-senzeni-zokwana-grants-interim-relief-fishers-access-portion-offshore-west-coast (accessed on 10.3.2021)

3.2.1.3 Catches and CPUE

Although a steady decline in the median total catch for the active vessels is apparent over the seasons (Figure 3.2.1.2), the only significant difference, occurs between the season 2013/14 and the season 2018/19 (Mann Whitney U test p-value: >0.0001).

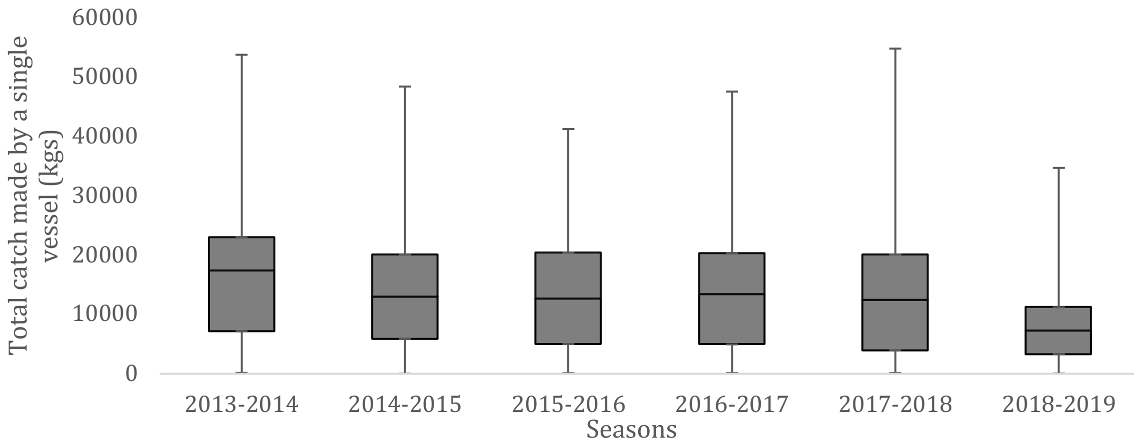


Figure 3.2.1.2. Total catch (kgs) made by a single vessel in the offshore commercial sector for the seasons 2013/14-2018/19. Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the maximum and minimum values (DEFF landing records 2019).

While the first quartile of a total catch per vessel remained quite stable over the last three seasons (Q1 = 2016/17: 4 954.18 kgs, 2017/18: 3 938.63 kgs, 2018/19: 3 311.83 kgs) the median and third quartile declined quite drastically in 2018/19, to just over half of the respective total catches per vessel in 2016/17 (from a median of 13 389.5 kgs to 7 294.4 kgs and a third quartile of 20 346.33 kgs to 11 195 kgs from the season 2016/17 to 2018/19).

The proportion of a single vessel's catch for the quota of the vessel owner and the proportion for another quota holder's quota for vessel owners catching both for themselves and for others changed slightly from year to year, but the interquartile range for the catch for self, versus others (for all vessels catching for themselves and for others in a given season) remained largely consistent over the seasons 2013/14-2018/19, with the median remaining between 0.458 and 0.52.

The mean catches per trip for the seasons 2013/14 - 2018/19 were predicted using a GLM, which accounted for the differences in the catch distributions between months, seasons and the super-areas. The predicted means suggest that the highest mean catches per trip were made in 2017/18

(300.0 kgs/trip) followed by 2018/19 (297 kgs/ trip), while the lowest overall catches were made in 2015/16 (193.6 kgs/trip) (Figure 3.2.1.3).

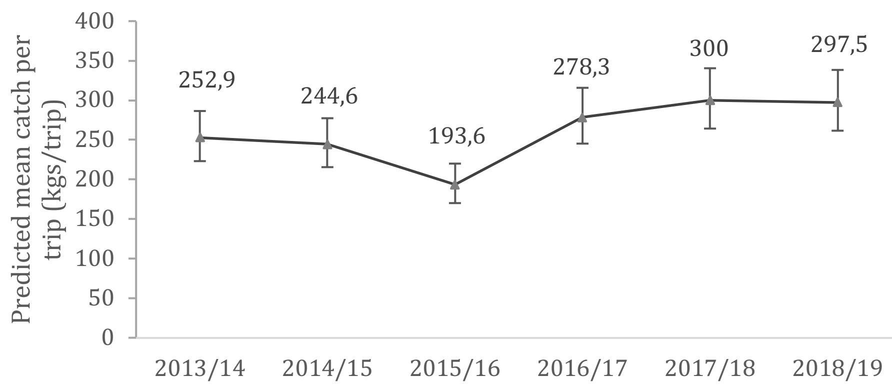


Figure 3.2.1.3 The GLM predicted mean catch per trip (kgs/ trip) for vessels in the offshore commercial sector with error bars indicating the 95% confidence interval for the seasons 2013/14 – 2018/19 (DEFF landing records 2019).

All factors included in the GLM were found to be significant in the calculation of the predicted means (Table 3.2.1.4).

Table 3.2.1.4. Wald test assessing the significance of the effects included as independent categorical factors in the GLM modelling the mean catches per season for the offshore commercial sector.

	Degree of freedom	Wald stat	p
Intercept	1	7763.573	0.00
Season	5	470.576	0.00
Landing month	11	1588.890	0.00
Super-area	3	585.381	0.00

3.2.1.4 Costs and income

3.2.1.4 a) Fishing running costs

The main running costs for vessels were fuel and bait costs, which were given as totals over the seasons. The two respondents for this study both represented large companies and were predominantly active in the more southern areas (Zones D E and F). While costs for a trip could vary substantially between areas, particularly regarding fuel costs, there was not sufficient information available to make distinctions in this regard. The averages obtained from the surveys, reflect many trips over the entire seasons and thus present some averaging over the areas. The averages per trip used are calculated by dividing the total amount spent on the different cost categories over the season by the numbers of trips recorded for the respondents (Table 3.2.1.5).

Table 3.2.1.5. Average fishing costs incurred per trip by an offshore commercial vessel and their standard deviations, weighted by the number of vessels employed by each respondent in each season (N indicates every discreet entry for these values, in terms of respondents and seasons) (Interviews and surveys 2019).

Cost	Average	Standard deviation	n
Fuel cost (R/trip)	2 935.5	994.0	6
Bait (R/trip)	3 162.6	614.8	6
Total fishing cost (R/trip)	6 098.1	1 526.4	6

3.2.1.4 b) Fishing income

The average catching fees in the Offshore sector (weighted by the number of vessels per respondent and season) was calculated to be 82.11 R/kg ± R 12.0).

The offshore sector is strongly vertically integrated and the net price received per kg by vessel owners was only reported in the survey of the non-vessel owning quota holder, with the average (weighted by total mass caught over the three seasons) of 322.45 ±50.79 R/kg over seasons 2016/17-2018/19). This was used, as it was similar to the independently calculated mean net price received after deductions, damages and fees, given for this sector in Appendix 4.

3.2.1.4 c) Annual vessel costs

Different categories of annual costs (maintenance, insurance and other miscellaneous costs) were combined in this analysis since these costs were provided in different ways by the respondents. Thus, the total annual costs were calculated for each respondent and each season separately and weighted by the total number of vessels for each respondent in the different seasons and only the totals were then averaged. From the data, it was estimated that a vessel and related assets would require an average of R 685 758.21±147 401.57 annually for repairs, maintenance, insurance and other annual costs.

The surveys did not yield sufficient information to calculate an average of the total capital worth of a vessel and related equipment in this sector. Estimates of one respondent put the average value of one of their offshore vessels and related equipment at around R 2.5 million (OC stakeholder pers. comm. 2019). Since this is an approximation and no standard deviation could be calculated, a high level of uncertainty was assumed and a standard deviation of R 500 000 was designated.

3.2.1.4 d) Employees and salaries

Costs related to the crew and skipper were calculated on an annual basis, as it was suggested by respondents that both crew and skippers in this sector usually receive fixed salaries that are independent of numbers of trips or masses caught.

According to information received, the standard vessel in the commercial offshore sector generally carries six crew members and one skipper, who are paid on a monthly basis throughout the year and may also receive bonuses. The salary figures given in Table 3.2.1.6 are assumed to be inclusive of bonuses and were weighted by the number of vessels active for each respondent in each season.

Table 3.2.1.6. Average annual salaries and numbers of employees in the WCRL offshore commercial fishing sector and their standard deviations (weighted by the number of vessels employed by each respondent in each season) (n indicates every discreet entry for these values, in terms of respondents and seasons) (Interviews and surveys 2019).

Crew:	**Average**	**Standard deviation**	**n**
Number of crew (n/ vessel)	6		
Total crew salaries per vessel (R/year)	811 606	117 793	4
Yearly salary per individual (R/year/person)	135 262	19 655	
Monthly salary per individual (R/month/person)	11 271	1 637	
Skippers:			
Number of skippers (n/ vessel)	1		
Yearly salary per individual (R/year/person)	263 061	12 926	4
Monthly salary per individual (R/month/person)	21 922	1076	
Total Salaries per vessel owned (R/year/vessel)	1 074 668	196 932.1	**4**

Adding the total annual salaries and the total annual maintenance costs for each respondent and in each season, the total annual costs for a vessel in the offshore commercial sector, excluding the fishing running costs, was averaged across the different seasons and weighted by the numbers of vessels employed to give an overall estimate of R 1 760 426 ± R 67 492.47.

3.2.2 Nearshore commercial

3.2.2.1 Actors and assets

The numbers of active NC quota holders vary strongly between the super-areas. By far the most populous super-area is A8+, having more than 70 % of the active quota holders for the examined seasons (74.5% to 75.7%). The second-largest population of NC fishers is found in A3+4 with 15.8% to 17.5% of all quota holders, followed by A5+6 (5.3.% to 6.6%) and lastly A1+2 with only 2.1% to 3.1% of all NC quota holders (Table 3.2.2.1).

Table 3.2.2.1. Numbers of active quota holder, vessels and vessel owners in the nearshore commercial sector across the different super-areas and seasons (2016/17-2018/19) (DEFF landing records 2019).

	Number of active quota holders			Number of active vessels			Number of active vessel owners		
	16/17	17/18	18/19	16/17	17/18	18/19	16/17	17/18	18/19
A1+2	23	8	12	23	6	12	9	3	5
A3+4	120	63	98	100	55	85	95	54	81
A5+6	50	20	31	24	11	18	24	11	18
A8+	560	285	423	201	131	156	189	123	149
All areas	751	376	560	346	201	264	314	189	245

Vessel owners in A3+4 and A5+6 generally fish for only one quota code (meaning they fish only for themselves). The number of vessel owners fishing for more than one quota code is notably higher in A8+, where the median number of quota codes fished for by a single vessel owner is 2 (self plus one other) for all seasons except 2017/18 and the maximum number of quota codes caught for by one vessel owner in A8+ further is much larger (ranging from 16 (2018/19) to 28 (2016/17)) than in the other super-areas (where the maximum ranges from 3 to 11 for all areas) (DEFF landing records 2019).

The overwhelming majority of vessel owners in the different super-areas only own one vessel, with only a few individuals (particularly in A1+2 and A8+ owning more (DEFF landing records 2019). For the purpose of this study, one vessel per vessel owner was assumed.

3.2.2.2 Quota sizes

The percentage of the global TAC allocated to the NC sector has declined substantially over the three seasons and the total mass allocated to the NC declined by around 55 % from the season 2016/17 - 2018/19 (Table 3.2.2.2).

Table 3.2.2.2. Total allocated quota and total catches for the nearshore commercial sector in the seasons 2016/17 – 2018/19 (DEFF landing records 2019).

	2016/17	2017/18	2018/19
NC TAC (t)	376.1	305.7	170.25
NC percentage of global TAC	19.5 %	15.9 %	15.7 %
Total catch of all vessels (t)	341.47	243.05	151.83
Percentage of TAC that was caught	90.8 %	79.5 %	89.2 %

The quota sizes per NC quota holder are calculated annually based on the global TAC imposed. Every super-area receives a designated portion of the NC TAC (generally roughly proportional to their local estimated biomass), which is then divided by the number of quota holders registered in that super-area (Table 3.2.2.3.).

The nearshore commercial sector underwent some drastic changes in the past three seasons. In the season 2017/18 the number of NC rightsholders was reduced by almost half[19], but increased again by some 186 quota holders by the season 2018/19 due to successful appeals by previously excluded quota holders[20]. This reduction was in part due to the decision by DEFF to grant a total of 90% of

[19]https://www.nda.agric.za/docs/media/FRAP2015-16%20West%20Coast%20Rock%20Lobster%20(Nearshore)%20General%20Published%20Reasons%20and%20Provisional%20Lists%20(Zone%20A%20to%20Zone%20C).pdf (accessed on 10.3.2021)

[20]https://www.dalrrd.gov.za/docs/media/THE%20MINISTER'S%20DECISION%20ON%20APPEALS%20FILED%20IN%20THE%20WEST%20COAST%20ROCK%20LOBSTER%20(NEARSHORE)%20ZONE%20F.pdf (accessed on 10.3.2021)
https://www.dalrrd.gov.za/docs/media/THE%20MINISTER'S%20DECISION%20ON%20APPEALS%20FILED%20IN%20THE%20WEST%20COAST%20ROCK%20LOBSTER%20(NEARSHORE)%20ZONE%20D%20Final.pdf (accessed on 10.3.2021)
https://www.dalrrd.gov.za/docs/media/THE%20MINISTER'S%20DECISION%20ON%20APPEALS%20FILED%20IN%20THE%20WEST%20COAST%20ROCK%20LOBSTER%20(NEARSHORE)%20ZONE%20B%20final.pdf (accessed on 10.3.2021)
https://www.dalrrd.gov.za/docs/media/THE%20MINISTER'S%20DECISION%20ON%20APPEALS%20FILED%20IN%20THE%20WEST%20COAST%20ROCK%20LOBSTER%20(NEARSHORE)%20ZONE%20C.pdf (accessed on 10.3.2021)

the nearshore TAC to the small-scale and IRP sector in the provisional decision[21]. However, before the implementation of this new division in 2018/19, this was amended to a roughly 50/50 split between NC and IRP allocations.

Table 3.2.2.3 demonstrates how these changes in numbers of quota holders and the changes in percentage allocation of the NC TAC to the different super-areas resulted in strongly varying trends of individual quota sizes for the different super-areas and seasons.

Table 3.2.2.3. The number of registered nearshore commercial quota holders per super-area, percentage of the NC TAC allocated to each super-area, and the quota per rightsholder per super-area for the periods 2016/17 to 2018/19 (DEFF landing records 2019).

	Number of registered quota holders (n)			Percentage of nearshore TAC (% of NC TAC)			Quota per Rights holder (kgs)		
	16/17	17/18	18/19	16/17	17/18	18/19	16/17	17/18	18/19
A1+2	29	16	20	6.38%	6.54%	7.36%	615.4	1250	626.6
A3+4	131	71	100	17.47%	17.96%	13.49%	501.5	773.2	229.7
A5+6	65	25	37	7.66%	14.13%	23.71%	443.1	1728	1091.1
A8+	587	298	435	68.49%	61.37%	55.55%	438.8	629.5	217.4
All areas	812	410	592						

3.2.2.3 Catch and CPUE

The number of trips and total catches were largely proportional to each other and the TAC allocated to the different super-areas (Table 3.2.2.4).

Table 3.2.2.4 The total number of trips conducted and total catch made by the nearshore commercial sector in the different super-areas and the entire fishing area for the seasons 2016/17 – 2018/19 (DEFF landing records 2019).

	Number of trips (n)			**Total catch (kgs)**		
	16/17	17/18	18/19	16/17	17/18	18/19
A1+2	304	45	178	7 026	1 158	4 995
A3+4	1484	1123	994	59 834	32 205	22 242
A5+6	179	174	179	22 247	25 372	28 414
A8+	2333	1401	1079	252 368	184 315	96 175
All areas	**4300**	**2743**	**2430**	**341474**	**243049**	**151862**

The mean catches per trip were calculated for the entire area and the different areas separately using the GLM outlined in the methods. The resulting predicted mean catches per trip are given in

[21] https://www.dalrrd.gov.za/docs/media/FRAP2015-16%20West%20Coast%20rock%20lobster%20nearshore%20Final%20Decisions%20on%20Allocation%20of%20Rights%20(Zone%20A%20to%20D).pdf (accessed on 10.3.2021)

Figure 3.2.2.1 for the seasons 2013/14 to 2018/19, indicating stark differences between the trends in mean catches per trip over the three seasons for the different areas.

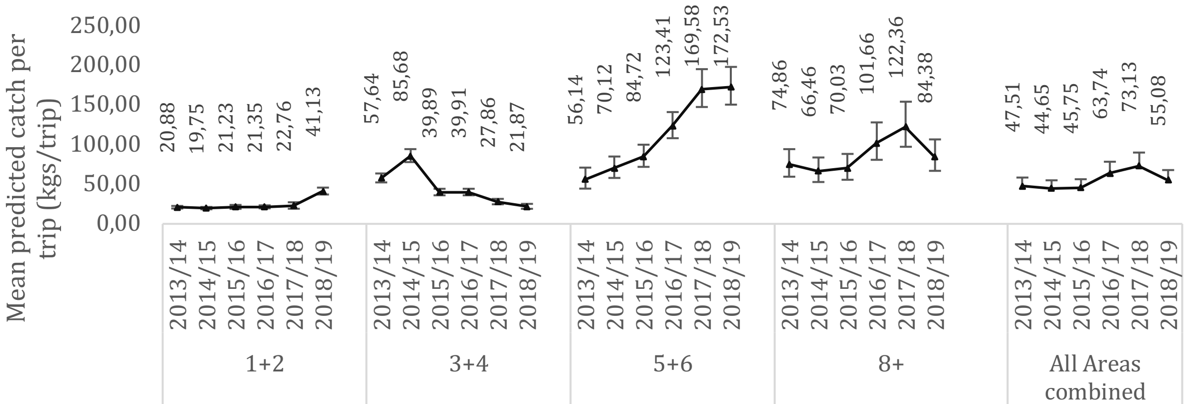


Figure 3.2.2.1. GLM predicted means for the catch per trip (kgs/trip) made by nearshore commercial fishers for each season (2013/14-2018/19), for each super-area and all combined with error bars indicating the upper and lower 95% confidence limit. The GLM Is outlined in the methods of this chapter (DEFF landing records 2019).

All factors used in the GLM were deemed to contribute significantly (Table 3.2.2.5).

Table 3.2.2.5. Wald test assessing the significance of the effects included as independent categorical factors in the GLM calculating predicted mean catches per trip in the nearshore commercial sector for a) super-area and B) for the entire fishing area.

		A1+2		A3+4		A5+6		A8+	
A)	Degrees of freedom	Wald Stat	p	Wald Stat	p	Wald Stat	p	Wald Stat	p
Intercept	1	14670,8	0,00	5980,72	0,00	13587,21	0,00	1438,34	0,00
Landing month	5	128,72	0,00	1607,97	0,00	126,13	0,00	172,572	0,00
Season	6	205,65	0,00	603,944	0,00	63,16	0,00	1425,06	0,00

B)	Degrees of freedom	Wald Stat.	p
Intercept	1	1444,145	0,00
Season	5	1299,455	0,00
Landing month	10	171,498	0,00
Super-area	3	2561,670	0,00

3.2.2.4 Costs and income

3.2.2.4 a) Fishing running costs

The largest cost for a fishing trip in the NC sector was generally the fuel cost (857.21 R/trip), followed by the bait cost (571.85 R/kg) (Table 3.2.2.6).

Table 3.2.2.6. Average fishing costs (R/trip) incurred by a nearshore vessel per trip and their standard deviations (n indicates every discreet entry for these values, in terms of respondents and seasons) (Interviews and surveys 2019).

Cost per trip (R/trip)	Average	Standard deviation	N
Bait cost per trip	576,02	226,17	14
Fuel cost per trip	844,26	214,87	14
Harbour cost per trip	60,55	22,09	7
Transport cost per trip	173,48	103,13	5
Oil cost per trip	87,49	23,84	3
Total Cost per trip	1741.8	577.5	

3.2.2.4 b) Income for vessel owners and crew members

From the interviews and surveys, the following averages for the price received per kg of one's own quota and the average catching fee were calculated (Table 3.2.2.7). These figures have a larger sample size than on the cost input variables, as they could include figures given by non-vessel owning quota holders (n:3), non-fishing IRP community caretakers (n: 4) and figures given by a PMC that works with several IRP communities and NC fishers in A8+ (n: 1). Unlike the cost estimates, these prices were weighted by the individual quota or the community quota in the case of the IRP sector, since certain estimates pertained to the price received for entire community quotas rather than the estimates given by one individual for their own catch and thus weighting them here was deemed appropriate.

While there were considerable variations between the "over the scale" price and the catching fee reported by the different respondents, the typical "over the scale price" ranging from 220 R/kg to 320 R/kg, and the catching fee ranging from 60 to 140 R/kg, overall, it appeared that the catching fees and the "over the scale prices" reported were proportional.

Unlike the OC sector, NC and IRP vessel owners pay their crew on a per kilogram basis. As the vessels differ in size and power in this sector, the number of crew varies markedly between vessel owners from one to six crew, with a median number of 3 crew members per vessel and an interquartile range from 1 to 4 crew members per vessel. The average crew fee was calculated from the responses of the vessel owners.

Table 3.2.2.7. Average net price received for a kilogram of caught lobster ("over the scale") (R/kg), catching fees (R/kg) and crew fees (R/kg) and their standard deviations for the nearshore operating quota holders (n indicates every discreet entry for these values, in terms of respondents and seasons) (Interviews and surveys 2019).

	Average	Standard deviation	N
"Over the scale price" received (R/kg)	282.7	31.4	19
Catching fee (R/kg)	94.3	31.2	14
Net price after catching fee deductions	191	27.6	14
Crew fee (R/kg)	17.3	5.8	11

3.2.2.4 c) Annual costs for vessel owners in the nearshore commercial and the IRP sector

The main annual costs consisted of the maintenance of vessel, engines, vehicle and trailer (Table 3.2.2.8). Most annual costs showed quite a large standard deviation, as estimations from participants ranged widely, for vessel maintenance (from less than 2500 R/year to 16 000 R/year), or for the maintenance of the vehicle (from 2000 R/year to more than 10 000 R/year). These ranges were not surprising, given the big differences in the socio-economic situation of different fishers, state of vessel and equipment and further natural stochasticity in spending between years (increasing the variation between individuals due to the "snapshot" nature of the collected data).

Table 3.2.2.8. Average annual costs for a vessel, fishing related equipment and operation for nearshore vessel owners (R/season) and their standard deviations (n indicates every discreet entry for these values, in terms of respondents and seasons) (Interviews and surveys 2019).

Annual costs (R/season/vessel)	Average	Standard deviation	N
Maintenance vessel	7711.9	5148.3	9
Maintenance engines	2125	250	4
Maintenance vehicle	4302	3058.5	6
Maintenance trailer	1666.7	577.3	3
At sea equipment replacement	2402.6	1002.3	9
Permit quota	1676	0	official
Permit	640	0	official
Transport for permits	500	0	2
Telephone bill	2000	0	2
SAMSA	429.1	61.4	11
Total annual costs	23453.3	6104.4	

The numbers given as annual costs here were crosschecked with several stakeholders and were considered to be good approximations by individuals knowledgeable of the sector although leaning towards the conservative side.

3.2.2.4 d) Capital costs for vessel owners in the nearshore commercial and the IRP sector

Table 3.2.2.9. demonstrates the extreme variety in investment costs for a vessel owner in the NC and IRP sectors. As discussed in the methods, the vessel and at sea equipment costs were combined to account for individual differences in attribution of costs to the two categories.

Table 3.2.2.9. Average capital costs for nearshore vessel owners (R) and their standard deviations (n indicates every discreet entry for these values, in terms of respondents and seasons) (Interviews and surveys 2019).

Capital costs (R)	Average	Standard deviation	N
Vessel	74 818.2	45 534.2	13
At sea equipment	25 714.3	30 581.6	9
Vessel & at sea equipment	101 428.6	39 677.2	9
Vehicle	46 428.6	22 307.3	9
At-home equipment	4 400	2 190.8	7
Trailer	13 333.3	2 886.7	5
Total Capital costs:	165 590.5	39 842.4	

3.2.3 Interim relief permit sector

3.2.3.1 Actors and assets

There are roughly 42 registered IRP fishing communities and roughly 2464 quota holders in the IRP sector (Table 3.2.3.1), although this number has slightly shifted over the past seasons due to different community designations or splits (DEFF pers. comm. 2019). Until 2018/19 the two communities in Zone A were considered IRP communities until they were awarded the small-scale cooperative status in 2018 under the SSFP. As discussed in the methods, data concerning the numbers of individuals per community are only available for the season 2017/18. They are thought to be reasonable approximations for the previous and later season and will be assumed to apply for the three seasons studied here.

Table 3.2.3.1. Number of communities and total number of quota holders for Zones B-F (Data from 2017/18) (DEFF pers. Comm. 2019).

Zone	Number of quota holders	Number of Communities
B	338	5
C	478	13
D	994	10
E	152	1
F	535	13
Total	2464	42

The number of quota holders within a single IRP community ranges from 8 to 198 individuals with a median of 41.5 quota holders per community (Figure 3.2.3.1).

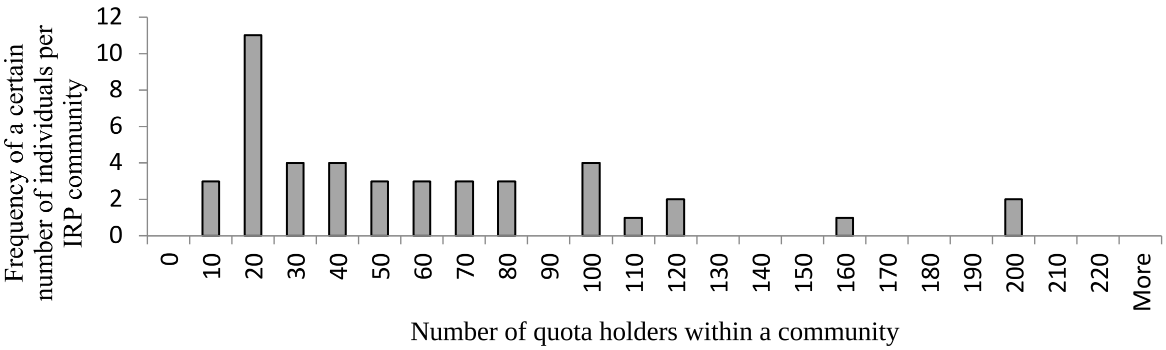


Figure 3.2.3.1. Number of quota holders within all the different IRP communities, data for season 2017/18 (DEFF pers. comm. 2019).

In 2016/17 there were 1993 quota holders registered in the IRP sector, which increased to 2 464 in 2017/18 and had been reduced to 1880 quota holders in 2018/19 (DEFF pers.com. 2019). In the season 2018/19 a total of 156 vessels were registered as catching for the IRP nearshore quota, of these, however, only 32 are owned by IRP fishers while the other vessels are assumed to belong to NC fishers (DEFF pers. comm. 2019). This figure from the department reflects the pattern observed in the field, especially in Zone D, E and F where the caretakers and marketers interviewed suggested that the majority of communities rely on vessel owners outside of the IRP sector to catch both the IRP nearshore and offshore allocation.

3.2.3.2 Quota sizes

Quotas in the IRP sector are allocated to communities and not to individuals (Isaacs 2016). However, community quota sizes are calculated in consideration of the number of quota holders within the community and the nearshore resource availability for the given zone (DEFF pers. comm. 2019). Dividing the community allocations by the number of quota holders in that community (using the DEFF record from 2017/18 given in Table 3.2.3.1) provides a better approximation for the calculations than community quotas due to the great variation in community sizes across the fishing area (Figure 3.2.3.2). The season of 2018/19 was the first time that the IRP and small-scale sectors were allocated offshore quotas in addition to their nearshore quotas. Since Zone E (False Bay) only contains one community, with very similar per-person quota size to Zone D, the subsequent calculations will treat Zone D and E together. The data available for this study only outlined the numbers of quota holders per community for the season 2017. While this is sufficient to make an approximation of the numbers of quota holders for the two other seasons considered here, some precision might be lost.

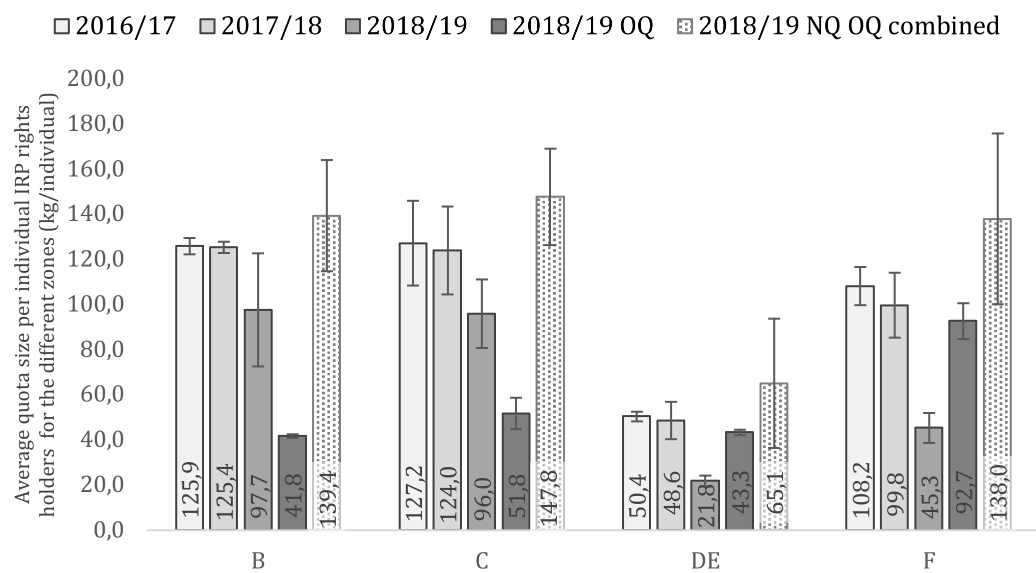


Figure 3.2.3.2. Average sizes of the quotas received per individual in the different zones (calculated as the community quota given by DEFF divided by the number of quota holders given for the community (2017)) (kgs/person). For the seasons 2016/17 (white- grey), 2017/18 (light grey), 2018/19 nearshore allocation (medium grey), 2018/19 offshore allocation (dark grey) and 2018/19 near and offshore allocations combined (dotted fill) with the error bars indicating the standard deviation (DEFF pers. comm. 2019).

While for the Zones B and C the nearshore quota in 2018/19 was significantly larger than the offshore quota, the reverse held true for the zones D+E and F. Zone D and E received the smallest quotas across the different seasons and divisions. The IRP sector is the only sector that saw a net increase in the overall average quota size per individual between the seasons 2016/17 to 2018/19, due to the allocation of 20% of the offshore commercial quota towards the IRP sector and a larger proportion of the nearshore resource, resulting in a net average increase of 11 %, 19 %, 28% and 38 % from the season 2017/18 to 2018/19 (offshore and nearshore quotas combined) for the Zones, B, C, DE and F respectively.

3.2.3.3 CPUE and catch per trip

As discussed in the methods, due to the lack of catch and trip specific data for the IRP sector at a scope and scale comparable to the commercial sectors, as well as the similarity between the capacity of the actors and vessels and the interchange between the sectors, the same catches per trip are assumed to apply to vessels in the IRP and NC sectors.

3.2.3.4 Costs and income

The vessel owners within the IRP and vessel owners in the NC sector are assumed to have the same expenses and incomes for this study. For the calculations for individual vessel owners the input variables explored in section (3.2.2.4) (composed of NC and IRP interview and survey data) are used for the IRP sector too.

3.2.4 Small-scale sector

3.2.4.1 Actors and assets

The small-scale cooperatives that have rights to the WCRL are Port Nolloth and Hondeklipbaai, two previous IRP communities in Zone A, that were granted their 15 -year fishing rights as the first official small-scale co-operatives in South Africa in September 2018[22]. The two co-operatives differ in size and assets (Table 3.2.4.1).

Table 3.2.4.1. Number of members and active vessels in the small-scale co-operatives in Port Nolloth and Hondeklibaai (Interviews 2019).

Cooperative	Number of members in the cooperative (n)	Number of vessels (n)
Hondeklipbaai	26	3 (owned by one individual)
Port Nolloth	69	9 (owned by the cooperative)

It was reported by a representative of the Port Nolloth cooperative that the 9 vessels in Port Nolloth were funded by the government. According to a someone familiar with the small-scale cooperative in Hondeklipbaai, the community there also received vessels, engines and safety equipment to help the newly formed cooperative but these were sold, with the revenue reportedly not being distributed equally across members of the cooperative.

[22] https://www.gov.za/speeches/small-scale-fisheries-21-sep-2018-0000 (accessed on 14.3.2021)

3.2.4.2 Quota sizes

Both co-operatives were allocated a nearshore and an offshore quota in 2018/19 (Table 3.2.4.2). Both cooperatives noted that due to their permits arriving late (in December) they did not manage to get their entire nearshore quota out of the water.

Table 3.2.4.2. Quota sizes, landed catch and exported mass (kgs) for Port Nolloth and Hondeklipbaai for 2018/19 (DEFF Export summary 2020).

	Quota (kgs)	Landed (kgs)	Exported (kgs)
Port Nolloth NQ	9100	5636	6755
Hondeklipbaai NQ	3400	3175	2783.5
Port Nolloth OQ	4380	1714.8	992
Hondeklipbaai OQ	4380	4380	5402

The export summary received in communication with DEFF (pers. comm. 2020), given in Table 3.2.4.2 revealed some irregularities (as in some cases the export was higher than the recorded landed mass or the quota), and further differed to some extent from the figures received from representative stakeholders in the communities. Upon enquiry it was stated that in some cases, since the data is not captured live, mistakes can occur, and particularly in cases of OC vessels landing, processing and exporting the quota of the IRP sector it can happen that permits are mixed up and legally caught lobster is exported under the wrong permit. The possibility of illegal harvesting cannot, however, be dismissed here. This points to a problem that is a common occurrence across all sectors, that incidents where a misdemeanour has occurred, are often only identified post-hoc at which point investigations are difficult and can be very money and time intensive (DEFF representative pers. comm. 2020).

3.2.4.3 CPUE and catch per trip

Since the Port Nolloth cooperative does not cover their own fishing costs, as will be discussed in the cost and income section below, the number of trips conducted, and the catch per trip is irrelevant for the calculations of the net seasonal profit in this sector.

3.2.4.4 Costs and income

As stated above the dynamics within the two cooperatives varied significantly in their internal dynamics and mechanisms for economic distribution. Given the more representative sample of respondents consulted in Port Nolloth and the fact that this co-op was deemed to be the more functional of the two co-ops by many outside respondents, the focus is given to the economics of Port Nolloth for the purpose of investigating how future cooperatives may perform socio-economically.

Port Nolloth cooperative

When the Port Nolloth cooperative was declared a small-scale cooperative in September 2018[23], it was allocated a basket of species including WCRL (restricted), Snoek (unlimited), Kelp (unlimited), Tuna (restricted) and Yellowtail (restricted). The consulted representative of this co-op estimated that their income as a co-operative for the first year consisted of 60% of WCRL, 20%-line fish and 20% kelp.

The co-operative works with a PMC in Lambertsbaai for their nearshore allocation, and at present this PMC is handling the majority of the costs, from bait and fuel for fishing to transport to the PMC after landing. After subtracting costs, the cooperative received a fixed rate of 250 R/kg from the PMC throughout the season. Of these 250 R/kg, 150 R/kg are allocated to the sea-going members of the cooperative that caught the lobster (generally divided equally between the skipper and two crew members thus giving R50 each) and the remaining 100 R/ kg will go to the co-operative where they serve as a salary to the admin and management personnel and miscellaneous costs (roughly 30R/ kg), as a fund for necessary repairs and maintenance (roughly 40 R/kg), and to support the members of the co-operative who cannot go to sea (roughly 30 R/kg) (there are 8 women in the co-operative, 4 disabled individuals and 10 pensioners who are supported this way). It was stated that generally all members of the co-operative actively fish except for the 22 pensioners/women/disabled individuals. The division of the 100 R//kg allocated to the co-

[23] https://www.gov.za/speeches/small-scale-fisheries-21-sep-2018-0000 (accessed on 14.3.2021)

operative and dependent members appeared to still be in discussion and to a certain extent fluid, but these were the best estimates, and will be used for the purpose of this study.

The offshore quota was rezoned to A8+, where a locally based company fished the quota for the co-operative. Under this arrangement, the co-operative received 235 R/kg for every kilogram caught of their Offshore quota, while incurring no further costs. It was suggested that the income from the offshore quota is divided equally between all members.

3.2.5 Processing, marketing and exporting

3.2.5.1 Actors and assets

The processing and marketing companies (PMC) are widely diverse in their size and capacity, as well as their dependency on WCRL, as the majority processes other products as well. The number of value chain "links" that a PMC is directly involved with varies between the different entities, as PMCs in some cases hold quotas and own vessels in the WCRL fishery (mainly in the OC sector), while other PMC's do not have their own quota and only process and market for other quota holders. Whether exporting is done by the PMC itself or by an independent agent further differs between individual cases.

A total of 18 of the registered PMCs were active in the 2016/17-2018/19 seasons with every season having 17 active PMCs, while a total of 44 different exporters were registered, (26 in 2016/17, 27 in 2017/18 and 28 in 2018/19). Of the exporters, 9 were registered as exporting for the IRP sector only. A single PMC can be exporting through more than one registered exporter and vice versa, although one-on-one or one-on-two relations are most common.

3.2.5.2 Masses processed and exported

The range of the total mass processed by a single PMC ranged widely, and was strongly positively skewed. The median mass processed by a single PMC did not change drastically from 2016/17 – 2018/19 but the larger PMCs were strongly affected by the reduction in the global TAC as the maximum total mass processed by one PMC decreased to 71 % of the mass in 2016/17 by 2017/18 and to 69 % of the mass of 2017/18 by 2018/19) (Table 3.2.5.1). The total masses exported by a single exporter mirrored these trends with the median mass exported by a single exporter decreasing only slightly while the third quartile and maximum masses exported changed much stronger in response to the global TAC reductions.

Table 3.2.5.1. The interquartile range of A) the total mass exported per exporter (kgs) and B) total mass processed by a single PMC (kgs), and the total numbers of active entities for the seasons 2016/17-2018/19 (DEFF export data, 2019).

	Total mass processed by a single PMC (kgs)			Total mass exported by a single exporter (kgs)		
	2016/17	2017/18	2018/19	2016/17	2017/18	2018/19
Minimum	154,6	990,8	4487,6	27.8	396.91	247.4
First quartile	36187,6	31931,1	17697,8	1496.9	3018.6	2631.4
Median	43763,9	37269,4	38574,4	13290.7	14444.3	8955.7
Third quartile	58046,4	54678,8	47523,1	57263.5	54678.8	44850.7
Maximum	327654,7	235731	163861,9	327654.7	235731	148000.0
Number of active entities	17	17	17	26	27	28

The total mass exported from each of the sectors was largely proportional to their allocation from the global TAC and is given in Figure 3.2.5.1.

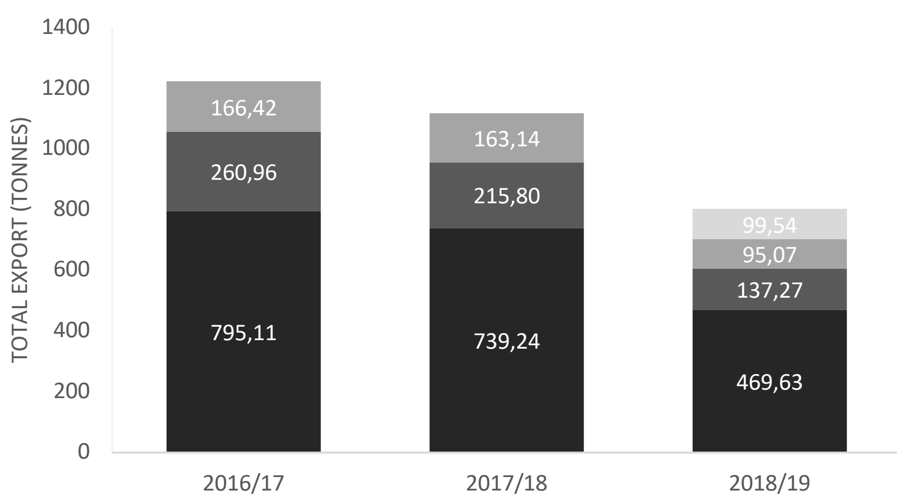


Figure 3.2.5.1. Total WCRL mass (t) exported in the seasons 2016/17. - 2018/19 for the different sectors: OC (black), NC (dark grey), IRP and small-scale nearshore allocation (medium grey) and IRP offshore allocation (light grey).

The proportion of the TAC that was exported successfully and the percentage of the recorded catch that was exported successfully are shown in Figure 3.2.5.2.

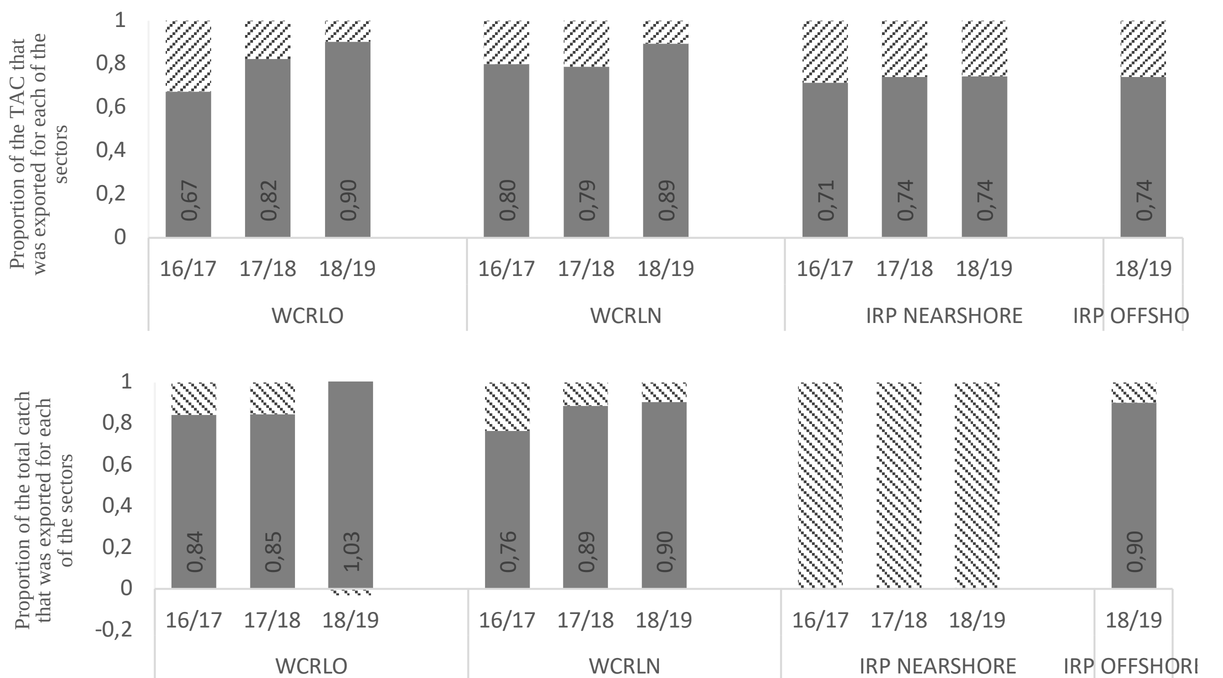


Figure 3.2.5.2. A) Proportion of the TAC that was exported and B) and proportion of the total catch that was exported for each of the sectors for the seasons 2016/17 – 2018/19 (dark grey shading). For the IRP nearshore quota total annual catch data was not available (DEFF export data 2019).

Figure 3.2.5.2 demonstrates that the percentage exported per TAC or per total landings varies from season to season and between the sectors. Overall, the highest rates of export for the TAC occurred in the commercial sectors, while the export per kg TAC is generally lowest in the IRP nearshore sector. The catch that is not exported is either lost in the value chain (due to death and other substantial damage incurred before reaching the PMCs) or consumed or sold locally, although the local market was estimated by stakeholders to capture less than 2 – 5 % of the WCRL harvest (pers. comm. 2019).

Another issue that has to be remarked upon is the export rate of above 100% of the total catch that is recorded as being exported in the OC in 2018/19. Different explanations for this offered by expert stakeholders included the possibility of mistakes in the records (i.e. catches might have been landed for the IRP offshore allocation and mistakenly exported under the OC sector allocation) but the possibility of instances of misdemeanour where catches are supplemented through illegal sources (IUU fishing) cannot be reliably excluded (DEFF representative pers. comm. 2019).

3.2.5.3 Quality damages, and categories of export

Between the landing of the lobster and the arrival at the final consumer, there are a few critical steps where some of the mass to be exported is diminished in quantity or in quality. The following estimates were given as approximations for some of the predictable losses in mass throughout the value chain. While the majority of the export is exported live, a certain percentage is exported frozen whole (average 3.25%), while some lobsters are so damaged that only their tails are frozen and exported (average 4.9 %) and a further percentage (average 2.3%) will be completely lost at the processing stage due to cannibalism or severe damage. Estimates are given in Table 3.2.5.2.

Further at the export stage, it was noted that it is usual for the exporter to "overpack" the lobster weight to account for water loss and potential damage in transit. The prices obtained for these different product categories differed slightly between respondents, but the concrete prices by some PMCs and exporters roughly matched the assertion by one prominent PMC representative, that whole frozen lobster achieve around 40 %, and frozen tails achieve around 25 % of the market price for live lobster (PMC representative pers. comm. 2019).

According to a number of respondents, the quality of the catch and thus the percentages of different categories of final product varied between the sectors, with the IRP generally delivering the poorest quality catch (meaning that higher percentages will not be exported or not exported live). For this sector it was reported that sometimes only 50% of the catch was exported live. Due, however, to the uncertainty and extreme variability of this notion and lack of further data, the damages and losses were assumed to be equal across the different sectors.

Table 3.2.5.2. Average percentages for different product categories and losses at the processing and exporting stage of the WCRL value chain and their standard deviation, as well as their approximate prices (n indicates every discreet entry for these values, in terms of respondents and seasons) (Interviews and surveys 2019).

Product	Average proportion of processed mass	Standard deviation	Estimated price	N
Live export	0.85 – 0.92%		Export market price	
Frozen whole	0.0325	0.005	Around 40 % of live export market price	3
Frozen tails	0.049	0.0299	Around 25 % of live export market price	3
Dead/ lost lobster	0.023	0.0115	R 0	3
Overpacking	0.0366	0.0115	R 0	3

3.2.5.4 Costs and income

3.2.5.4 a) Yearly international market price fluctuations

The market price fluctuates over a given season, with generally better prices available at the start of the season due to high demand and low supply (November to January) with the Chinese New Year in January generally maintaining a high demand. The following months usually yield lower prices until they pick up again due to lower competition and supplies in the winter months from around April/ May to the end of the season (Figure 3.2.5.3).

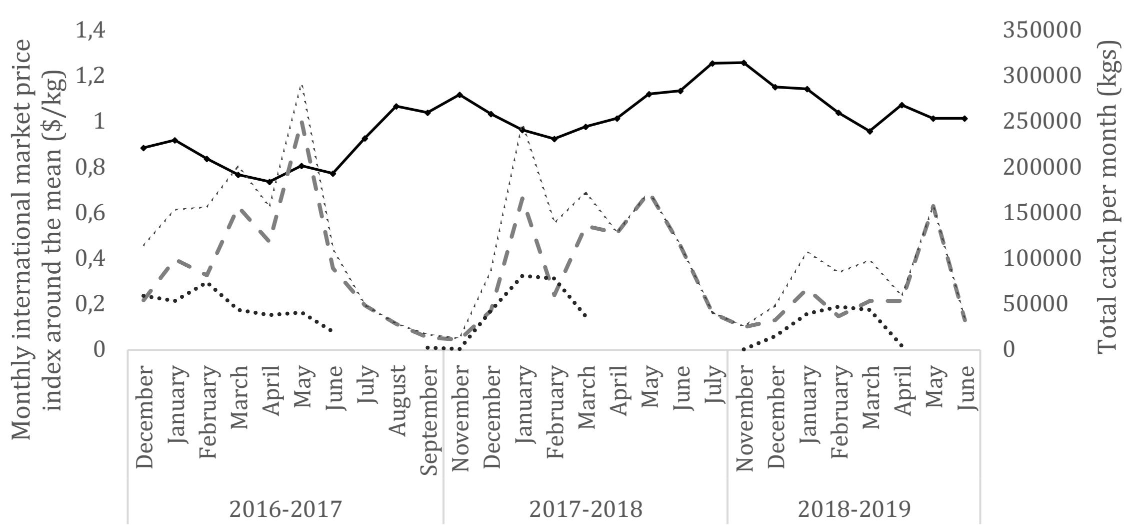


Figure 3.2.5.3 Average monthly market prices (USD/kg) from international buyers for the months for which data was available for the seasons 2016/17 – 2018/19 standardized around the mean market price (42.22 USD/kg) (black solid line, primary axis) and the total catches (kgs) made per month on the secondary axis for the offshore sector only (striped grey line) and the nearshore sector only (black dotted line) and both sector's combined (fine dotted grey line) (consulted stakeholder, pers. comm. 2019) (DEFF landing records 2019).

The OC sector, due to the longer season and catch in the winter months, when the price generally rises, overall obtains higher average international market prices than the NC sector. The averages for the NC weighted by mass caught per month were substantially lower than the average price obtained by the OC sector in the season 2017/18, but very similar in the other seasons, even being slightly higher in the 2016/17 season (Table 3.2.5.3).

Table 3.2.5.3. Average international market prices for the seasons 2016/17 – 2018/19 (Consulted stakeholder, pers. comm. 2019) (weighted by mass caught in each month, for the NC and the OC separately and for the two sectors combined). The prices received for all seasons combined were further weighted by each season's total mass caught. Values as R/kg were calculated using the average annual exchange rates given in the first row[24]. Lastly averages were calculated by weighting the approximate prices received for discounted products by the estimated proportion of the total mass, using the information in Table 3.2.5.2. (for more information on this, see Appendix 4).

	2016/17	2017/18	2018/19	All seasons combined
Average exchange rate (R/$)	13.1	13.25	14.4	
Commercial sectors combined	457.82 ± 41	575.72 ± 48	644.50 ± 47	539.70±75
Nearshore commercial	460.14 ± 33	536.16 ± 24	643.69 ± 47	526.14 ±70
Offshore commercial	456.7± 43	585.14 ± 49	644.77 ± 47	544.00 ± 77
Commercial sectors combined average after predictable losses and deductions	400.58± 38	505.036± 45	565.434±45	473.5 ± 67

3.2.5.4 b) Fees to quota holders

The following are averages of the main fees charged by PMCs to quota holders as provided by participants in the processing, marketing and exporting industry (weighted by the total mass processed per respondent) (Table 3.2.5.4).

Table 3.2.5.4. Averages and standard deviations of different fees charged by the PMC and exporters (R/kg) (n indicates every discreet entry for these values, in terms of respondents and seasons) (Interviews and surveys 2019).

	Average	Standard deviation	N
Marketing fee (proportion of market price)	0.08		3
Processing fee (R/kg)	60.9	10.7	7
Airfreight fee (R/kg)	58.2	1.8	8
Levy (R/kg)	4.5		standard

[24] https://www.ofx.com/en-au/forex-news/historical-exchange-rates/yearly-average-rates/ (accessed on 14.3.2021)

3.2.5.3 b) Costs of running and maintaining a PMC

Most respondents did not provide a breakdown of the processing and maintenance costs, and preferred to give totals. It was however stated that the running costs in general include water, electricity, rent of office spaces (where applicable) as well as other consumables such as feed and packaging products and that maintenance costs in general include costs such as services and replacement to equipment (tanks, pumps and overall facilities), health certificates and controls and general repairs. There were significant differences between the PMCs consulted in their reliance on lobster products, and respondents had difficulties in estimating maintenance and running costs that were directly linked to the lobster processing, marketing exporting processes.

Two PMCs in A8+ reported that their other main products, farmed and wild Abalone, made up the majority of their income (while one respondent did not give concrete approximations but noted that especially farmed abalone is their main export, the other one estimated that WCRL only contributes around 25% of their annual income for the past three seasons). While researchers and respondents attempted to arrive at cost estimates reflecting the processes involved for the WCRL, this was not possible for many of the following estimates, due to temporal and spatial overlaps of the processes for the different products, especially in salaries and maintenance costs.

The costs incurred by different PMCs are difficult to compare between respondents, as the submitted cost estimates varied widely, mainly as a result of the size, capacity and diverse uses of the respective PMCs. This means that the yearly cost of maintaining the facilities and running the facility could range from approximately R 120 000 and R 480 000 for a smaller PMC to almost 2 million and 14 million Rands annually for a larger PMC. The attempt to standardize these to R/kg by taking the mass of WCRL processed by each PMC into account resulted in values with a great variance, rendering them largely meaningless, most likely as a result of the other processes occurring in the different PMCs that could not be accounted for in this study.

3.2.5.3 c) PMC employees and salaries

Similar to the running costs, the number of employees varied significantly between the different PMCs. The number of “factory workers”, whose role include the handling, processing and packing of the lobster, varied from 15 employees for one of the smaller PMCs interviewed (total seasonal mass processed around 40 t) to 31 individuals for one of the larger companies (total seasonal mass processed around 160t), however, taking the mass of WCRL processed into account, the smaller PMCs appear to employ significantly more people per kilogram processed than the larger companies. Some companies employ seasonal employees in the factories, as extra hands or in a packaging capacity for around 5-6 months during the height of the lobster season.

In terms of employee numbers in the "Management and support staff", generally 1-3 individuals were employed in the factory as supervisors, and a further 1-2 individuals are employed as drivers for the collection and airport delivery of the products. While on the management side, the PMCs generally employed around 1-2 managers with a 2-3 staff working under management and a further 3- 7 administrative employees in addition to a small board of directors.

The numbers of employees for discrete exporting enterprises, not directly linked to a PMC, are difficult to generalize, the only exclusively exporting company consulted consisted of two individuals who organized contacts between sellers, PMC, government and foreign buyers, but did not handle any products themselves and had next to no overheads.

To give rough estimations of the number of people who might be employed in the post-harvest activities in this fishery under the different TACs over the past three seasons, Table 3.2.5.5 can be used as an approximate guide of numbers of individuals employed per kg processed/ exported. The above-mentioned categories were combined into two overarching categories: Factory workers and Management and support staff to simplify subsequent analyses.

Table 3.2.5.5. Average standardized salaries and standard deviations for individuals in the WCRL processing, marketing and exporting industry (n indicates every discreet entry for these values, in terms of respondents and seasons) (Interviews and surveys 2019).

Salaries (R/month/employee)	Average	Standard deviation	N
Factory worker	7392	1726	6
Management and support staff	18 894	4442	6

For the combined mass of 420 741 kgs processed by the respondents a total of 87 individuals were employed in the "Factory" category while 40 in total were engaged in the "Management, Admin and support" category.

3.3 Results Part 2: The net seasonal income of the WCRL fishery (seasons 2016/17-2018/19)

3.3.1 Net seasonal income of the offshore commercial sector

3.3.1.1 Net seasonal income of the entire offshore commercial sector

The median net income for the entire offshore commercial West Coast rock lobster fishing sector was estimated to have ranged from R 158 607 640,68 (2016/17) and R 147 275 566,13 (2017/18) to R 43 669 337,08 (2018/19), with the NSI of the season 2018/19 presenting 27% of the net income of 2016/17 (Figure 3.3.1.1). This is disproportional to the TAC decrease over the same period with the OC TAC of 2018/19 representing 46 % of the OC TAC of 2016/17, which is likely a consequence of more vessels being active per tonne of TAC than in the previous seasons.

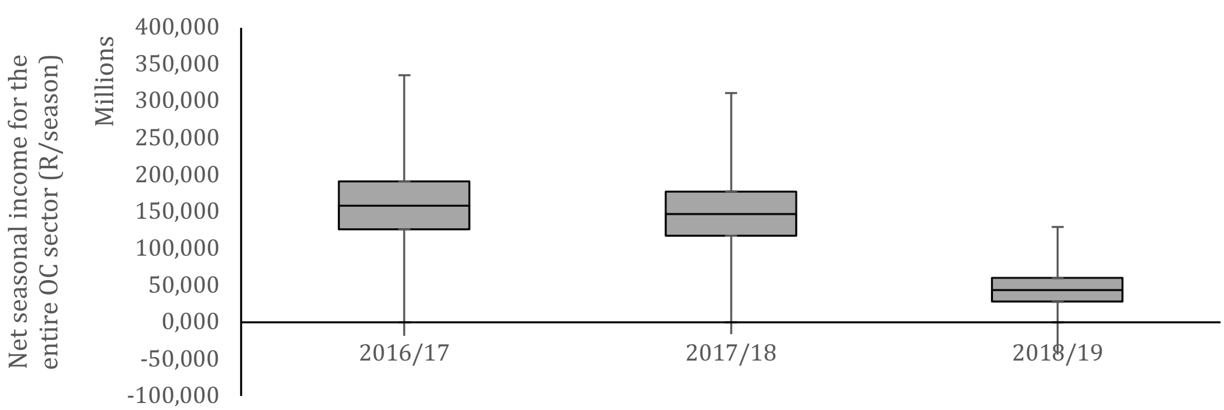


Figure 3.3.1.1. Net seasonal income of the entire WCRL offshore commercial sector for the seasons 2016/17-2018/19. Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the maximum and minimum values.

3.3.1.2 Net seasonal income for different actors in the offshore commercial

Estimates of the NSI of different individuals in the OC sector reveal the importance of considering how much of the catch of a vessel is made for the vessel owners own quota (receiving the full after deductions value per kilogram of lobster) or for someone else's quota (receiving only the catching fee per kilogram of lobster) (Figure 3.3.1.2).

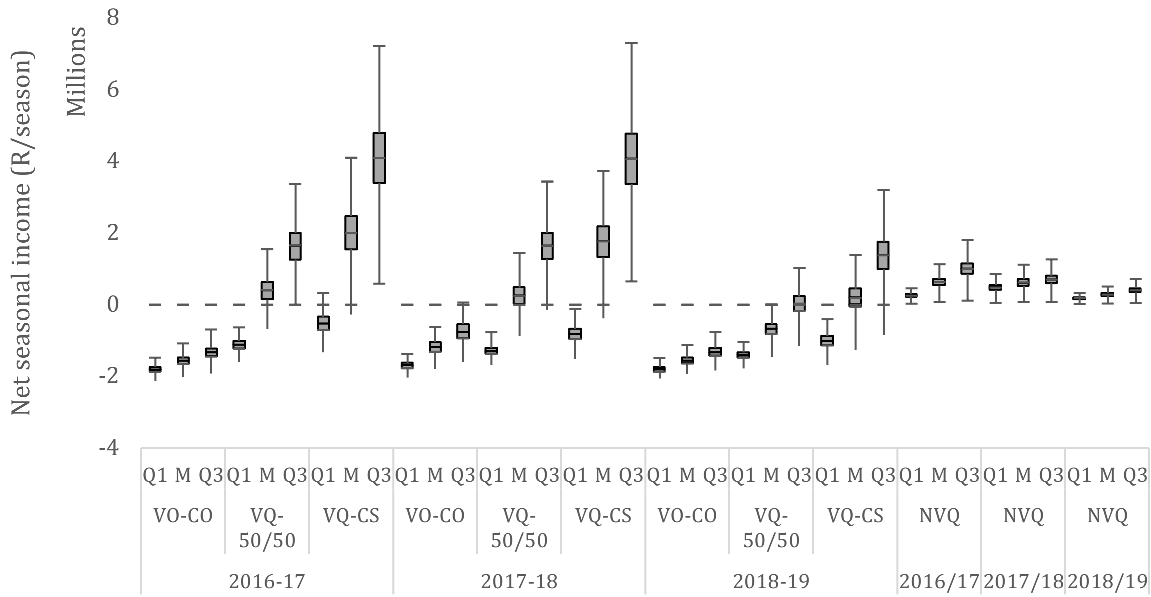


Figure 3.3.1.2. Net seasonal income of different representative individuals in the WCRL offshore commercial sector for the seasons 2016/17- 2018/19. Different vessel owners are characterized by the interquartile range of total catch sizes made per vessel over the seasons and by the proportion of that catch that is for their own quota (VO-CO, VQ-50/50 and a VQ-CS) as well as for NVQs using the interquartile range of quota sizes for that group. Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the maximum and minimum values.

According to the model, the vessel owners whose catch was exclusively for other quota holders (VO-CO) consistently made a negative median NSI across the range of total catch sizes and seasons. Vessel owners whose entire catch was for their own quota (VQ-CS) and vessel owners whose catch was to 50% for their own and to 50% for someone else's quota (VQ-50/50s) were estimated to make profits if their total catch size corresponded to the median or third quartile of the total catches recorded per vessel for a given season in 2016/17 and 2017/18, while in 2018/19 VQ50/50s were estimated to have only made a profit (of only a median of R 29 967) at the third quartile of catch sizes (Figure 3.3.1.2). The largest profits for these representative individuals were obtained by VQ-CS catching at the third quartile of total catches, with a median NSI around 4 million for the seasons 2016/17 and 2017/18 and a median NSI of around 1.5 million in 2018/19.

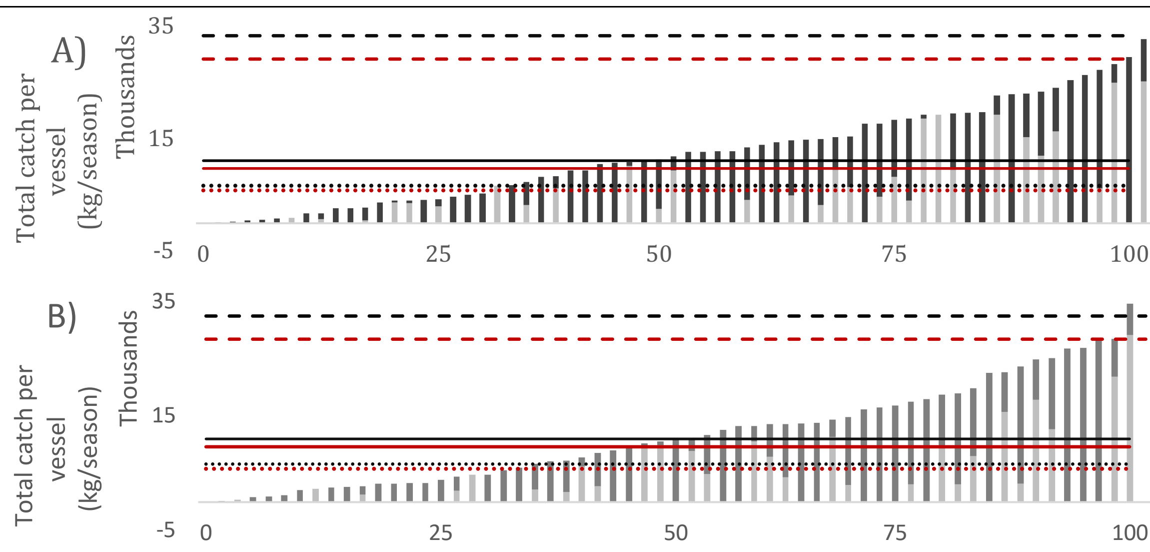
NVQs in the OC sector were estimated to have made a median NSI ranging from R 252 534 to R 1 001 707 in 2016/17, from R 447 644 to R 701 026 in 2017/18 and ranging from R 179 983 to R

399 229 in 2018/19, depending on the size of their quota within the interquartile range of quota sizes.

VQ-50/50s made a higher median profit than NVQs at the median and third quartile catch sizes for the seasons 2016/17 and 2017/18 while for the season 2018/19 they made less than NVQ at all catch sizes modelled. For all seasons VQ-CSs made a higher median NSI than NVQs at the median and third quartile of catch sizes, but not at the first quartile of catch sizes. VQ-Cos were consistently estimated to have made a lower median NSI than NVQs.

These comparisons highlight that owning a vessel in the OC sector is likely to be unprofitable: if a) not enough of the catch is receiving the full net value of a kilogram of lobster (i.e., if the vessel owner is catching predominantly for a catching fee) and b) if the total catch of the vessel is too small.

Using the running and annual cost received from interviews, minimum catch sizes needed to break even (NSI = 0) were calculated using SOLVER for the different types of vessel owners and taking into account the different mean catches per trip for the seasons modelled and all costs involved in maintaining and operating a vessel. The break-even points were calculated using the means of all input variables (not including any stochasticity) and are presented with the total catches of all vessels in Figure 3.3.1.3.



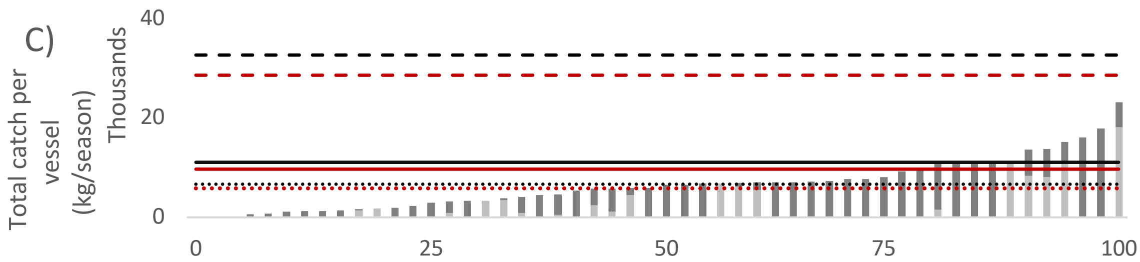


Figure 3.3.1.3. Total catches made by all individual vessels, arranged from smallest to largest and with the x-axis indicating the cumulative frequency as a percentage, for the seasons A) 2016/17, B) 2017/18 and C) 2018/19. Bars show for each vessel how much of the catch was made for the vessel owners own quota (dark grey) and quota holders different from the vessel owner (light grey). Lines indicate the estimated minimum total catch a vessel would have to make in each of the seasons if all costs are taken into account (black lines) and when depreciation costs are disregarded (red lines) for VQ-COs (striped lines), VQ-50/50s (solid lines) or VQ- CS (dotted lines).

Figure 3.3.1.3 shows the declining profitability of operating a vessel over the three seasons observed. As total catches decline, a decreasing percentage of the vessels appear to make any profit from their operations.

VO-CO have to make substantially higher catches than VQ-CS or VQ-50/50 to break even over a given season. Out of all vessels, active in the three seasons examined (n: 33, 29 and 24 respectively) a decreasing number of 20, 17 and 5 vessels were estimated to catch more in the seasons 2016/17, 2017/18 and 2018/19 respectively than they needed to reach the minimum mean NSI to break even under the assumption that half of their catch was for themselves and half was for other quota holders, while a total of 24, 23 and 11 vessels caught more than was required to reach the minimum NSI in the three seasons assuming that their entire catch was for themselves. As the majority of vessels fall somewhere on the spectrum of catch proportions for themselves and others and the incomes and costs are averages of varying amounts, these are only rough indications of what different vessel owners in the OC sector might have experienced economically over the three seasons examined here.

The income per trip, assuming the mean catches for each of the three seasons, was positive for all categories of vessel owners, however, vessel owners catching someone else's quota stood to make only just above one fifth the income that a vessel owner catching their own quota would make.

3.3.1.3 Employee numbers and salaries

There appears to be some variation regarding numbers of crew and skippers employed, as a crew/skipper can work on multiple vessels and vessels can vary in their size and capacity. The general constellation appears to be an average of 6 crew members and one skipper employed per vessel in the offshore sector. Scaling these averages up, around 384, 360 and 312 people were likely employed as crew, while 64, 60 and 52 individuals were likely employed as skippers in the seasons 2016/17, 2017/18 and 2018/19 respectively. Using these approximations and the mean salaries paid to the different employee categories given in section 3.2.1.4.d), Table 3.3.1.1 gives the estimated total numbers of individuals, and the estimated total salaries paid out to the different types of sea-based employees in the offshore commercial sector.

Table 3.3.1.1. Estimates of total numbers of crew and skippers active in the offshore commercial sector and their average combined annual salaries 2016/17 – 2018/19 (Interviews and surveys 2019).

	2016/17	2017/18	2018/19
Total number of active vessels	64	60	52
Total crew (n/year)	384	360	312
Total skippers (n/year)	64	60	52
Total annual salaries for all crew (R/year/ all)	51 940 872.8 ± 7 547 715.7	48 694 568.3 ± 7 075 983.5	42 201 959.2 ± 6 132 519.0
Total salaries for all skippers (R/year)	16 835 957.9 ± 826 838.0	15 783 710.5 ± 775 160.6	13 679 215.8 ± 671 805.9

3.3.2 Net seasonal income of the nearshore commercial sector

3.3.2.1 Net seasonal income of the entire nearshore commercial sector

The median total net income for the WCRL NC sector was estimated to have decreased steadily over the 3 seasons observed in both scenarios considered, and was higher in Scenario 2 than Scenario 1 in all three seasons (Figure 3.3.2.1).

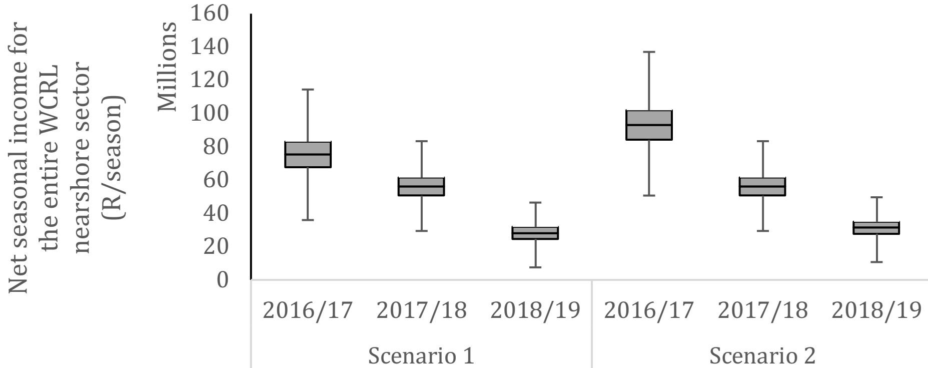


Figure 3.3.2.1. Net seasonal income for the WCRL nearshore commercial fishery sector for the scenario where the NC sector catches only the NC quota (Scenario 1) or where NC fishers are catching 80% of the IRP sector allocation in addition to the NC sector's quota (Scenario 2) for the seasons 2016/17- 2018/19. Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the maximum and minimum values.

The higher NSI in Scenario 2 is a consequence of this scenario assuming NC vessels to be catching 80% of the IRP quota while adding no extra costs beyond the extra trip costs.

3.3.2.2 Net seasonal income for different actors in the nearshore commercial sector

3.3.2.2 a) Vessel owners with their own quota

The net income estimated for different individual vessel owners with quotas in the nearshore commercial fishing sector varied between the super-areas and seasons (Figure 3.3.2.2).

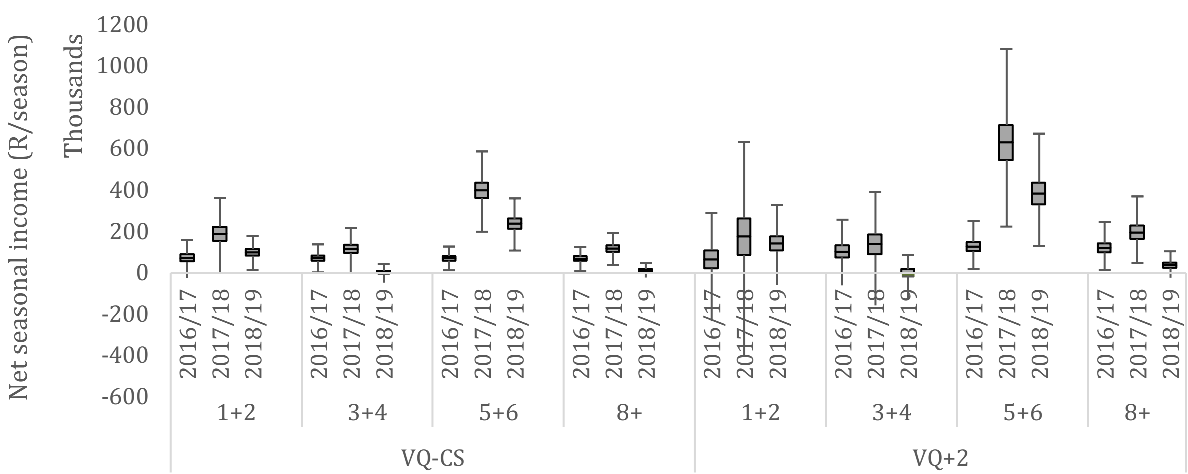


Figure 3.3.2.2. Net seasonal income for representative nearshore commercial vessel owners (VQ-CS and VQ+2) in the different super-areas, seasons 2016/17- 2018/19. Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the maximum and minimum values.

As the highest quotas were found in 2017/18 in all super-areas, that was the season of highest net incomes. Incomes in 2018/19 differed widely, with the estimated median NSI made by a single VQ-CS ranged from R 2 609,1 (A3+4) to R 238 470,3 (A5+6), and the estimated median NSI of a VQ+2, ranged from R 1 377,6 (A3+4) to R 385,843,9 (A5+6). In most super-areas and seasons VQ+2 made a higher median net income than VQ-CS except in A1+2 (seasons 2016/17 and 2017/18) and A3+4 (2018/19). Reasons for these differences in the profitability of operating a vessel will be further discussed in Section 3.3.4.

All super-areas and seasons exhibit a much larger uncertainty around the estimated NSI for VQ+2s, reflecting the increased uncertainty of making profits for each additional trip made for someone else's quota. The gross profit of a trip catching for another's quota (only receiving the catching fee per kilogram caught) that could be expected in A1+2 and A3+4 (Zone B) was often not enough to cover the mean estimated expenses of a trip due to the low mean catches found for those areas and seasons, rendering a large part of trips net losses.

3.3.2.2 b) Quota holders without a vessel

NVQs are assumed to have no costs and are earning an average of R 189 per kilogram of lobster caught for them, thus the differences between the areas in the NSI calculations directly reflects the differences in quota sizes for the different areas and over the different seasons (Figure 3.3.2.3).

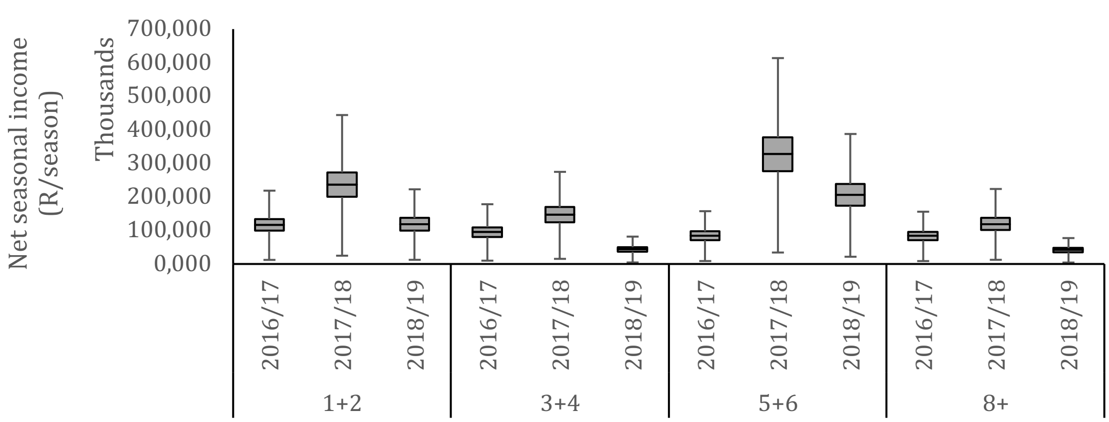


Figure 3.3.2.3. Net seasonal income for the WCRL nearshore commercial quota holders who do not fish their own quota for the different super-areas, seasons 2016/17-2018/19. Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the maximum and minimum values.

The median NSI for NC NVQs over the seasons studied ranged from R 116 415 to R 236 464 (A1+2), R 43 452 to R 146 267 (A3+4), R 83 821 to R 326 887 (A5+6), R 41 125 to 119 083 (A8+).

3.3.3 Net seasonal income of the IRP sector

3.3.3.1 Net seasonal income of the entire IRP sector for the seasons 2016/17-2018/19

The estimated NSI for the IRP nearshore sectoral TAC decreased steadily over the three seasons, but the IRP offshore sectoral TAC provided a similar NSI than the nearshore sectoral TAC in 2018/19 (Figure 3.3.3.1).

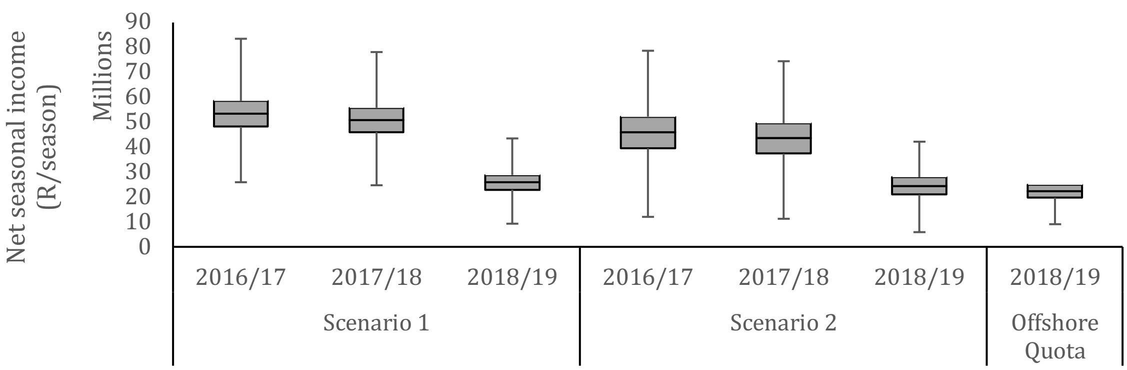


Figure 3.3.3.1 Net seasonal income for the WCRL IRP fishery sector for the scenario where the IRP sector catches the entire IRP quota (Scenario 1) or where NC fishers are catching 80% of the IRP sector's quota and IRP owned vessels catch only 20% of the IRP allocation (Scenario 2) for the seasons 2016/17- 2018/19. Both scenarios include the IRP offshore allocation (completely caught by the OC sector) for the season 2018/19. Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the maximum and minimum values.

Under the model's assumptions, the first scenario generated higher median net incomes for the IRP sector in the three seasons, however, the difference is larger in the two seasons with larger nearshore IRP TAC (2016/17 and 2017/18) than in the season with a much smaller nearshore IRP TAC (2018/19).

3.3.3.2 Net seasonal income for different actors in the IRP sector

3.3.3.2 a) Vessel owners with their own quota

As for the NC vessel owners, the NSI for IRP vessel owners was calculated using two scenarios, one where the NSI is calculated on the premise that the vessel owners in question are only fishing their own quota (VQ-CS) and one where the calculation is made assuming that the VQ is catching their own quota in addition to that of 5 other individuals from their zone (VQ+5) (Figure 3.3.3.2).

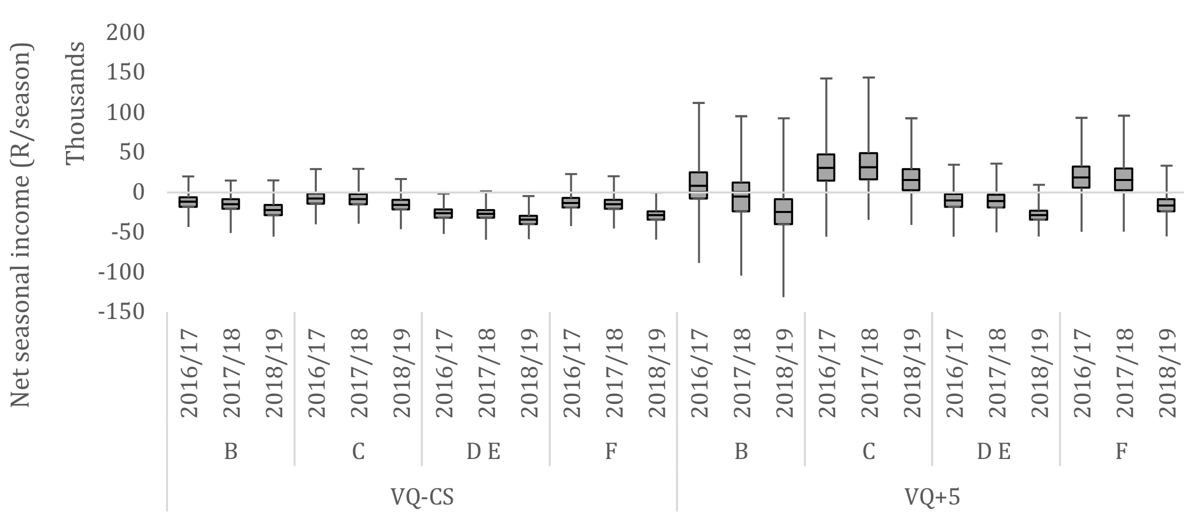


Figure 3.3.3.2. Net seasonal income for representative IRP vessel owners (VQ-CS and VQ+5) in the different zones over the seasons 2016/17 - 2018/19). Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the maximum and minimum values.

According to the model, all IRP VQ-CSs were estimated to have made a median net loss over the seasons 2016/17-2018/19. VQ+5s made a higher median net income than VQ-CS in all zones and all seasons studied, although the benefit of catching for more people was least pronounced in Zone D+E and for VQ+5s, the highest median NSI was achieved at just above R 30 000 in Zone C in the two earlier seasons.

As in the NC sector, the NSI estimations for all zones show a much wider range of possible results for VQ +5s than for VQ-CSs, thus quantitatively confirming the increased risk of catching for other people, largely due to the uncertainty regarding a profit on a per-trip basis.

3.3.3.2 b) Quota holders without a vessel

The NSI for the IRP NVQs is proportional to the size of the quota, reflecting an average income per kg of around 189 R/kg (Figure 3.3.3.3). The estimated NSI ranged from R 4 205 (Zone DE 2018/19) to R 23 701(Zone B 2016/17) for the nearshore quota, and from a R 11 818 (Zone B) to 26 173 (Zone F) for the offshore quota.

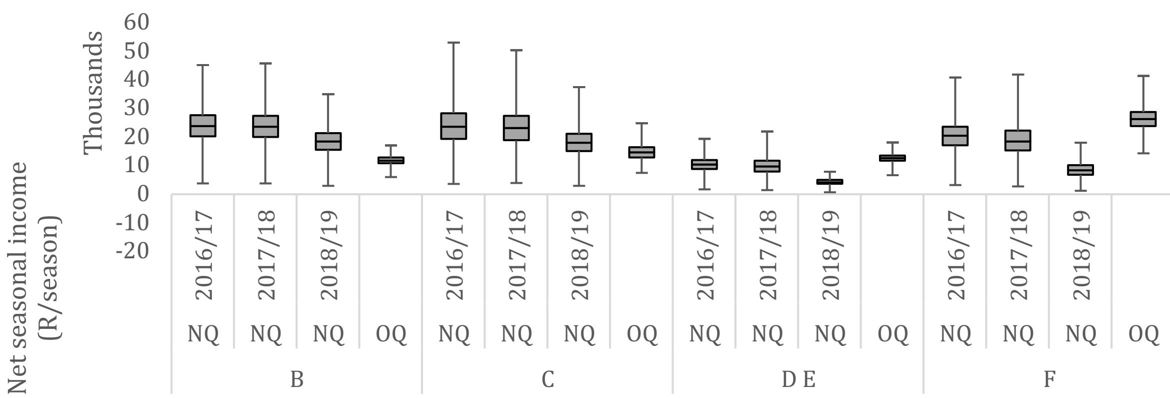


Figure 3.3.3.3. Net seasonal income for WCRL IRP quota holders who do not fish their own quota (nearshore and offshore quotas) for the different zones and the seasons 2016/17 – 2018/19 The offshore quota only applies to the season 2018/19). Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the maximum and minimum values.

In the catching of the offshore quota, IRP quota holders are not actively involved. Comparing the NSI from the NQ for NVQs and the NSI from the OQ, Zone B and C are estimated to obtain a higher income from the NQ, while quota holders in Zone D + E and F are estimated to obtain a higher income from the OQ.

3.3.4 Performance of the NC and the IRP sectors

3.3.4.1 Variables affecting the net seasonal income for vessel owners in the nearshore commercial and the IRP sectors

To explore the differences found between the NSI for the different actors across the super-areas/zones above it is necessary to look closer at the effect of two main factors: the differences in catch per trip and quota sizes in the different seasons and areas. The number of super-areas and seasons where a VQ-CS was estimated to make a higher median NSI than a VQ+2 (i.e. A1+2 (season 2016/17 and 2017/18) and A3+4 (season 2018/19)) in the NC sector, or than a VQ+5 (i.e. Zone B: season 2018/19) in the IRP sector indicate that in some cases catching for other people, on average, can bring about net losses rather than gains.

To explore this, the relationship between the minimum quota size and the minimum catch-per-trip necessary to break even (NSI = R0) was plotted, using the equations for vessel owners (6.2.1 e)) and the SOLVER add-in in excel. Solver did not include the uncertainty and calculated the variables using the mean values of each input variable.

The resulting function has a vertical and horizontal asymptote, indicating that both the minimum quota and the catch per trip cannot be reduced below a certain point without producing a negative NSI, however, these asymptotes have different values for the different vessel owner categories.

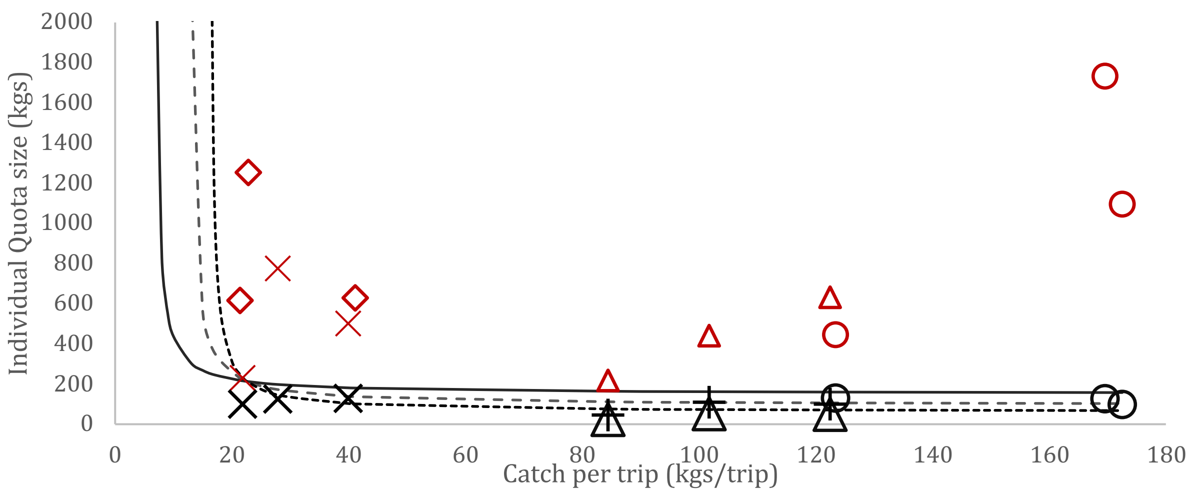


Figure 3.3.4.1. Interaction between quota sizes and catches per trip producing an NSI of zero for VQ-CSs (straight line), VQ+2s (striped line) and VQ+5s (dotted line). Markers indicating the actual location of the different super-areas for the nearshore sector (red markers) and the different zones for the IRP sector (black markers) for the seasons 2016/17-2018/19 (Markers: A1+2 = diamonds, A3+4/Zone B = Xs, A5+6/Zone C = circles, A8+/Zone D, E = triangles, Zone F = crosses).

The minimum quota sizes needed to make a positive NSI depend on the annual costs but also on the catch per trip and thus combined costs per trips. Figure 3.3.4.1 demonstrates that at high catches per trip a VQ-CS would require a higher minimum quota then a VQ+2 or VQ+5 to break even in each season. Taking all costs thus into account, the minimum quotas level out with increasing catches per trip at around 150 kg/trip for VQ-CSs, around 100 for VQ+2 and at around 65 kgs for VQ+5.

Further, at small catches per trip, quota sizes in turn become irrelevant, as quotas can be infinitely large, but if catches cannot cover the running costs, vessel owners cannot make a positive NSI. These limits occur at around 17 kgs per trip for VQ+5s, at around 14 kgs per trip for VQ+2s and at around 9 kgs per trip for VQ-CSs. The analysis suggests that if catches per trip were to decrease below these levels in particular localities, these sectors would experience commercial extinction in those localities.

VQ-CS can have lower catches per trip as their entire catch is assumed to obtain the full net value per kilogram, while in the case of VQ+2s and VQ+5s hypothetically only one third and one sixth of the catch respectively gets the full net value, while the other two thirds or five sixth of the catch (respectively) are only rewarded with the catching fee. In turn, VQ+2/+5 can have lower quotas as their annual costs are covered by their quota plus their catch for others, assuming that their catch per trip is large enough to yield a net gain per trip.

At present none of the super-areas or zones are limited by the catch per trip but rather by the quota sizes, however, the minimum limits estimated here are close to the actual catches per trip found in A1+2 and A3+4, thus demonstrating the economic need to recover the biomass and avert commercial extinction of the resource in those areas.

The IRP and NC quotas have different purposes in this fishery, and their profitability cannot be compared without taking these into account. The NC quotas are intended to be commercially viable on their own, while the IRP quotas are i) part of a basket of resources and therefore intended to contribute to a livelihood but not necessarily provide for one on their own, and ii) intended as part of a community allowance, not necessarily an individual one. The analysis, nonetheless, points to troubling trends in these sectors, as even if it were assumed that a vessel owner catches for an entire community and the community shares some of the vessel costs (as intended under the SSPF) diminishing catches per trip are of great concern, as the minimum catch per trip size is close to being reached in A1+2 (Zone A) and 3+4 (Zone B).

3.3.4.2 Estimations regarding crew income in the NC and the IRP sectors

From the median number of crew on a nearshore vessel (3) and average catching fee (Section 3.2.2.4 b)) the average income per trip per crew member was estimated for the different super-areas and seasons (Table 3.3.4.1).

Table 3.3.4.1. Approximate per trip income for an NC/IRP crew member in the different zones/ super-areas assuming that the 3 crew members on a vessel each get the same proportion of the total catch per trip.

	2016/17	2017/18	2018/19
A1+2	123.1 ± 41.1	123.3 ± 41.2	237.5 ± 78.8
A3+4 (Zone B)	230.4 ± 77.2	161.0 ± 55.1	126.4 ± 44.2
A5+6 (Zone C)	712.8 ± 236.6	979.5 ± 325.0	996.5 ± 330.7
A8+ (Zone D E F)	587.2 ± 197.8	706.8 ± 236.3	487.5 ± 164

Given the different rates of catches per trip in the different super-areas or zones, generally each trip is likely to be more lucrative for an individual crew member in the super-areas (zones) with higher average catches. The income per trip in 2018/19, for example, ranged from almost R 1000 in A5+6 (Zone C) to just 126 R in A3+4 (Zone B).

The following are estimations regarding the total payment to crew members from the NC and IRP sectors combined and the subsequent average income that a crew member might have expected to have made over the seasons 2016/17 – 2018/19 (Table 3.3.4.2). The average is based on the total biomass that was caught in the sectors and the catching fee per kg, divided by the approximate total number of crew members active in the two sectors.

Table 3.3.4.2. Estimated total number of crew (assuming three individuals per vessel), the total estimated money going to crew members in the combined two nearshore sectors and the estimated average annual income that a crew in the two sectors might make.

	2016/17	2017/18	2018/19
NC sector (n/year)	1038	603	729
IRP (assumed 32 vessels) (n/year)	96	96	96
Total number (n/year)	1134	699	888
Total economic contribution to crew members (NC and IRP combined) (R/all/year)	9 958 412 ± 3 312 791	8 033 205 ± 2 672 346	4 844 750 ± 1 611 667
Average annual income for each crew member (R/crew/year)	8 781 ± 2 921	11 492 ± 3 823	5 455 ± 1 814

While the season 2016/17 overall generated the highest income to all crew members combined, with a mean total of R 9 958 412 ± 3 312 791 going towards payment of crew, the proportion of crew members assumed to have operated to the total catch means that 2017/18 was estimated to be the highest-grossing season for an individual crew member, with an estimated average annual income of R 11 492 ± 3 823. The high variability surrounding the crew fee paid to crew members per kilogram found during this study means that all calculations have a high uncertainty.

3.3.5 Net seasonal income of the small-scale sector

3.3.5.1 Net seasonal income for the entire Port Nolloth co-operative and different individuals

Only the Port Nolloth cooperative was considered for calculation of entire co-operative and individual NSI for the season 2018//19 (the only seasons in the series in which the cooperative was in existence).

From the allocated quotas and the price received per kilogram of lobster (section 3.2.4.2 and 3.2.4.4. respectively), the gross income for the entire cooperative was calculated to be R 2 275 000 for the nearshore quota and R 1 012 380 for their offshore quota, assuming the entire quota to be caught. The income for different individuals within the cooperative revealed that under the current system pensioners, women and disabled individuals received an average NSI for the season from the nearshore quota of 12 409, while seagoing individuals received an average NSI of R 9 680 and each member of the cooperative received an additional R14 672 for the season of the offshore quota.

Our calculations further reveal that the amount of around 40 R/kg of the nearshore quota allocated to the fund for maintenance and repair of vessels was far below the total amount theoretically needed for the maintenance costs of the nine vessels belonging to the cooperative, as at R 23 453 vessel/year estimated to be necessary for the annual upkeep of nearshore vessels this fund fell R 170 634 short of the estimated needed amount.

3.3.6 Net seasonal income for the post-harvest components of the WCRL fishery

3.3.6.1 Gross income from WCRL exports for the seasons 2016/17 – 2018/19

From the mean export prices obtained for each season (weighted by time of catching and the likely proportion of exports with discounted prices) (Table 3.2.5.3) and the total exported mass, gross income from the WCRL resource could be estimated (Figure 3.3.6.1.).

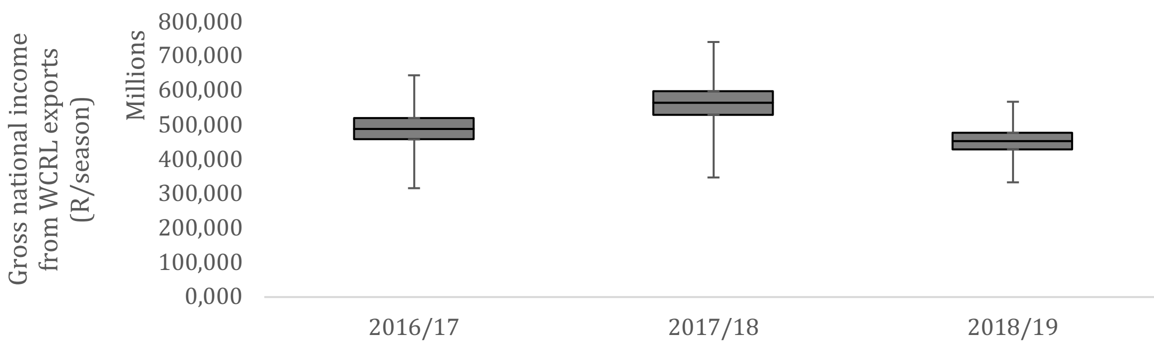


Figure 3.3.6.1. Gross income from the national WCRL exports for the seasons 2016/17-2018/19. Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the maximum and minimum values.

The estimated gross income ranged from a median of R 453 185 008 in 2018/19 to R 564 721 230 in 2017/18. For the gross income, 2017/18 was the highest-grossing year due to the increase in the international market price from the previous season while the total mass exported remained similar to 2016/17. Due to the steep increase of the average international market price from 2016/17 to 2018/19, the difference of the gross annual income between those two seasons is much smaller than one might expect given the notable decrease in the global TAC between those two seasons.

3.3.6.2 Employment and income opportunities in post-harvest activities

Using the combined numbers of employees from the four PMCs interviewed, approximations regarding the total numbers of employees could be made for the three seasons (Table 3.3.6.1).

Table 3.3.6.1. Approximate numbers of people employed in the WCRL post-harvest value chain operations, and approximate average total annual salaries for the two categories: employees working in the factories, and employees engaged in management, admin or management support.

	2016/17	2017/18	2018/19
Employees working in the factories (n)	253	231	166
Employees in Management, Admin and Support staff (n)	116	106	76
Total salaries for employees working in the factories (R/all/year)	22 422 770 ±5 238 120	20 509 590 ± 4 791 188	14 701 198 ± 3 434 306
Total salaries for Management, Admin and Support staff (R/all/year)	26 353 582 ± 6 190 727	24 105 013 ±5 662 515	17 278 384 ± 4 058 870

3.3.7 Net seasonal income of the entire fishery

3.3.7.1 Combined net seasonal income from all sectors

The combined median net income from landed lobster from the different sectors was estimated to be R 297 550 403, R 246 753 284 and R 118 163 510 for the seasons 2016/17, 2017/18 and 2018/19 respectively (Figure 3.3.7.1). The NSI made by the PMCs and exporters is not included here as the data received on costs was insufficient to account for the great diversity of actors at that level of the value chain. If the profits from these groups were also included the total NSI could be expected to be considerably higher.

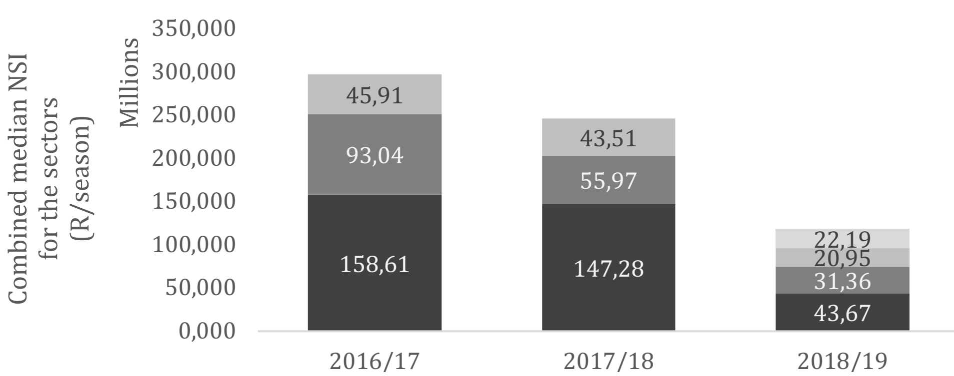


Figure 3.3.7.1. Total median net seasonal income of the WCRL fishery for the seasons 2016/17 – 2018/19 (dark grey: OC sector, medium grey: NC sector, light grey IRP/small-scale sector and white IRP/small-scale sector offshore quota).

3.3.7.2 Employment across the entire value-chain

Apart from the quota holders many people are directly engaged with this fishery, both sea-going through casual work as crew on NC or IRP vessels, as crew or skipper employees on OC vessels, and land-based as employees in the PMCs, in the form of factory workers, processing the harvest, supervision, transport or management of value chain operations (Table 3.3.7.1.).

Table 3.3.7.1. Total number of sea-going and land-based individuals directly engaged in the WCRL fishery and their combined annual salary. Quota holders are not explicitly included in these estimates but in some cases quota holders will be included amongst the sea-going individuals, particularly in the IRP and NC sectors.

	2016/17	2017/18	2018/19
Approximate number of sea-going individuals engaged in the fisher (n)	1582	1119	1252
Approximate number of land-based individuals engaged in the fishery (n)	369	337	242
Total number of individuals engaged in the WCRL value chain (n)	1951	1456	1494
Combined annual salary (R/season/all)	132 851 734 ± 14 506 753	122 138 615 ± 13 438 750	97 045 483 ± 10 970 304

From the distinct approximate salaries received by the different employees, the annual combined salaries given in Table 3.3.7.1 were calculated to give an approximation of total annual economic benefit of the fishery to those who do not necessarily hold quotas or vessels in the fishery

The total number of those employed in this fishery estimated here is lower than other numbers reported by DEFF. This will be elaborated on in the discussion of this Chapter.

3.4 Discussion

The analysis of the income for the fishery, sectors and actors in the WCRL fishery over the seasons 2016/17 – 2018/19 revealed the fishery is very valuable, with a gross income ranging from a median of R 453 185 008 to R 564 721 230 over the three seasons examined. On an individual level, however, the profits from this fishery appear to be unequally distributed. Particularly under lower quotas vessel owners from all three sectors were estimated to make proportionally less income than non-vessel owning individuals (NVQs). There are also substantial differences between the NSIs found in the different super-areas and zones for the NC and IRP sectors, due to the different quota sizes, but also as the resource productivity between zones differs markedly. The decreasing global TAC and quotas have exacerbated these patterns, and management strategies and further research into ways of addressing these trends are urgently needed.

3.4.1 The sectors

3.4.1.1 Offshore commercial

The OC sector accounted for the largest sectoral NSI of the WCRL fishery, however, the results for representative individuals in this sector showed that the income depends on their individual attributes including whether they own a vessel, how much that vessel is catching and how large the vessel owner's own quota is. There are several gaps and limitations in the findings for this sector, for which further study is strongly recommended.

The results are to be interpreted as representative and general, as the variation of quota and catch sizes, numbers and possible combinations of factors did not allow a straightforward way to calculate profits for individual quota holders or vessel owners in this sector. There are indications that a large percentage of fishing operations have become unsustainable over the seasons 2016/17 – 2018/19 (Figure 3.3.1.3), which has been corroborated by interviewees from the sector. A large majority of vessel owning quota holders did not appear to have quotas large enough to cover the annual costs of operating an OC vessel from their own quota alone. While catching for other quota holders can be used to enhance a vessel owner's annual profit, the proportion of the catch belonging to a vessel owners own quota was important in determining their overall profit. The decreasing quota sizes (with a slower rate of decrease in numbers of vessels/vessel owners) mean that each vessel owner generally made lower total catches, particularly at the upper ends of the range of total catches made per vessel. The decreased quota sizes and lower total catches per vessel of 2018/19 meant that in that environment, the only vessel owners who were estimated to make a higher median NSI than NVQs (within the interquartile range of quota sizes) were VQ-CS of total catches above-median sizes.

During interviews with knowledgeable stakeholders in the OC sector, it was mentioned that as a rule of thumb, an OC vessel catching WCRL needed a minimum catch of around 20 tonnes to be profitable. It was not specified, however, what constituted a “profitable” operation in this sense, and how much of these 20 tonnes would be attributed to the vessel owners own quota. The analysis exploring the minimum catch to break even for the different types of vessel owners (Figure 3.3.1.3), suggests that this estimate is too low for vessel owners catching only quotas from other people, but to be well above the minimum catch needed to break even when assuming the vessel owner to be catching 50/50 their own and other’s quotas and when catching only their own quota, and thus likely to yield a decent profit under those assumptions.

The number of vessels, particularly those owned by VO-CO, which appear from the results of this study to generally not have made a profit over the studied seasons (even when disregarding the depreciation rate) present a possible problem for the analysis of these figures, as it is unlikely that so many vessels would operate under such economic losses. Explanations for this apparent discrepancy could be due to several reasons. Firstly, this sector, more so than the other ones, is characterized by extensive variation concerning quota sizes, total catches of vessels, allocation of catches and numbers of vessels per vessel owner, all variables that could not be fully explored in their diversity and range of combinations given the limitations of this study and the received responses. Secondly, the magnitude of intrasectoral interactions and the importance of shares of vessels and differences in catching agreements between stakeholders could not be captured in these models. The data used to determine vessel owners and quota holders provided by DEFF does not report the partial ownership of vessels or other possible arrangements between the different stakeholders and the respondent’s answers to this effect were insufficient to make generalisations. It is thus possible that some of the vessel owners, who appear to only catch other people’s quotas, are in some close arrangement with at least some of the quota holders that they are catching for, be it through companies or other mechanisms, that would result in their fiscal relationship not consisting solely of the exchange of the harvest and catching fee, as was assumed for this model.

The calculations suggest that this sector engaged approximately 448, 420 and 364 individuals through direct sea-going employment in the offshore fishing operations. Receiving sizeable monthly retainers independent of catch or number of trips seems to afford these individuals a stable economic existence. While the total number of employees was around half the number engaged in the NC and IRP fisheries, the total combined salaries paid to them were estimated to be around 6-7 times the size of the total salary of those individuals engaged as crew in the NC or IRP fishery.

While there have been several reports published in recent years detailing different socio-economic aspects of the small-scale and artisanal WCRL fishery (Isaacs 2015, Jordan 2016, Wentink et al. 2017, Botha 2020) there have not been any recent publications regarding these aspects in the WCRL OC. The most extensive socio-economic profile published in the past 5 years is a section of the "Policy for the Allocation and Management of Commercial Fishing Rights in the West Coast Rock Lobster Commercial (offshore) Fishery", where 5500 employees were estimated to be engaged in the commercial offshore sector (of which 2500 were sea-going), the average annual income per employee was R 26 500 and the overall value of vessels in the offshore fishery was estimated to be at around R130 million (DAFF 2015a). These figures are almost certainly outdated, since the same economic figures were given, verbatim, in the homonymous Policy of 2005 (DEAT 2005) and therefore likely reflect the state of the commercial sector in 2005, before many of the major changes related to the allocation of rights to the IRP sector and extensive reductions in the TAC occurred. The numbers presented in this study regarding numbers employed are much lower (and do not capture any land-based personnel involved in the OC sector), while the estimates regarding annual salaries are substantially higher. While DEFF's published numbers are open to question, it is acknowledged that numbers from this study are also subject to a large number of uncertainties and are only to be taken as approximations given the limited number of participants and quantitative results gathered, as well as the fact the respondents involved represented large quotas and large investments.

Given the long-overdue need to determine the economic and social parameters for this sector, it is hoped that these findings can contribute to the discussion around the management of this sector, despite their limitations. A more extensive study and analysis of this sector, to add and compare to the findings presented here to is strongly recommended.

3.4.1.2 Nearshore commercial and IRP sectors

The NC sector achieved a higher median sectoral NSI than the IRP in the seasons 2016/17 and 2017/18, but the equal division of the nearshore TAC and the additional allocation of a part of the offshore resource meant that in 2018/19 the combined median NSI for the IRP was higher than that of the NC sector.

The findings regarding the NSI for representative individuals in the NC and IRP sector over the seasons 2016/17-2018/19 show that the decreasing quotas seen in 2018/19 had a more negative effect on individuals owning vessels than NVQs in the different areas. Owning a vessel brings with it costs and economic risks that, especially under low quotas, are disproportionate to the estimated benefits of being an active fisherman in the NC and IRP WCRL fishery. Especially in the IRP sector, the small quotas available to individual fishers make it economically necessary to catch for a large number of other individuals, but given the low catches per trip in some of the areas, catching larger masses for the average catching fee necessitates a large number of trips for little to no gain and additional risks. This has likely contributed to the reason that only an estimated 32 vessels remain in the IRP sector. The unequal and disproportionate costs of engaging in this fishery between the different kinds of actors in the NC and IRP sector requires renewed scrutiny and potentially some management changes to incentivize and reward active fishers who are invested in these sectors.

A large number of the IRP communities interviewed outsourced the catching of their entire quota to individuals from outside the community, often making catch-agreements with NC vessel owners. In many cases, it was found that even though IRP quota holders within the community owned or had access to vessels, they were not contracted to make the community's catch due to economic, personal or micro-political reasons. While the IRP quotas are allocated to the communities and are not intended to be sufficient for individual vessel owners to make a substantial profit of their own quota, the situation as observed during data collection suggested that in many communities there appeared to be a rift between the caretakers and individual vessel owners. Reasons given by representatives for not supporting IRP vessel owners from their own communities included cheaper catching fees from other vessel owners or (and often intertwined) interpersonal and political reasons. IRP communities can be highly heterogeneous and politically driven (Wentink et al. 2017) and the lack of unity can contribute towards the economic unviability of active fishing by individual vessel owners.

The analysis surrounding differences in catch-per-trip and quota sizes between the super-areas/zones reveals that the management approach to ensure the profitability of fishing operations requires different points of focus for the different localities. In the NC sector, there is still some economic incentive to owning a vessel, as the majority of VQ+2s are likely to make a higher income than an NVQ from that sector. However, VQ+5s in the IRP sector only made a higher NSI than NVQs in Zone C and only in the seasons 2016/17 and 2017/18. In no season or zone in the IRP sector, and only in season 2017/18 and 2018/19 in A5+6 in the NC sector, did a VQ-CS make a higher NSI than an NVQ. While the quotas received by the NC vessel owners in all cases were estimated to be sufficient to cover all annual and maintenance costs from their own quota alone (although not necessarily contributing to a surplus), in almost no instance could the IRP quotas alone be considered to cover the annual and depreciation costs alone. The interactions between quota size and catchability are important to consider, as they indicate that a vessel owner in A5+6 and 8+ (Zone C, D, E and F) can enhance their annual income through additional catching agreements with NVQs (theoretically only limited in the number of quotas they can contract and the number of trips they can make in a season), while for vessel owners in A1+2 and A3+4 (Zone B), the catch-per-trip can present a limit to the NSI as the profit they could expect per trip for another's quota is negligible to non-existent, and the only way to increase their NSI would be through higher catching fees or increased quotas.

The above considerations are highly relevant to any future management approaches to this fishery. From these estimations, it appears that in both the NC and the IRP sector the comparative costs of owning a vessel and associated potential for making economic losses are increasing with decreasing quotas. Further, while the IRP system was not designed for an individual's quota to sustain the operation of a vessel, but to encourage communal pooling of the quotas and harvesting practices, this does not appear to be the most common way for IRP communities to function, and in many cases, the vessel owners did not report catching for a sufficient number of individuals (by their own choice or due to external factors) to meet their operational costs from the WCRL harvest.

Many NC vessel owners and all IRP vessel owners reported having access to other species as well, ranging from high-value species like abalone in the southern areas (for NC fishers) to species of low economic value like line fish. Many vessel owners reported having relied more and more heavily on other species under the recent decreasing WCRL quota sizes. In particular the snoek (*Thyrsites atun*) fishery has been noted as a decent and increasingly important alternative source of income for IRP fishers. However, apart from abalone, most of these species require a lot more time and energy investment for smaller returns (Jordan 2016).

As there was insufficient information, this study did not differentiate between costs and catches for different vessel sizes or different costs in different areas presenting a large limitation to the findings of this study. These differences are important and could be the subject of further research. However, it appears that the cost estimates presented here, overall, are likely to have been conservative and that the minimum quotas and catches to meet annual and running costs for vessel owners could be higher than the ones calculated. One consulted expert remarked that the average annual costs calculated from the interviews and surveys appear to be at the lower end of the spectrum, as according to them, a particularly bad, but not too uncommon, year could easily spell more than R100 000 in costs for a vessel owner. A comparison with the recent findings from Jordan (2016) regarding fishing expenses for West Coast rock lobster fishers in the Kogelberg District (Area 8) further shows the annual and running expenses estimated in that study as being higher for almost every category. The comparable conservativeness of the averages used here and the high variation of these parameters found both within and between areas, suggests that the results are useful in indicating general trends and problems in the two sectors, and probably underestimate the economic costs involved with fishing WCRL rather than overestimating them.

If the goal of the NC and IRP sectors is to empower traditional and small-scale active fishers , then it appears that, at least in some instances, the goal is currently not being met and that the variables favouring "arm-chair fishers" over active fishers are increasing with decreasing quotas. The mechanism intended to rectify this trend as well as to empower individuals who, through external circumstances, have not had access to a vessel despite their experience in this fishery, is the move towards a co-operative system under the SSFP. While more communal sharing of the costs of fishing is crucial to ensure the viability of small-scale operations under decreasing quotas, a transition to a co-operative system is likely to result in difficulties of its own, as discussed below and in Chapter 5.

3.4.1.3 The small-scale sector and the move towards co-operatives in the IRP sector

One of the ways of achieving more equitable access for small-scale fishers is the anticipated implementation of the SSFP, under which vessel costs would be carried more collectively.

The basic analysis of the figures as received by the Port Nolloth co-operative suggest that in their case the funds for covering annual costs associated with the vessels were far below the theoretical approximate amount needed for the maintenance of 9 vessels. However, given the fact that the season 2018/19 was the first season of the cooperative’s official existence, and the vessels were recently donated by the government it is likely that the costs of repair and maintenance for that season were not as high as the standard annual costs recorded by other vessel owners, and that in the coming seasons, once the co-operative builds their financial records, these allocations will be adjusted.

The hope that the government will supply vessels was expressed repeatedly by IRP individuals and the steep initial investment was given by many as the primary reason that they were not “active fishermen”. As more IRP communities are anticipated to be integrated into the small-scale fishing sector in the coming seasons, there needs to be careful consideration regarding the economically realistic numbers of vessels and how the different communities and zones can make the division of profits and the burden of costs most equitable. Factors affecting these considerations would likely include numbers of vessels that have to be maintained and operated, the catch per trip, division of running costs and the proportion of sea-going to individuals versus those who are not active in the fishery, for example, pensioners.

Co-operatives can have many advantages, as envisaged in the SSFP, but can also present opportunities for exploitation by savvy and connected individuals, who are often not the ones directly engaged in fishing (Schultz 2017). In interviews conducted for this study, many NC vessel owners reported feeling pressured to apply for rights under the small-scale co-operative lists but expressed strong reluctance as they largely believed that entering into a co-operative would expose them to being taken advantage of and losing their current comparable financial independence. It is important for management to engage with these "micro-politics" to ensure that this type of elite capture does not prosper under the new arrangements. A disjunct between "Bona Fide" fishers and their representatives (actors who engage with middlemen and government) was found in some communities interviewed, and also discussed in previous publications (Wentink et al. 2017; Isaacs 2015; Schultz 2017).

Internal politics and issues surrounding the verification process of quota applicants have been noted to complicate the implementation of the SSFP. Recently, this resulted in the Minister approaching the court to set aside and review the small-scale rights in the Western Cape due to the verification process to date, which was deemed inadequate und unjust by an internal audit launched in 2019 and delaying the implementation by at least another year [25]. While a change to a more co-operative setting is urgently needed, the verification process must be conducted with the highest accuracy, fairness and transparency possible.

3.4.2 Post-harvest considerations

3.4.2.1 PMC and sector interactions

In addition to varying quota sizes and different operational dynamics, gear and fishing areas, the sectors differ considerably in their relationship with the PMCs, responsible for post-harvest activities.

The quasi-hierarchical nature of the WCRL value chain was outlined in Wentink et al. (2017). Many PMCs are directly linked to or hold quotas in the OC sector, which is important to consider in regards to the price received per kilogram by such vertically integrated companies. The quantitative benefit of such an arrangement could not be determined specifically, but it could be a factor contributing to substantially higher prices received by some stakeholders. Another important consequence of such a dynamic is the control over quality that was remarked upon tentatively by

[25] https://www.gov.za/speeches/minister-barbara-creecy-asks-courts-review-small-scale-fishing-rights-process-western-cape# (accessed on 14.3.2021)

a number of IRP caretakers and some NC commercial fishers. In PMCs where the movement of an individual's catch is not tracked and handled transparently, there are suspicions that PMCs will "pool" the harvest and assign healthy and undamaged lobsters to their own or close associate's quota while attributing the lobster that is going to achieve lower prices (exported frozen or as tails) to quota holders from the IRP or NC sectors who have little recourse. Similar comments regarding the potential for abuse of power in such a dynamic were reported by previous researchers (Wentink et al. 2017; Isaacs 2015).

On the other hand, some PMCs preferred not to work with IRP quota holders, giving the generally poorer quality of lobster and the high administrative and organizational effort as the main reasons. Out of five PMC and export organizations consulted, only two worked with lobster from IRP quotas, with the first remarking that they only still engaged with the IRP sector, because 85% of the catch from the IRP communities that they contracted was landed by NC fishers, and the other PMC only worked with specific IRP communities under strict protocol conditions. In some cases, it was remarked that the PMCs were discontinuing, or considering to discontinue their agreements with NC fishers, as their diminishing quota sizes meant that increasingly large numbers of quota holders have been necessary to provide enough mass to run the PMC profitably. Higher numbers of individuals, increase the administrative cost significantly, and therefore decrease the profit margin. For one PMC, for example, NC fishers made up about 60% of the quota holders, but delivered just over 10% of the mass, creating a significant disjunct between the effort that the PMC expends in handling their affairs and the profit that they obtain from this sector. One of the effects of the exclusion of the smaller quota holders (IRP and NC) by the larger and more reputable PMCs, is that they are more exposed to predatory and unfavourable marketers and contracts. This is elaborated on in the section on "over-the-scale" prices.

3.4.2.2 Prices and options for raising the profitability of WCRL export

A way to mitigate the losses experienced as a consequence of the decreasing quotas would be to ensure higher prices received per kilogram of lobster. In the discussion around this issue, a clear distinction has to be made between two overarching categories for "prices". The first concerns the international market prices, which fluctuate over the season and are driven by demand and supply, the timing of similar markets, international events, such as the Chinese New Year, the reputation and standing of the exporter and lastly quality standards and consistency of the exported product. The second type of "price" to be discussed is the price paid out directly to a quota holder or fisher, and these, particularly in the IRP and NC sectors, can vary substantially and be influenced by many factors ranging from quality of the lobster, community dynamics to relations with and systems employed by the PMC and exporters (Wentink et al. 2017).

International market prices

The average international market price received in South Africa is pertinent to the economic future of the fishery. According to one interviewee with extensive knowledge of the fishery over decades, the price of South African caught lobster has decreased significantly relative to its sister species from New Zealand and Australia. While this may partly be due to the other nations' proximity to the Chinese market, making the transport more economic and less risky, it was stressed that the divided and poorly controlled market in South Africa, meant that the quality of the product was variable and unreliable, which had strongly contributed to the comparably decreasing prices.

Before the advent of democracy, there were six operations processing and exporting lobster nationwide, while at present there are around three times as many. The lack of unification within the marketing body was deemed by the expert to be a major reason for the lack of consistent export standards leading to decreased international market prices. According to different PMC related interviewees, the quality of the landing was overall significantly better within the OC sector than in the NC and IRP sectors, due to the vessels being larger, having more storage facilities, traps generally damaging the catch less than hoop nets and lastly as a result of more oversight and quality control. These factors play a significant role in both the price that an individual receives and for the fishery as a whole. While a lot of these factors are intrinsic to the sectors, the IRP and NC sectors might profit from directed and practical training and provision of support and gear that would allow them to harvest more safely and deliver higher quality lobsters with a better chance of live export (one interviewee from a PMC stated that in their case at present only around 55% of the IRP catch delivered to them can be exported live). It is hoped that the implementation of the SSFP will bring about greater unity and ownership of the resource by present IRP communities which in combination with handling training and support might help to ensure a higher standard quality of the harvest and enhance prices (Wentink et al. 2017). Within the planning of the implementation of the SSFP, it should remain a priority for the management of this fishery to ensure that sufficient resources are dedicated to providing ongoing training and assistance in the first years of the co-operative's existence.

Another factor pertinent to the average international market prices received is the timing of fishing operations. Due to the limitations of this study, the matter of the timing of fishing activities was only included in the weighting of average seasonal international market prices and GLM calculating the average catches per trip, but not quantitatively considered in a more detailed way. However, the decreasing length of the season, particularly over the winter months[26], was given as a key concern by several interviewees from the OC sector for decreasing the profitability of their operation. As indicated in the presentation of the annual developments of the market price given in Figure 3.2.5.3, and corroborated by anecdotes from many interviewees involved in post-harvest activities, the months around and including June to August generally achieve above-average market prices and are of high value to the OC sector. The closing of the season in most areas before June in the past years meant that OC fishers are restricted to harvesting in times of the years where the supply of WCRL or similar international species are abundant and sellers thus become "price takers". Ideally, the lobster will be held in the holding tanks for no longer than 7 days (as per one exporting company) to avoid damages and cannibalism, and after that every week adds risks of losses, meaning that it is undesirable for PMCs to "store" harvest until the market is more favourable. The timing of the season thus has a big impact on the economics of this fishery and, while ensuring that the strategy is coherent with the ecological and enforcement goals, could be worth considering by management as a way of enhancing the fisheries economic success.

One suggestion regarding the current timing of the season would be to maintain total allowable effort restrictions (TAE) by giving each vessel a certain number of sea days but to leave it up to

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[26]
2016/17 & 2017/18: https://www.gov.za/speeches/agriculture-forestry-and-fisheries-announces-201718-west-coast-rock-lobster-tac-and
2018/19 and 2019/20: https://www.daff.gov.za/docs/media/190926%20Media%20Statement%20TAC%20determined%20for%20the%202019-2020%20WCRL%20TAC%20Fishing%20Season.pdf
2019/2020: https://www.environment.gov.za/mediarelease/westcoastrocklobster_totalallowablecatch_recreationalfishingseason
2020/21: https://www.environment.gov.za/mediarelease/westcoastrocklobster_totalallowablecatch_recreationalfishingseason
(accessed on 14.3.2021)

each individual to determine when, over a longer season, they utilise these sea days. The three main issues with that suggestion given by an expert were that 1) the timing of the season is linked to important biological events for *J. lalandii* and catching at any point of the year could be adverse to recovery goals (Bergh 2015); 2) the shortened season curbs IUU fishing, as detection of illegal lobster when the season is closed is much easier (Burg 2017); and 3) restricting the TAE by sea days per vessel/quota holders would require a high level of ad hoc oversight and reliable documentation of individual parties, which, at present, might exceed the managements capacity (Cochrane et al. 2020). Bearing these counterarguments in mind, it might still be useful to further investigate a feasible and responsible way to give vessel owners a chance to engage in the market at a point that is more economically favourable for them.

Similar issues are pertinent to the IRP and nearshore sector, in that the timing of the season can differ substantially between super-areas/zones, affecting the prices received in different areas (Botha 2020). For the reasons given above this was not quantitatively addressed, but remains an important consideration for the management of the fishery. A system to counteract the effects of the different seasons' timings is the "pool-system" employed by one exporting company consulted, whereby the entire harvest of the quota holders contracted with this exporter is "pooled" and the market prices received for all catch exported by them over the season is equally divided between different quota holders, to ensure that those with less favourable seasons are not unduly economically penalized. While this system is unlikely to be applied across the entire fishery, it does provide an example of an attempt to equalize advantages and disadvantages across quota holders.

"Over-the-scale" prices

The prices received directly by individual fishers and quota holders can depend on a number of other factors. While the "over-the-scale" prices (referring to the net money obtained by a fisher or quota holder per kilogram of lobster) should, in theory, be proportional to international market prices, there is a substantial lack of transparency around the determination of the final prices paid out and can vary strongly between marketers and arrangements, as reported by interviewees and previous literature (Wentink et al. 2017).

The prices calculated in this study and used in the model are higher than the prices reported for IRP fishers of 180 – 270 R/kg given in a recent study (Jordan 2016) and prices of 160 – 180 R/kg reported for the period between 2013 and roughly 2016 (Wentink et al. 2017). However, both the trends of the export prices given in the results and the continuous depreciation of the rand have generally given South African export fisheries an advantage in the international market (Crosoer et al. 2006) and, likely, the prices received directly by quota holders would have reflected the upward trend.

Prices paid to quota holders and fishers directly were determined in different ways by the marketers, either in direct relation to the day's international market price or as a flat rate average, remaining the same across the season. The PMCs consulted in this study generally operated under a system where certain deductions were made from the international market price and the remaining funds were then paid to the quota holder (more information on this process can be found in Appendix 4). However, some quota holders and fishers from the IRP and NC sectors reported receiving a flat rate, or otherwise daily prices determined according to some undisclosed variables. The NC and IRP fishers are often very vulnerable to the marketers and often have little control over the prices received (Wentink et al. 2017). Some IRP interviewees reported incidents where marketers coerced individuals with little financial literacy to sign into unfavourable agreements, by pressure, deceit, or by getting them to sign "empty" contracts that were filled out post-hoc with the prices and conditions that the quota holders had no control over. Another mechanism by which marketers might tie IRP or NC quota holders into unfavourable agreements is by the process of "soft loans" given in the "dry" months before the start of the fishing season, a system common among global small-scale fisheries (Ruddle 2011; Johnson 2010). If not managed correctly and transparently, communities and individuals who enter into the loan system can find themselves in debt, leading individuals into increasingly vulnerable positions, as the marketer will often contract the debtor to 'sell' them next year's quota, often at reduced prices, to pay off their due, thus perpetuating cycles of debts. More information on this and the implications of this system can be found in Wentink et al. (2017).

Particularly in the communities where the entire quota was outsourced, the caretaker of the community often handled the transfer of the harvest and reception of the funds for the community's quota, while individual quota holders appeared to be largely unaware of the details of that transaction and the concrete prices that they were receiving per kilogram. This can lead to conflicts, as reported by interviewees, when the income anticipated by the community members and the final income received were at odds, leading to blaming between the parties, as caretakers insisted that the reason for this involved exploitation by the marketers or under-catching by those contracted with the harvest of the quota. "Elite capture" of fisheries resources is not rare (Isaacs 2011, Schultz 2017, Wentink et al. 2017) and increased transparency of transactions would certainly contribute positively to avoiding these disputes.

Interviewees, ranging from experts, management and caretakers expressed hope that the anticipated implementation of the SSFP would lead to higher prices for small-scale fishers, as quality could be ensured more consistently, and the collective would have greater bargaining power. Findings to this effect were documented in (Wentink et al. 2017), where the favourable and stabilizing effects of integration into the value chain of a conglomerate of co-operatives is outlined. But it is far too early to determine whether this desired result will be achieved.

Undercatching

For all sectors and through the three seasons studied the TAC was undercaught. It seems that with decreasing quotas an increasing portion of the quota would likely be caught, however, the numbers do not appear to support this with the three seasons studied showing only roughly 75- 90 % of the TAC caught per season in the two commercial sectors, and no trend associated with the decreasing TAC of 2018/19. This was a big issue of contention for IRP communities in regards to their offshore allocation as many claimed that more than half of their offshore quota remained in the sea, as the OC vessels contracted had not managed to harvest it all (although the official records suggest that at least 78 % of the IRP OQ was harvested). Reasons for the undercatch given by OC vessel owners included decreasing catches per trip, the shortened season, and fewer sea days due to bad weather during the season. The undercatch is certainly worth being investigated further, as fully utilizing the quota should contribute to enhancing the sectors' NSI.

Improving the overall international market price available to South African WCRL quota holders could present an important alleviation of financial losses under decreasing quota sizes, and the issues addressed are relevant to the implementation of differential management strategies and support systems aimed to achieve this. It is, however, of equal importance that the interactions between the marketers, caretakers and/or community/quota holder interactions are overseen, and that the transparency is increased, to allow greater insight to all concerned into the prices, reasons for prices, harvest quantities and loan repayments.

3.4.3. Summary and recommendations

The WCRL fishery continues to be a very valuable national asset with a large gross income from domestic exports over the three seasons examined here and providing employment and income to thousands of people. While many facets of this fishery and nuances in dynamics and mechanisms could not be directly addressed in this study as a result of the limited number of participants willing to engage and the large scope of this study, the findings provide a quantitative profile for the different sectors and some representative actors in this fishery. It is hoped that the points brought forward by this analysis will serve as a starting point for further studies into the fishery's economic and social parameters.

Given that the numbers of quota holders and quota sizes are not to change until the next FRAP, vessel owners likely cannot expect to receive higher proportional quotas and, given the state of the biomass, recovery efforts and resulting low global TACs will have to be maintained over the foreseeable future if the closure of the fishery and commercial extinction of the WCRL are to be avoided. Our analysis suggests that under the current low quotas, vessel owners are likely being harder hit than NVQs. Any further decreases would exacerbate this problem. Measures to address these trends could include research into ways to give vessel owners greater control over- or standardization of the catching fees, as well as increasing efforts and capacity for the speedy implementation of the SSFP. Workshops, training and extended assistance to IRP/small-scale communities and cooperatives could enhance their capacity to function effectively and increase the transparency of their affairs and exchanges while bringing about a more equitable division of operating costs between members of communities.

Further, management could investigate the ways to increase the international market price, through more training and oversight to increase the quality standards of landed catches and exports across the sectors and collecting of more information regarding the points in the value chain where assistance would be most needed and effective to increase the overall quality of the harvest (e.g., equipment, training, oversight). Reviewing the season times and lengths might be beneficial and possibilities for adjusting these or implementing an alternative system to control effort to allow access to better international market prices might be of value. Lastly, future research could further investigate the economic relationships between PMCs and fishers and ways to ensure that transactions are fair and equitable, through for example, incentives to reputable PMCs to enter into agreements with IRP and NC fishers and mechanisms to ensure agreements with marketers are transparent to all individuals. This might be achieved through technology that allows the tracking of the lobster along the value chain, such as that being used by Abalobi, to help improve the direct and live communication between buyers and sellers.

The economic trends of the fishery, the sectors and the different individuals that make up this fishery over the three seasons examined indicate important areas of success, weaknesses, complexity and conflicts of interest. This analysis is intended as a step towards developing a better understanding of the factors surrounding the economic existence of those in the fishery but many unanswered questions remain, requiring further study. Management must increase the focus and effort in quantifying and understanding the socio-economic characteristics of the fishery to be able to develop strategies that ensure optimised social and economic consequences of future decisions.

Chapter 4: Net present value for the WCRL fishery under different TAC management scenarios

This chapter explores the social and economic effects of three different TAC management scenarios from the season 2018/19 to the next fishing rights allocation process in 2030/31 for the different sectors and actors in the WCRL fishery. Given the precarious state of the WCRL resource at present management has had to reduce the fishing pressure for the foreseeable future to ensure ongoing recovery of the biomass. The lack of current information surrounding the human dimension of the sectors and actors in this fishery means, however, that the economic consequences and potential needs for mitigation cannot be quantified. This exploration of the NPV for the sectors and actors resulting from the different management decisions aims to address this gap.

The following different TAC management scenarios were explored:

1. Maintaining the global TAC at 1084 tonnes for the seasons until 2030/31
2. Increasing the global TAC to 1280 tonnes for the seasons until 2030/31
3. Decreasing the global TAC to 640 tonnes for the seasons until 2030/31

The three scenarios were calculated by MARAM (UCT) on behalf of the DEFF Rock Lobster Scientific Working Group to achieve different biomass recovery rates by 2025, in comparison to the "benchmark" estimated biomass of 2005. The TAC of 1084 t was estimated to produce a 7 % increase above the 2005 biomass by the 2025 season (Johnston and Butterworth 2018b). Further, the 1280 t and 640 t TAC scenarios were included in the 2019 updated projection by MARAM, and are calculated as leading to the recovery of the biomass to the benchmark median estimated biomass of 2005 by 2025 (1280 t TAC option), and a recovery halfway between reaching the 2005 median benchmark and the maximum recovery if all catches were to cease, i.e., a TAC of zero t (640 t TAC option). These TAC scenarios assume an illegal catch mass of 700 t per year, which is the higher of two poaching scenarios considered (Johnston and Butterworth 2019a).

These three TAC scenarios are considered by the WCRL scientific working group as potential management targets (MARAM pers. comm. 2019) and cover a wide range of the possible quota size and biomass recovery trajectories, making them useful for this study. It is important to note, that the recovery goals of all three of these scenarios are actually small, and the TAC options at present are designed to avoid further decline and encourage some biomass recovery while allowing the fishery to remain open. A typical 'safe' target for a fully but sustainably utilized resource would generally be between 25 and 50% of pristine (depending on the particular characteristics of the resource and fishery), which none of these targets will be able to reach within the projected timeframe.

4.1 Methods

4.1.1 Methods for calculating the net present value 2030/31

4.1.1.1 Net present value 2030/31 overview

The economic outcome for actors in the WCRL fishery as a consequence of the different TAC management scenarios was examined by comparing the net present value (NPV) achieved over the projection timeframe under the different TAC options. NPV is a standard measure in economics and allows researchers to assess monetary income at different points in time over the projected timeframe in a manner that makes them comparable to the present income, taking the delay in achieving them into account by means of the discount rate (Lallemand et al. 2016). These annual NPV values can be added for all seasons concerned to give the compound profit of different decisions made in the present.

The NPV for the projections was calculated according to Equation 4.1 for each of the sectors and entities outlined in Table 4.1.1:

$$NPV = \sum_{t=0}^{n} \frac{R_t}{(1+i)^t}$$

Eq. 4.1

Where: NPV= The net present value (R)

R_t= net cash flow in a given season (R/season) (using the NSI formula for each sector and quota holder category from Chapter 3.)

i = the social discount rate

t = the number of seasons (n)

R_t here designates the net seasonal income (NSI) calculated for each season (t) from 2018/19 to 2030/31 according to the equations given for each sector and quota holder category in Chapter 3. Since some of the variables are projected to change with each season the net seasonal profit was calculated for each season 2018/19 – 2030/31 separately to give the final NPV. Where the variable was not projected to change over the 13 seasons the same input variables as given in Chapter 3 were used in each season (Summaries of all variables can be found in Appendix 3). The social discount rate i used was the standard discount of 10% (Lallemand et al. 2016) and was assumed to be the same for the different sectors and entities. It is acknowledged that the perception of long-term investment reflected in the social discount rate is likely to be different in the different sectors, with research suggesting small-scale and artisanal fisheries often having substantially higher discount rates than well-established commercial fisheries (Teh et al. 2014). Given the limitations of this study, however, it was decided to maintain them at the same level in this study to facilitate comparability between the sectors.

The NPV was calculated for the sectors and individual actors as outlined in Table 4.1.1, and the Gross Present Value (GPV) was calculated for the total exports.

Table 4.1.1 Summary of the model outputs for the different sectors and actors for Chapter 4.

	Offshore commercial	Nearshore commercial	IRP		PMC & Export
Entire sector:					
	NPV 2030/31	NPV 2030/31	NPV 2030/31		GPV 2030/31 total gross profit from exports for all PMC combined
	Net income (R/year) for seasons 2018/19 and 2030/31	Net income (R/year) for seasons 2018/19 and 2030/31	Net income (R/year) for seasons 2018/19 and 2030/31		
Representative individual: vessel owning quota holders					
	NPV 2030/31 given a range of total catches, quota size and catch for others	NPV 2030/31 (per SA) Catching for self only	NPV 2030/31 (per zone) Catching for self only		
		NPV 2030/31 (per SA) catching for self + 2 other quota holders	NPV 2030/31 (per zone) catching for self + 5 other quota holders		
Non- vessel owning quota holders			NQ	OQ	
	NPV 2030/31 for the median, first and third quartiles for NVQ quota sizes	NPV 2030/31 (per SA)	NPV 2030/31 (per zone)	NPV 2030/31 (per zone)	
Vessel owners without their own quotas:					
	NPV 2030/31 for a range of total catches				

As for the NSP, the NPV was calculated using the Monte Carlo method with 5000 simulations, thus accounting for the uncertainty of the input variables. Each calculation was further submitted to a tornado sensitivity analysis to give insight into the relative contribution of the different variables to the variance of the final NPV values. Tornado analyses are one-way sensitivity tests for models, assessing the reactivity of the model's output to the defined variation of all the nominated input variables and are useful tools in assessing which input variables bear the greatest weight in determining the outcome (Borgonovo and Plischke 2016).

4.1.1.2 Input variables for the net present value 2030/31 calculations

To calculate the NPV at 2030/31 for the different sectors and actors within the sectors, the NSI equations given in Chapter 3 were repeated for each subsequent season within the projected timeframe. Variables given in these equations fall into three broad categories: variables that are projected to remain constant for each season and scenario in the projected timeframe, variables that change in response to the different TAC scenario, and variables that change each year either due to the different biomass trajectories or due to the depreciation of property over time (absolute depreciation cost) (Table 4.1.2).

It is recognized that in the time frame of these simulations inflation and changes in exchange rates as well as other shifts in the national economy are likely to affect the local costs and incomes. The way that these might change over the next 13 years is very difficult to predict and attempting to do so is beyond the scope of this project. Costs and incomes are therefore based on values and exchange rates at the time of this study, and assumed to remain unchanged.

Table 4.1.2 Summary of the input variables for the calculation of the NPV (2030/31) for the different sectors and actors, differentiated by their assumed response to the TAC management scenarios and the resulting different biomass recovery trajectories.

Variables staying the same for the projected timeframe and the TAC scenarios	Variables predicted to change with different TAC masses	Variables predicted to change seasonally over the projected time frame
• Catchability coefficient q		• Biomass
• Cost per fishing trip		• Catch per trip
• Depreciation rate		• Reduction in value of capital assets through depreciation
• Proportional quota sizes	• Absolute quota sizes	
• Annual and capital cost per vessel	• Number of vessels (NC & OC)	
• Percentage catching for self vs others (OC)	• Total catch per vessel (OC)	
• Proportion of global TAC that is exported	Absolute total mass exported	
• Number of quota holders (per sector & SA)		
• Market price, catching fee, crew fee		
• Social discount rate		

4.1.2 Input variables for the net present value 2030/31 calculations

4.1.2.1 Total catches and quota sizes

Unlike Chapter 3, where calculations could be done using the actual total masses caught by the different sectors (with the exemption of the IRP sector) actual total catches cannot be predicted for the future scenarios and it will therefore be assumed that each sector and each quota holder catches their entire allocated quota. Undercatching of quotas and TACs referred to in Chapter 3 is therefore assumed not to occur in the projections.

The proportions of the TAC allocated to the sectors and individuals are assumed to remain the same for the three scenarios as they were for the 2018/19 season.

To calculate the NPV for representative vessel owners in the offshore commercial sector it was necessary to determine the likely total catch for a single vessel under each of the scenarios. Analyses showed a linear relationship between total catches per vessel and the sector's TAC to be an adequate model (Equation 4.2).

$$Tct_{OC} = \alpha + \beta \, TAC_{OC} \qquad \text{Eq 4.2.}$$

Where Tct_{OC} is the total catch per vessels in the offshore commercial sector (kgs/vessel/season), α is the y-intercept, β is the slope and TAC_{OC} the TAC allocated to the OC sector (t).

4.1.2.2 Number of active vessels

Predicting the numbers of vessels that are likely to operate under the separate TAC management scenarios was done by inferring a linear relationship with the sector's TACs, which was found to be an adequate relationship (Equation 4.3):

$$nVs_{sect} = \alpha + \beta \, TAC_{sect} \qquad \text{Eq 4.3}$$

Where nVs_{sect} is the number of vessels active in a sector, α =the y-intercept, β = the slope and TAC_{sect} = the TAC allocated to the sector in question in a given scenario and season.

There was less available data regarding the numbers of vessels active in the IRP sector as elaborated in Chapter 3. For that reason and due to the fact that many vessels active in the IRP sector belong to NC quota holders, it was assumed that the numbers of vessels in the IRP sector show the same relationship to the TAC as vessels in the NC sector. Given the rate calculated for the NC sector and the total number of vessels that fished for IRP quota holders and the IRP TAC for 2017/18 as inputs, the numbers of vessels likely to be active in the IRP sector could be estimated under the different TAC scenarios.

4.1.2.3 Biomass projections

The biomass estimates for the past and the projections for the future were made by MARAM (UCT), and are constructed for the 1084 t TAC scenario using a variety of input variables such as recruitment, somatic growth indexes, poaching scenarios and future catch scenarios (Johnston and Butterworth 2018b). The two other TAC scenarios considered here (1280 t and 640t global TAC) were developed in 2019 using the same approach (Johnston and Butterworth 2019a). The biomass estimates for each year over the timeframe 2018/19- 2030/31 for these three TAC scenarios (for every super-area and the whole area) were obtained from MARAM (MARAM pers. comm. 2019).

4.1.2.4 Catchability coefficient q

A basic assumption in traditional fisheries theory defines the catch per unit effort at time t ($CPUE_t$) as the product of the available biomass of the target species (B_t) and the catchability coefficient (q), formula given in Equation 4.4 (FAO, fisheries concepts).

$$CPUE_t = B_t \times q$$

Eq. 4.4

Where $CPUE_t$ is the catch per unit effort, defined as the catch per trip (kgs/trip) for this study, B_t is the estimated biomass given by the MARAM forecasts (t) and q is the catchability coefficient (kg/t), a probability measure, ranging from 0 to 1, giving the probability of a single unit of fish (in this case one kg of rock lobster) being fished given one unit of available biomass, in this case one tonne. While it is acknowledged that "catchability" is an elusive parameter, that can be affected by a wide variety of fisheries specific characteristics (Arreguín-Sánchez 1996, Swain 2000), q is commonly treated as a constant, which is the approach taken for this study.

The q values for the different sectors and areas were calculated for the data from 2013/14 to 2018/19 by dividing the GLM calculated predicted mean catches (see section 3.2.1.3 and 3.2.2.3) by the estimated biomass for those seasons (from MARAM pers. comm. 2019). These q values for each sector (OC and NC) and each super-area in the case of the NC sector were then averaged over the seasons 2013/14-2018/19 (Equation 4.5).

$$\bar{q}_s = \frac{\sum_{i=1}^{n} \frac{\overline{Catr_{i\,s}}}{B_i}}{n}$$

Eq 4.5

Where $\bar{q}_s$ is the mean catchability coefficient for the seasons combined, $\overline{Catr_i}$ is defined as the predicted mean catch per trip (kgs) (section 3.2.1.3 and 3.2.2.3) for a given season, sector and super-area, B_i refers to the estimated biomass for a given season and super-area, and n designates the number of seasons for which catch per trip was available.

In combination with the biomass projections provided by MARAM, CPUE as the catch per trip for a given season and scenario could then be estimated using these catchability coefficients, according to equation 4.4.

4.1.2.5 The proportion of the global TAC that is exported

As explained in Chapter 3, the scope of this study did not permit an in-depth exploration of the costs and income associated with the post-harvest processes of this value chain. The average of the annual proportion of the TAC that was exported was calculated for the seasons 2016/17-2018/19 (DEFF export records 2019). Total export ($Texp$) (calculated as per equation 4.6) was then substituted in the equation calculating gross profit of post-harvest activities in Chapter 3.

$$Texp_{scen} = gTAC_{scen} \times Pexp$$

Eq 4.6.

Where $Texp_{scen}$ gives the total exported mass expected under a given management scenario, $gTAC_{scen}$ gives the global TAC mass under a given TAC scenario (tonnes) and $Pexp$ gives the average proportion of the TAC that is expected to be exported in a given season.

Gross present value for all WCRL exports over the timeframe 2018/19 – 2030/31 was then calculated according to Equation 4.7 using the average market price (weighted by mass exported per season and including discounts for the different types of exports) from the past three seasons (given in Chapter 3.) and the Total projected export ($Texp_{scen}$) expected under the different scenarios:

$$GPV_{Scen} = Texp_{scen} \times IntMpr$$

Eq 4.7.

4.1.2.6 Annual depreciation

Annual depreciation was calculated using a standard annual depreciation rate (Dpc) of 10% following equation 4.8.

$$Csdp_s = Cptc_{s-1} \times Dpc$$

Eq. 4.8

Where $Csdp_s$ is the annual depreciation cost per vessel per season (R/season), $Cptc_{s-1}$ is the capital value of the previous season (R) and Dpc is the depreciation rate (%/season).

4.1.2.7 Summary of variables that are not predicted to change in these models

The variables that were not predicted to change are listed in Table 4.1.2. Total numbers of quota holders were not projected to change, since these were finalized after the last round of appeals for the FRAP 2015 and are projected to remain largely unchanged until the expiration of the present fishing rights in 2030. However, while it can be expected that the proportion of the global TAC allocated to individuals or entire sectors will remain largely the same until FRAP 2030/31, the absolute quota size for an individual in the different sectors will change corresponding to the global TAC scenario.

Changes in the annual costs per vessel and the capital cost of assets are difficult to predict and doing so falls outside the scope of this project. Annual and capital costs per vessel are therefore assumed to remain the same irrespective of changes in TAC, quota or biomass. However, since changes in the total number of vessels per sector under different TAC scenarios can be anticipated, overall annual cost (for all vessels) for the entire sector models will accordingly respond to different TAC scenarios. While this model will assume the cost per trip to remain constant over the next 12 seasons for the reasons above, by virtue of the average catch per trip changing with the biomass, the cost for all trips per year will show some changes. There are no immediate indications that a change in the overall quantity of WCRL (through smaller or larger global TACs) will create a change in the demand for the lobster and thus substantially change the international market price obtained, as it has been pointed out that there are several other global markets capable of filling the gap and the international market does not respond directly to the South African supply (Consulted stakeholder, per comm 2019).

4.1.2.8 Sector specific variable calculations: SOLVER

For the different sectors some more specific calculations concerning minimum requirements for certain variables under the existing models were conducted using the SOLVER add-in in Excel. The values for which the equations were solved for in each sector are rough ballpark figures of what the individuals in those sectors suggested in interviews would be a satisfactory amount to be drawn from this fishery. As the exact amounts are loose approximations, they can only help to indicate general trends and point at problem areas in the economics of this fishery without attempting to make specific and exact recommendations. These were not executed in a stochastic manner, and thus only take the mean input variables into account. All SOLVER results are therefore subject to a lot of uncertainty that was not quantified and can therefore only be interpreted as rough estimations and general tendencies. The NPV 2030/31 equations used for the vessel owner models in the different sectors were thus solved for the following variables:

- Offshore commercial sector: minimum total catch necessary for the different vessel owner categories for a NPV 2030/31 of greater than R 2 million (roughly R256 000/year) and the maximum number of vessels that could theoretically sustain such a catch under the different TAC scenarios.
- Nearshore commercial sector: minimum individual quota for vessel owners for the NPV 2030/31 of greater than R 1 million (roughly R128 000/year) and maximum numbers of vessel owners being able to hold quotas of those sizes in the different super-areas and under the different TAC scenarios.
- IRP sector: Minimum number of quota holders that one vessel owner would have to catch for, for their NPV to be greater than R 390 000 (roughly R 50 000/year)

and average numbers of trips that would be needed, calculated both at the catch-per-trip estimated at 2018/19 and 2030/31 in the different zones and under the different TAC management scenarios.

4.2 Results Part 1: Input variables for net present value 2030/31 calculations

The variables that are assumed to remain stable over the projected timeframe given in Table 4.1.2 have been elaborated on and discussed in Chapter 3. and summaries of those variables can be found in Appendix 3. The following sections will explore only those variables that are expected to change under different TAC scenarios or over the projected timeframe.

4.2.1 Quota sizes and total catches

The percentage of the global TAC allocated to the sectors is assumed to remain the same as the proportions given in 2018/19 in the TAC allocations (DEFF TAC allocations 2019) (Table 4.2.1). The exact divisions between the sectors given by DEFF in personal communication differ slightly from the official release[27].

Table 4.2.1. Proportion of the global TAC allocated to the different sectors in 2018/19 (DEFF TAC records 2019) and the anticipated total size of the sector's quotas under the three TAC management scenarios (DEFF TAC allocations 2019).

	Proportion of global TAC in 2018/19	Anticipated quota for the sectors under the different global TAC scenarios (t)		
		640 t	**1084 t**	**1280 t**
Offshore commercial	0.5202	332.8	563.68	665.6
Nearshore commercial	0.1571	100.48	170.188	200.96
IRP + small-scale nearshore allocation	0.1571	100.48	170.188	200.96
IRP + small-scale offshore allocation	0.1299	83.2	140.92	166.4
Recreational fishing	0.0357	23.04	39.024	46.08

Individual quota sizes were calculated as proportions of the global TAC for the different groups or localities within the different sectors and are given in Table 4.2.2.

[27] https://www.gov.za/speeches/daff-announces-201819-west-coast-rock-lobster-total-allowable-catch-tac-and-recreational (accessed on 14.3.2021)

Table 4.2.2. Individual quota sizes as proportions of the global TAC and as absolute masses for A) offshore commercial sector quota holders (interquartile range for NVQ and VQ individuals), B) nearshore commercial quota holders, (differentiated by super-areas), C) IRP quota holders (differentiated by zone and the nearshore and offshore quota), and D) small-scale commercial co-operative quotas, differentiated by the co-operative and nearshore and offshore quota (Individual quota proportions sourced from DEFF landing records 2019).

	Quota as a proportion of global TAC in 2018/19	Anticipated individual quota sizes under the different global TAC scenarios (kgs)		
A) Offshore commercial sector		**640 t**	**1084 t**	**1280 t**
NVQ				
First Quartile:	0.00069	442.6	749.7	885.3
Median:	0.00108	691.2	1170.7	1382.4
Third Quartile	0.00153	981.8	1662.9	1963.6
VQ				
First Quartile:	0.00161	1029.7	1744.1	2059.4
Median:	0.00218	1393.6	2360.5	2787.2
Third Quartile	0.00312	1994.4	3378.1	3988.8
B) Nearshore commercial:				
Super-area				
1+2	0.000578	367.0	626.6	739.9
3+4	0.000212	135.6	229.7	271.2
5+6	0.001007	644.2	1091.1	1288.4
8+	0.000201	128.4	203.1	256.7
C) IRP sector				
Zone	Nearshore Quota			
B	0.00009 ±0.0 00023	57.7	97.7	115.4
C	0.00009± 0.000014	56.7	96.0	113.3
D+E	0.00002± 0.0000031	12.9	21.8	25.7
F	0.00004±0.0000061	26.8	45.3	53.5
Zone	Offshore Quota			
B	0.00003852 ±0.00000073	24.65	41.76	49.31
C	0.00004776 ± 0.00000641	30.57	51.78	61.14
D+E	0.00003998 ± 0.00000408	25.59	43.34	51.18
F	0.0000855 ± 0.00000734	54.72	92.68	109.44
D) Small-scale sector (nearshore quota)				
Port Nolloth	0.00839483	5372.7	9100.0	10745.4
Hondeklipbaai	0.00313653	2007.3	3400.0	4014.8
Small-scale sector (offshore quota)				
Port Nolloth	0.00404059	2586.0	4380.0	5172.0
Hondeklipbaai	0.00404059	2586.0	4380.0	5172.0

4.2.2 Total catch made per vessel in the offshore commercial sector

As noted in Chapter 3. there was a significant decrease in the total catch made by all vessels active in the OC sector between the seasons 2013/14 and 2018/19 (Kruskall and Wallis p- value: 0.0110. To reflect a range of individual vessel owners in the offshore sector, the analysis will be conducted on the interquartile range of total catches made by a single vessel over the seasons 2013/14 – 2018/19 (Figure 4.2.1).

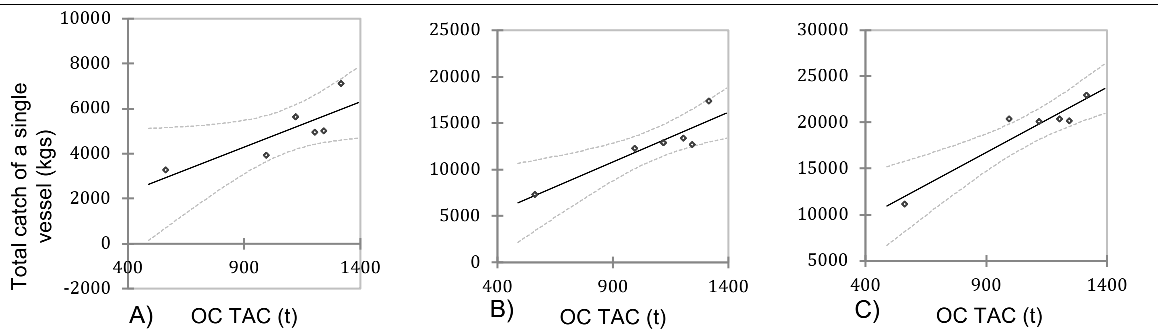

Figure 4.2.1. Regression of the total catch per vessel under the six different OC TAC scenarios of the seasons 2013/14-2018/19 for A) the vessels catching the first quartile size of catch per year (r^2=0.671), B) the vessels catching the median size of catch per year (r^2=0.832) and C) the vessels catching the third quartile size catch per year (r^2=0.896), giving the actual data points, the trendline for predicted catches (solid line) and the 95% Mean confidence interval (dotted line) (DEFF landing records 2019).

For the catches made at the first quartile, median and third quartile level of total catch of a single vessel to the OC TAC a linear fit was found to be suitable. ANOVA tests suggested that the linear regression provided a better estimation than a simple mean would (p- value: 0.046, 0.011 and 0.004 respectively). Using the regression equations, Table 4.2.3 gives approximations of the total catch per vessel that might be expected at the three catch levels under the three different TAC management scenarios.

Table 4.2.3. Anticipated interquartile range of total catch per vessel in the offshore commercial sector (kgs/season) under the three TAC management scenarios, and the equations used to calculate the anticipated catches using the OC TAC as the independent factor.

	Anticipated total catch per OC vessel (kgs/season) under the three TAC scenarios:				
	640 t	1084 t	1280 t	MSE	RMSE
First Quartile	3242.3	5030.7	5820.1	741048.347	860.842
Median	8040.0	12797.6	14897.9	2157452.083	1468.827
Third quartile	13087.4	19361.2	22130.7	2167152.360	1472.125

First Quartile

$$Tct_{OC\ Q1} = 664.41 + 4.028 \times TAC_{OC}$$

Median

$$Tct_{OC\ med} = 1182.22 + 10.715 \times TAC_{OC}$$

Third quartile

$$Tct_{OC\ Q3} = 4044.03 + 14.130 \times TAC_{OC}$$

4.2.3 Numbers of active vessels

4.2.3.1 Numbers of vessels in the offshore and nearshore commercial sectors

Linear fits were found to be suitable to describe the relationship between the TAC of the NC and OC sector to the number of vessels active between 2013/14 – 2018/19. The number of active vessels in the OC sector showed a strong relation to the OC TAC (r^2 =0.761), while in the NC sector, the numbers of active vessels in relation to the NC TAC showed a weaker but passable relationship (r^2 = 0.499) for the seasons 2013/14-2018/19 (Figure 4.2.2).

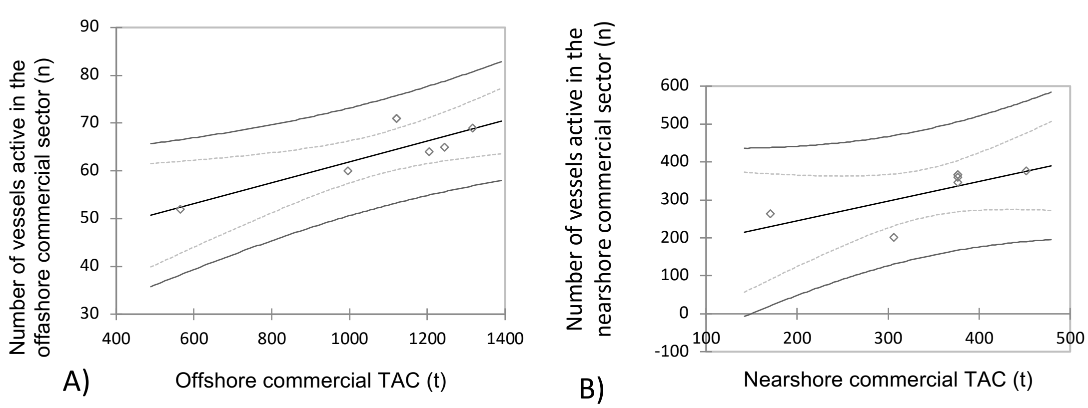

Figure 4.2.2. The linear relationship between the number of active vessels in a given year and the sectoral TAC (tonnes) for A) the offshore commercial sector (r^2 = 0.761) and B) the nearshore commercial sector (r^2 is 0.499) (solid black lines). Dotted lines: Confidence Interval (Mean 95%); grey lines: Confidence Interval (Observations 95%) for the seasons 2013/14 – 2018/19 (DEFF landing records 2019).

The number of vessels likely to be active under the three studied TAC management scenarios was estimated from the linear relationships (given in Table 4.2.4), with total vessels active in the OC sector likely to range from 47 to 55 vessels under the different TAC scenarios, and the number of vessels in the NC ranging from 193 to 246 vessels in the NC sector (Table 4.2.4).

Table 4.2.4. Approximations regarding the number of vessels (rounded to integers) likely to be active in the offshore and nearshore commercial WCRL fishing sector under the different TAC management scenarios, the mean squared error of the relationship and the equations used to calculate the anticipated numbers of vessels using the sectoral TAC as the independent factor.

Global TAC scenario (t)	Vessels active in the OC sector (n)	OC MSE	OC RMSE	Vessels active in the NC sector (n)	NC MSE	NC RMSE
640	47	13.950	3.73	193	3121.9	55.87
1084	52			230		
1280	55			246		
$nV_{OC} = 40.051 + (TAC_{OC} \times 0.0218)$				$nV_{NC} = 141.19 + (TAC_{NC} \times 0.519)$		

4.2.3.2 IRP numbers of vessels

The number of active IRP vessels was assumed to have the same relationship to the IRP TAC as the NC vessels had to the NC TAC (NC slope: 0.519) and to have included a total of 156 vessels active in the IRP sector under an IRP TAC 170.29 in 2018/19. Given these numbers Table 4.2.5 gives approximations regarding the likely number of vessels to be active under the different TAC management scenarios.

Table 4.2.5. Approximations regarding the number of vessels (rounded to integers) likely to be active in the WCRL IRP fishing sector under the different TAC management scenarios.

Global TAC scenario (t)	Vessels active in the IRP sector (n)
640	120
1084	156
1280	172
	$nV_{IRP\ OWN} = 67.6 + (TAC_{IRP} \times 0.0519)$

4.2.4 Biomass estimates for the different super-areas and the entire fishing area

The biomass projections for the seasons 2018/19-2030/31 obtained from MARAM anticipated under the global TAC scenarios of 640 t, 1084 t and 1280 t are illustrated in Figure 4.2.3. A8+ is the super-area with the largest overall biomass, and the recovery trend shows an unusual trajectory which is to a lesser effect reflected in the trajectories estimated for the entire fishing area (Figure 4.2.3). The reasons for this mini-peak and subsequent temporary decline include changes in local recruitment patterns in previous decades and are elaborated on in Johnston and Butterworth (2018a).

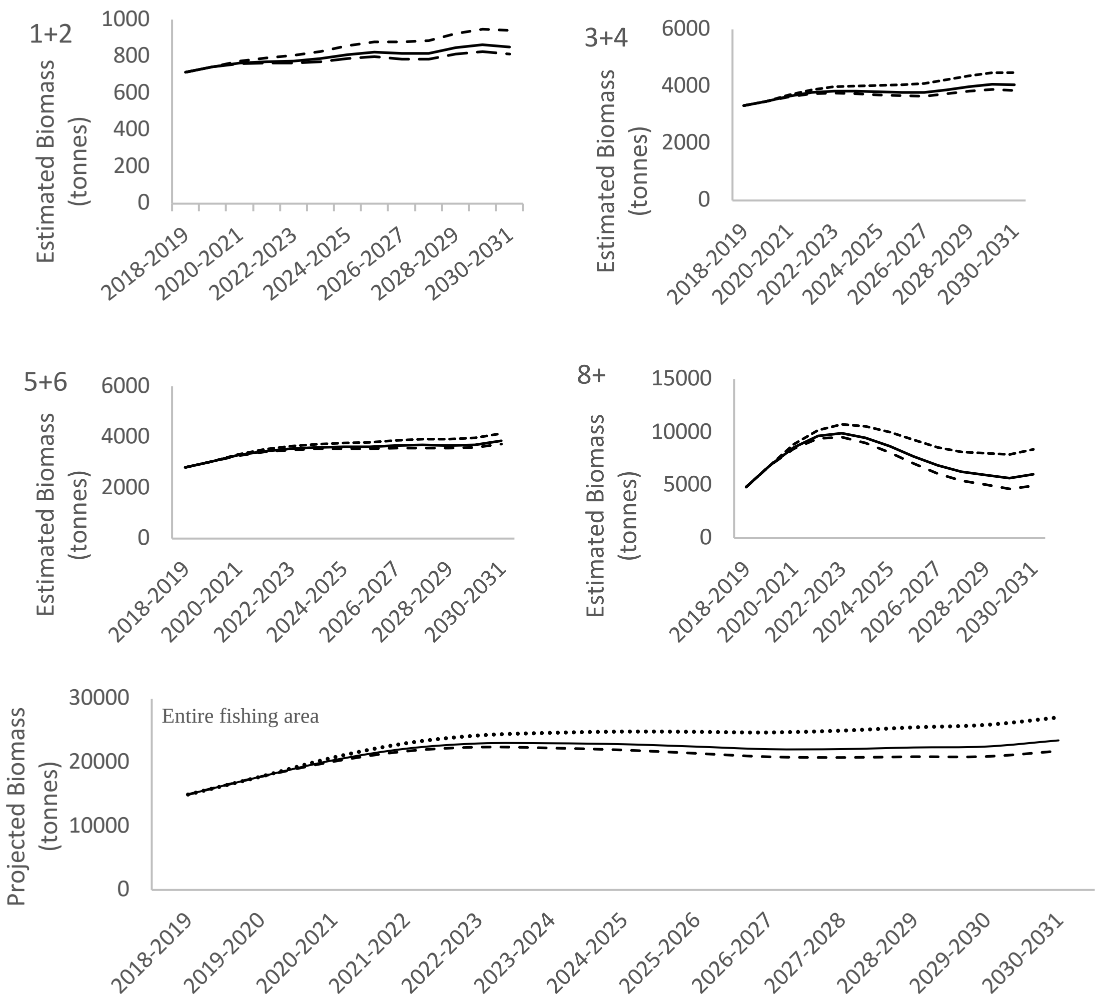

Figure 4.2.3. Estimated Biomass in the four super-areas fished by the NC fishers and the entire fishing area under the three different TAC scenarios for the seasons 2018/19-2030/31. (small dotted: 640 t TAC, solid line: 1084 t TAC, striped line: 1280 t TAC) (MARAM pers. comm. 2019).

According to the biomass projections illustrated in Figure 4.2.3, the recovery of the biomass under the three proposed global TAC scenarios will show different trajectories and rates in the different super-areas.

The biggest difference between the recovery of the estimated biomass as a result of the different TAC management scenarios is found in A8+ where the biomass under the 640 t TAC scenario is projected to increase by 3537.1 t (a 73.3 % increase), compared to a recovery of only 120 t (2.5% increase) under the 1280 t TAC scenario. The biomass in A1+2 is projected to show the smallest absolute rate of recovery with an increase of less than 300 tonnes (although this is an increase of 63.5 %) under the 640 t TAC scenario.

The biomass for all areas combined is estimated to increase from 14 974 tonnes (estimated for 2018/19) to 27 085.5 tonnes under the 640 t TAC management scenario, to 23 470.9 tonnes under the 1084 tonnes TAC management scenario and to 21 810.9 tonnes under the 1280 TAC management scenario, presenting a total increase of 12 112 tonnes, 8 497 tonnes and 6 837 tonnes (80.8%, 56.7% and 45% increase respectively).

4.2.5 Catchability coefficient q

4.2.5.1 Offshore catchability coefficient for all super-areas / zones combined

The average catchability coefficient calculated for the OC sector over the entire fishing area and the six seasons was 0.01715 ± 0.00299.

4.2.5.2 Nearshore (N, IRP and small-scale) Catchability coefficient for each super-area and the entire fishing area combined

The catchability coefficient calculated for nearshore fishers is highest in SA 5+6, while it is lowest in SA 3+4 followed by SA 8+ (Table 4.2.6). Since q for the entire areas is calculated using the sum of all biomasses and but still only the mean catch per trip from all trips, q is substantially lower for this category.

Table 4.2.6. Catchability coefficient q in the nearshore commercial sector, for the different super-areas and all areas combined.

Q (kg/t)	**A1+2**	**A3+4**	**A5+6**	**A8+**	**Entire area**
Average	0.038151	0.011671	0.040724	0.017896	0.003625
Standard Deviation	0.009571	0.005039	0.017457	0.005593	0.000876

4.2.6 PMC and exporter related projections

An average of the proportion of the global TAC that is exported across all sectors in the seasons 2016/17 – 2018/19 was calculated and was found to be 0.7056 ± 0.056. Using this average proportion, the export masses given in Table 4.2.7 were calculated for the different TAC management scenarios.

Table 4.2.7 The likely masses that will be exported per season under the three TAC management scenarios given the average proportion of export to TAC of 0.7056 ± 0.05.

TAC scenario	640 t	1084 t	1280 t
Anticipated total export (t)	451,58 t	764,87 t	903,1 t

The above anticipated total masses to be exported were then multiplied by the average price for the past three seasons (Table 3.2.5.3), weighted by the times of catching and the anticipated losses and prices discounts for different export categories (tails, frozen etc.).

4.2.7. Sector specific summaries

Sector specific summaries of input variables used for the Monte Carlo simulations calculating the NPV 2030/31 for the different sectors and actors can be found in Appendix 5.

4.3 Results Part 2: Net present value 2030/31 calculations

4.3.1 Net present value 2030/31 of the offshore commercial sector

4.3.1.1 Net present value 2030/31 of the entire offshore commercial sector

The NPV for the entire OC sector was positive for all three TAC management scenarios, ranging from a median of R 125 406 559 for the 640 t scenario to R 823 454 055 for the 1280 t scenario. The difference in NPV between the TAC scenarios 640 t and 1084 t is higher (almost five-fold) than that between the TAC scenarios 1084 t and 1280 t (around 1.3-fold) (Figure 4.3.1.1). The difference can be calculated as the NPV per kilogram of quota received over the 12 years of the projected timeframe: under the 640t TAC scenario the net value of each kilogram is only R 31 under the 640 t TAC scenario versus R 92,5 and R 103 for the 1084 t and 1280 t TAC scenarios. The results of the sensitivity analyses help to explain these differences.

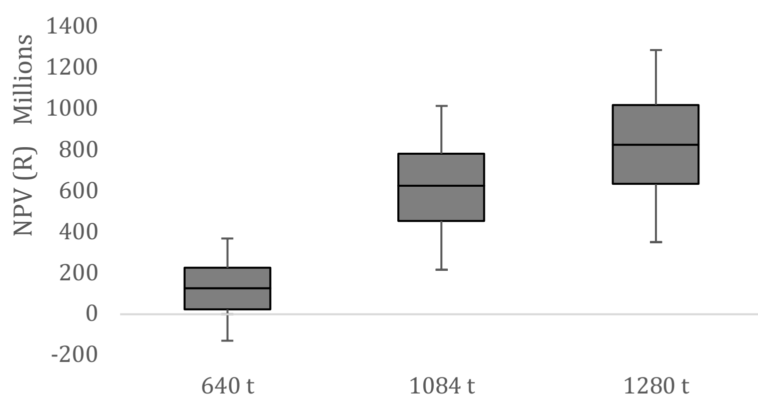

Figure 4.3.1.1 NPV 2030/31 of the entire offshore commercial sector for the three TAC management scenarios. Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the 5the and 95th percentage values.

The sensitivity analysis for these models (Figure 4.3.1.2) reveals that the largest contributor to the model's output is the net price received per kilogram. In the 640t TAC scenario, there is a much larger weight on influence of the total number of vessels than in the other two scenarios (13,36 % versus 5,36% and 4,13% for TAC 640 t, 1084 t and 1280 t respectively), indicating for the low TAC scenario the high number of vessels and the big costs they carry are disproportionate to available quota.

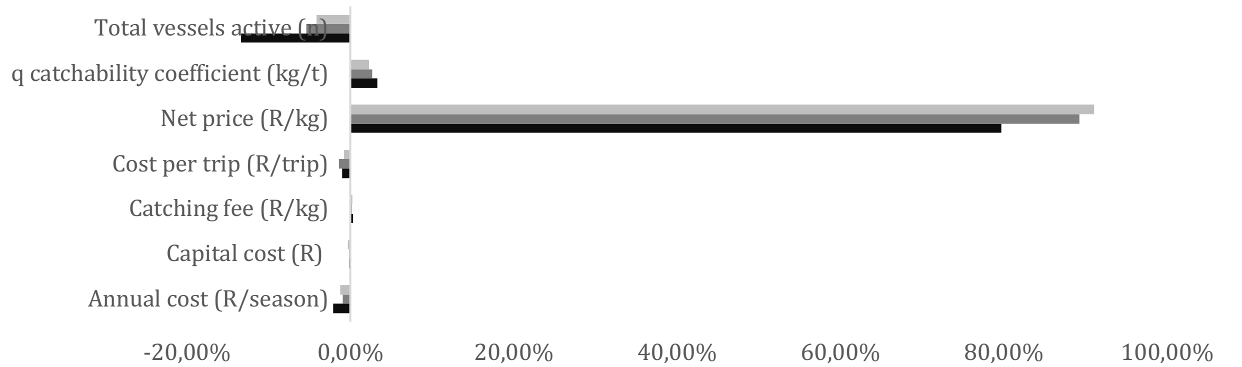

Figure 4.3.1.2. Tornado sensitivity chart for models calculating the NPV of the entire offshore commercial sector for the three TAC management scenarios of 640 t (black bars), 1084 t (medium grey bars) and 1280 t (light grey bars).

Using Solver, it could be calculated that for the entire OC sector to make a comparable R/kg net income (dividing the NPV by the total mass allocated to the sector for the timeframe considered) under the 640 t TAC as for the other two scenarios (an average of 100 R/kg net income over the projected timeframe) the number of vessels would have to be reduced to 29 vessels (18 vessels less than the number predicted to be fishing under that TAC scenario). This would yield a NPV value of R 399 513 731 for the 640 t TAC scenario.

4.3.1.2 Net present value 2030/31 of different actors in the offshore commercial sector

4.3.1.2 a) NPV 2030/31: Vessel owning quota holders

All vessel owners catching at the lower end (Q1) of total catches per season did not have a positive NPV over the projected timeframe under any of the TAC management scenarios. At the median and the third quartile of total catch ranges, under the 1084 t and the 1280 t TAC management scenarios the majority of VQ-CSs and VQ- 50/50s were projected to have positive NPV (Figure 4.3.1.3). VO-CO were not estimated to make a profit, at any of the catch sizes and under any of the global TAC scenarios. The sensitivity analysis for these vessel owners can be found in Appendix 6.1.

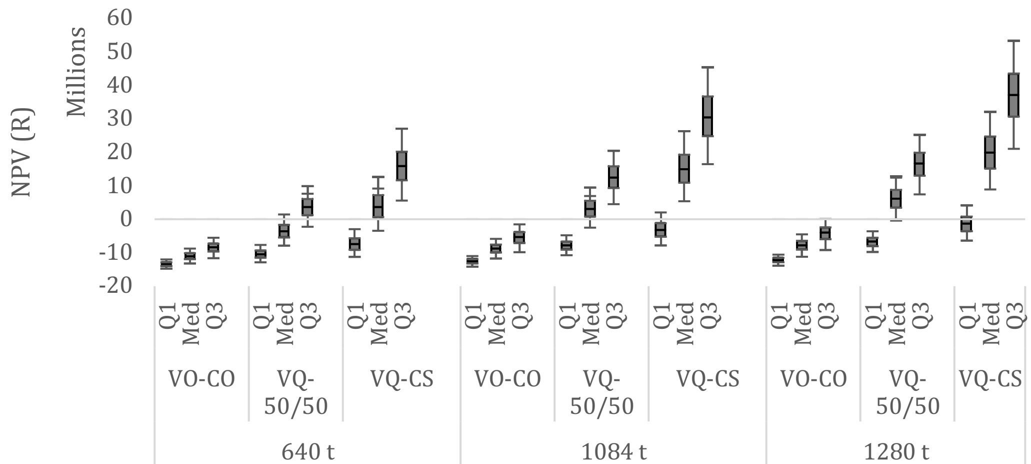

Figure 4.3.1.3. NPV 2030/31 results for representative vessel owners in the offshore commercial sector who are fishing a total mass at the first quartile, median and third quartile, for VO-CO, VQ 50/50s and VQ-CS. Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the 5the and 95[th] percentage values.

The extent of the increase in the NPV values with increasing TAC scenarios was highest for VQ-CSs, followed by VQ-50/50s and lastly for VO-CO. Table 4.3.1.1 gives approximations for total catches made by a vessel that would give the vessel owner an NPV of R 2 million, and the total number of vessels that could theoretically make such a catch under the different TAC management scenarios.

Table 4.3.1.1. Estimations regarding the average catch that an offshore commercial vessel would have to make in a season in order for the vessel owner to have an NPV of R 2 million (corresponding to an annual income of roughly R256 000 over the timeframe 2018/19-2030/31) for the three TAC scenarios, and for VQ-CS, VQ-50/50 and VO-CO. Further, the numbers of vessels that would be able to make a catch of that size under the different TAC scenarios are given, each calculation assuming that only those types of vessels remain in the sector.

	Total catch (kgs) a vessel would have to make for the vessel owner to achieve an NPV of R 2 million			Numbers of vessels that could be sustained under these minimum catch sizes under the different TAC scenarios (n)		
	VQ-CS	VQ-50/50	VO-CO	VQ-CS	VQ-50/50	VO-CO
640t TAC	7124.2	11733.2	33234.4	46.7	28.4	10.0
1084 t TAC	7145.4	11791.0	33702.3	78.9	47.8	16.7
1280 t TAC	7156.8	11821.9	33956.1	93.0	56.3	19.6

In the interpretation of Table 4.3.1.1. for the scenario where all vessel owners are VQ-CSs, and 47, 79 and 93 vessels can actively fish under the three TAC scenarios, it is important to keep in mind that it has been assumed that these vessel owners will all have a minimum quota of the same size as the estimated total catch required, and therefore the total number of quota holders would theoretically be restricted to the number of vessels that can actively fish.

Conversely, in the scenario where vessel owners catch half their own and half someone else's quota, they would each need a quota that is at least half their minimum catch (around 5 500 kgs), however the rest of the total OC quota could theoretically be divided by an unrestrained number of quota holders that don't own a vessel. The scenario that assumes all vessel owners are VO-COs and have an NPV of 2 million (Table 4.3.1.1) would allow the smallest comparable number of vessels to remain in the fishery (10, 17 and 20 for the 640 t, 1084 t and 1280 t TAC scenarios), while the total OC quota could be split among as many NVQs as is desirable.

These cases serve only as broad approximations for any real-life situation, which involves all three types of vessel owners, however, the numbers given can be useful example and indicate important trends.

4.3.1.2 b) NPV 2030/31: Non-vessel owning quota holders

Since both the income and costs (catching fee) for NVQs are calculated on a per kilogram basis, the increase in the NPV over the three TAC management scenarios was directly proportional to the increase in quota sizes (Figure 4.3.1.4).

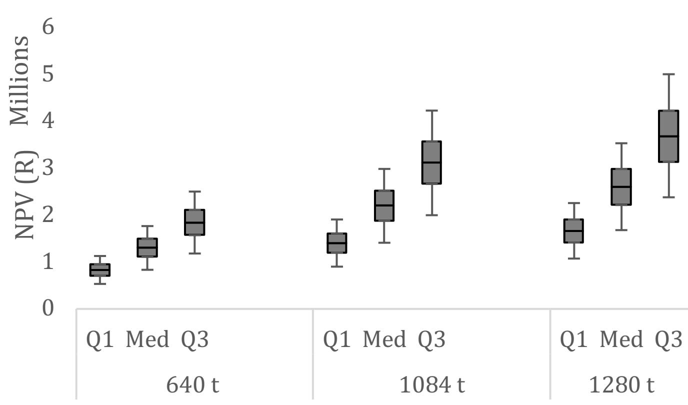

Figure 4.3.1.4. NPV 2030/31 for NVQs in the offshore commercial sector with quota sizes at the first quartile, median and third quartile of sizes. Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the 5the and 95th percentage values.

4.3.2 Net present value 2030/31 of the nearshore commercial sector

4.3.2.1 Net present value 2030/31 of the entire nearshore commercial sector

The median NPV calculated for the nearshore commercial sector ranged from R 180 892 385 (Scenario 1, 640 t scenario) to R 463 876 117 (Scenario 2 for the 1280 t TAC scenario) (Figure 4.3.2.1). The difference in NPV between the 640t TAC and the 1084 t TAC was proportionally similar to the difference between the 1084 t TAC and the 1280 t TAC, as shown by the net present value per kilogram of quota obtained for the three management scenarios over the projection timeframe showing only a slight increase in overall value under the more generous TAC scenarios (under Scenario 1 ranging from R150 R/kg (640 t TAC) to 157 R/kg (1280 t TAC)).

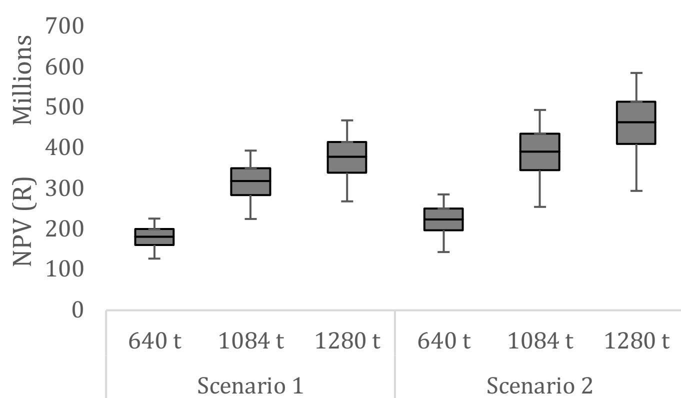

Figure 4.3.2.1. NPV 2030/31 for the entire nearshore commercial sector for the three TAC management scenarios, and sector Scenario 1 (nearshore fishers catching only their own quota) and Scenario 2 (80% of the IRP quota is outsourced and caught by the nearshore commercial sector). Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the 5the and 95th percentage values.

The tornado sensitivity analysis indicated that the variables differed in their contribution to the model's output between the two scenarios considered (Figure 4.3.2.2). The net price received by quota holders contributed almost twice as much to the results in Scenario 1 as to those in Scenario 2, while the catching fee only featured significantly in the calculations for Scenario 2, and the importance of catch per trip increased by almost double for that Scenario. These changes attest to the increased effort expended in trips for the catching fee alone to catch 80% of the IRP quota.

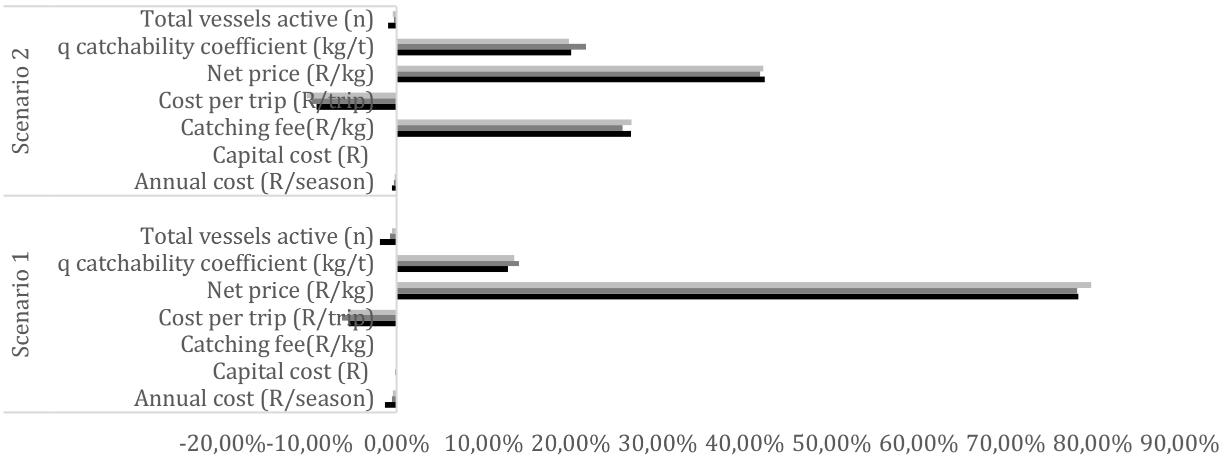

Figure 4.3.2.2. Tornado sensitivity chart for models calculating the NPV of the entire nearshore commercial sector of the WCRL fishery for the two scenarios and the three TAC management scenarios of 640 t (black bars), 1084 t (medium grey bars) and 1280 t (light grey bars).

As in the OC sector, the numbers of vessels and annual cost per vessel contributed more to the NPV ranges under the 640 t TAC scenario than under the two higher scenarios indicating that the projected rate of decrease in vessels in disproportional to the decrease in TAC.

4.3.2.2 Net present value 2030/31 of different actors in the nearshore commercial sector

4.3.2.2 a) NPV 2030/31: Vessel owning quota holders

The NPV for vessel owners in the nearshore commercial sector varies strongly between the super-areas and the different TAC management scenarios (Figure 4.3.2.3). Under the 640 t TAC scenario, VQ-CS in 3+4 and 8+ were estimated to have a negative NPV value for the timeframe 2018/19 – 2030/31. The highest NPV was achieved by VQ+2s in A5+6 for all three TAC management scenarios.

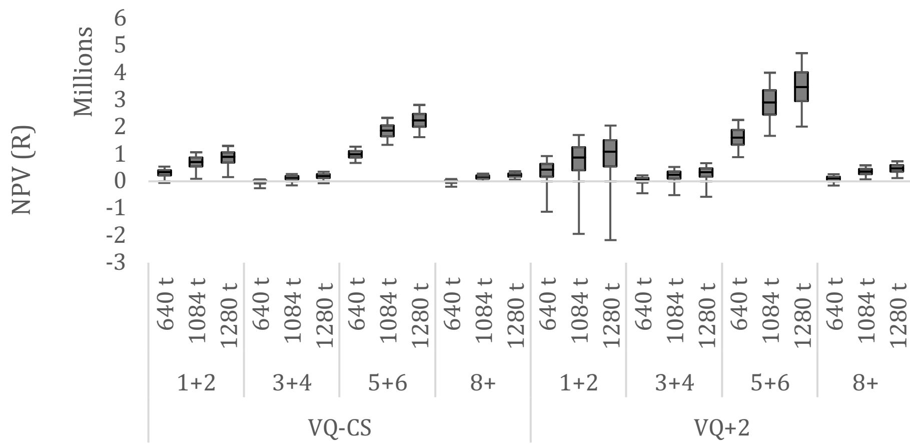

Figure 4.3.2.3 NPV 2030/31 for representative individuals in the nearshore commercial sector for A1+2, A3+4, A5+6 and A8+, vessel owners catching only their own quota (VQ-CS) and vessel owners catching their own quota plus that of two other quota holders in the super-area (VQ+2) for the three different TAC management scenarios. Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the 5the and 95th percentage values.

There is much higher uncertainty around the NPV 2030/31 for VQ+2s than for VQ-CSs, especially for those in A1+2 and A3+4. One reason for this can be found in the small catch sizes in those areas and the standard deviation around the mean q values explored in Figure 3.3.4.1. The likelihood of catches per trip falling below the minimum threshold for meeting the trip costs thus resulted in a higher probability of trips in these areas being net losses (particularly when catching for other quota holders), thus widening the range of NPV values. The sensitivity analysis demonstrates the importance of the catchability coefficient for those two super-areas under the VQ+2 scenario (Appendix 6.2).

Table 4.3.2.1 explores some of these dynamics more concretely, by estimating the minimum quota sizes that a vessel owner would have to have in the different super-areas under the different TAC management scenarios (assuming the mean value for all input variables) to only catch their own quota and have an NPV of R 1 million (which gives them an annual income of roughly R128 000 from this fishery for the projected timeframe).

Table 4.3.2.1. Solver calculated minimum quota sizes for vessel owners in the Nearshore sector to have a NPV of R 1 million for the projected timeframe and the numbers of quota holders that could hold a quota of that size in the different super-areas (assuming current sector and area splits of the TAC) and under the different TAC management scenarios, giving the number of quota holders in 2018/19 as a comparison.

		640 t TAC	1084 t TAC	1280 t TAC	2018/19 numbers
A1+2	Minimum Quota	775.3	783.7	787.9	
	Number of quota holders	9.5	16.0	18.8	20
A3+4	Minimum Quota	715.3	720.3	722.7	
	Number of quota holders	19.0	31.9	37.5	100
A5+6	Minimum Quota	640.9	641.8	642.2	
	Number of quota holders	37.2	62.9	74.2	37
A8+	Minimum Quota	640.6	644.3	646.8	
	Number of quota holders	87.1	146.7	172.6	435

Table 4.3.2.1 demonstrates that even by taking the different costs into account NC vessel owners in A1+2 and A3+4 would require a larger (by around 80 – 140 kgs) individual quota than vessel owners in A5+6 or A8+. While the minimum quota does not change substantially with increased catches (being only slightly lower under the lower TAC management scenarios due to slightly decreased total trip costs), the numbers of quota holders that could hold such a quota in each super-area responds strongly to the TAC scenarios, and are substantially lower than the current number of quota holders in A3+4 and A8+, while being similar (albeit slightly lower) in A1+2 and actually higher than current numbers in A5+6 under the 1084 t and 1280 t TAC scenarios.

4.3.2.2 b) NPV 2030/31: Non-vessel owning quota holders

The increase in the NPV for representative individuals over the three TAC management scenarios was proportional to the increase in quota sizes (Figure 4.3.2.4).

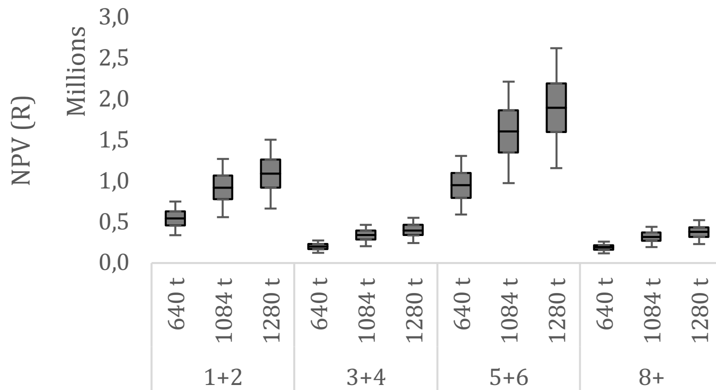

Figure 4.3.2.4. NPV 2030/31of quota holders without vessels in the nearshore commercial sector for A1+2, A3+4, A5+6 and A8+ for the three different TAC management scenarios. Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the 5the and 95th percentage values.

Across most super-areas, the NPV calculated for NVQs was higher than for VQs and VQ+2, with the only exception being A5+6 where both VQ and VQ+2 individuals achieved higher NPVs than NVQs under all three TAC management scenarios and for VQ+2s in A8+ under the two higher global TAC management scenarios.

4.3.3 Net present value 2030/31 of the IRP sector

4.3.3.1 Net present value 2030/31 of the entire IRP sector

The IRP NPV, combining the nearshore and offshore allocations, for 640 t total TAC was the highest of the three main sectors with a median of R 299 034 830 and R 281 610 954 for Scenarios 1 and 2 respectively (Figure 4.3.3.1), and under all three TAC management scenarios the IRP is estimated to have a higher NPV than the NC sector. While this is counterintuitive given the lower prices received per kg by the IRP and NC sectors and the high cost of fishing per kg, the reasons for this will be considered in the discussion. The highest overall NPV for the IRP sector was found for the 1280 t TAC option under Scenario 1 at R 618 606 166 (Figure 4.3.3.1). The net value for each kilogram of sectoral TAC was highest in this sector, and value increased with increasing TAC scenarios (although less strongly than in the other two sectors (under Scenario 1 ranging from 135 R/kg (640 t TAC) to 140 R/kg (1280 t TAC)).

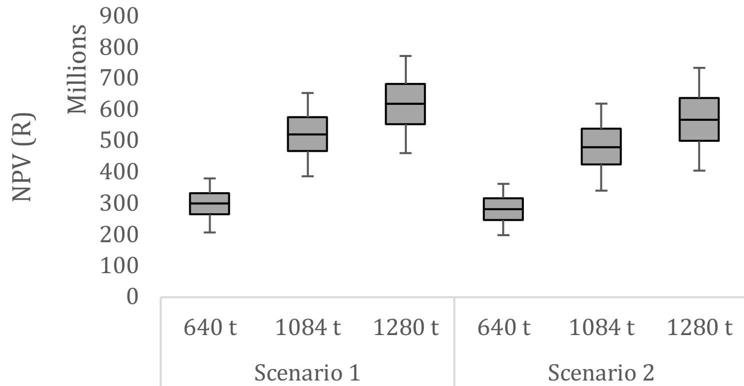

Figure 4.3.3.1. NPV 2030/31 for the entire IRP sector for three TAC management scenarios and sector Scenario 1 (IRP catching their entire nearshore allocation themselves) and Scenario 2 (80% of the IRP nearshore allocation is outsourced to the nearshore commercial sector) and including the income from the offshore allocation (all caught by offshore commercial vessels). Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the 5the and 95th percentage values.

The tornado sensitivity analysis (Figure 4.3.3.2) for the IRP sector shows that while the second largest contributor to the model's output under Scenario 1 was the number of active vessels, under Scenario 2 it was the catching fee as in this Scenario the majority of the catch is made by vessels from outside the sector.

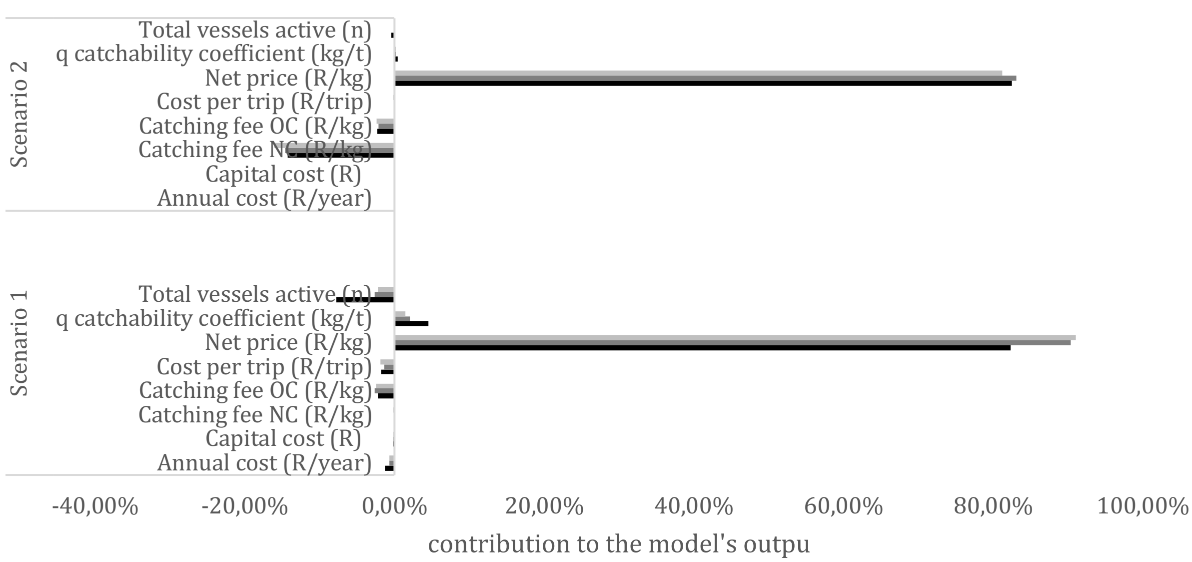

Figure 4.3.3.2. Tornado sensitivity chart for models calculating the NPV of the entire IRP sector of the WCRL fishery for the two scenarios and the three TAC management scenarios of 640 t (black bars), 1084 t (Medium grey bars) and 1280 t (light grey bars).

4.3.3.2 Net present value 2030/31 of different actors in the IRP

4.3.3.2 a) NPV 2030/31: Vessel owning quota holders (nearshore sectoral TAC)

Vessel owners in the IRP sector can only fish for the nearshore quota, as the offshore quota can only be accessed and harvested by offshore vessels, who have to be contracted. Any calculations regarding the vessel owners therefore only applies to the nearshore allocation, while all IRP individuals are treated as NVQs for the offshore allocation.

The analysis suggests that fishing operations will not be profitable for any vessel owner catching for 5 individuals or less under the 640 t TAC scenario (Figure 4.3.3.3). Further, it shows that the NPV is negative for all vessel owners catching for 5 other individuals or less in the Zones D, E and F under all TAC management scenarios. Lastly, the NPV for VQ-CSs is projected to be negative under all TAC management scenarios and in all active IRP zones.

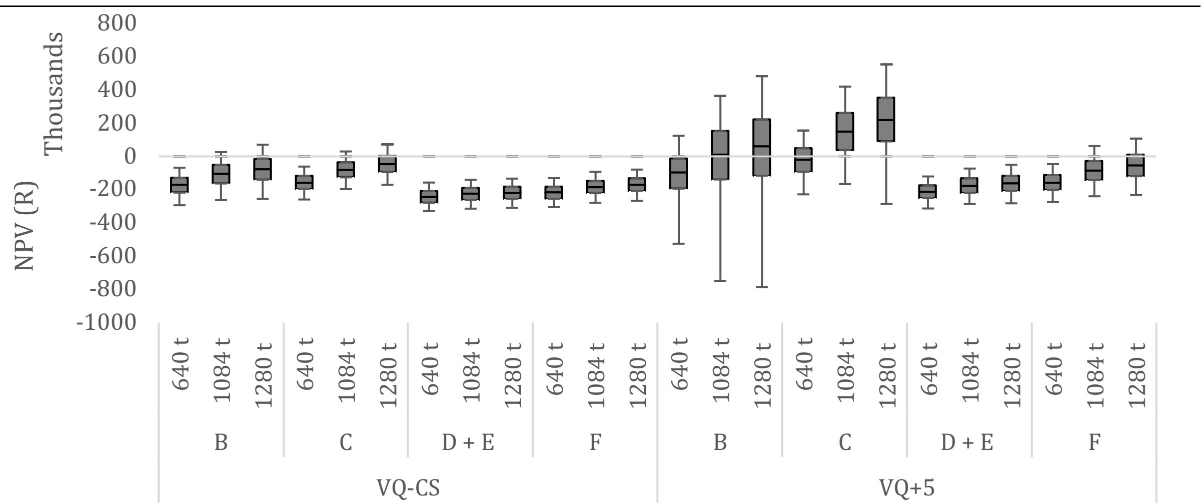

Figure 4.3.3.3. NPV 2030/31 for representative individuals in the IRP sector for the different zones (B, C, D+E and F), vessel owners only catching their own quota (CQ-CS) and vessel owners catching their own quota plus that of 5 other people from their zones (VQ+5) for the three different TAC management scenarios. Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the 5the and 95th percentage values.

The evident discrepancy between the overall economic success of the IRP sector as a whole and the overwhelming losses found for individual vessel owners can be explained by two factors: firstly, the IRP sector is projected to employ few (in comparison with the NC sector) and cheap (in comparison with the OC sector) vessels, thus experiencing little annual costs. However, while these costs are relatively small in comparison with the entire sector's income, they are large in comparison with an individual's income given the small individual nearshore quotas. Secondly, the proportion of numbers of vessels owners to numbers of NVQ in this sector is much smaller than either of the other sectors (particularly under Scenario 2). Annual cost was generally found to be by far the highest contributor to the results for individual vessel owners (Appendix 6.3).

Using Solver, the numbers of other quota holders that a VQ would have to catch for under the different TAC scenarios for their NPV to be R 390 000 (which corresponds to an average annual profit of R 50 000) were calculated, assuming the mean values for all other variables (Table 4.3.3.1).

Table 4.3.3.1. Numbers of IRP quota holders that an IRP vessel owner would have to catch for (in addition to their own quota) to have a NPV of R 390 000 in this fishery, and the number of trips that this would entail (for the biomass in 2018/19 and the biomass in 2030/31) under each of the TAC management scenarios.

Zone		640	1084	1280
B	Number of people to be caught for	32.3	17.4	14.1
	Total mass that would have to be caught (kgs)	1919,9	1796,2	1742,0
	Number of trips necessary (2018)	49.5	46.3	44.9
	Number of trips necessary (2030)	36.7	38.1	38.7
C	Number of people to be caught for	18.7	9.5	7.5
	Total mass that would have to be caught (kgs)	1134,7	1024,4	979,2
	Number of trips necessary (2018)	9.9	9.0	8.6
	Number of trips necessary (2030)	6.7	6.5	6.5
D & E	Number of people to be caught for	97.9	57.5	48.8
	Total mass that would have to be caught (kgs)	1265,4	1268,3	1275,9
	Number of trips necessary (2018)	14.7	14.7	14.8
	Number of trips necessary (2030)	8.5	11.8	14.4
F	Number of people to be caught for	47.0	26.8	22.4
	Total mass that would have to be caught (kgs)	1228,0	1203,6	1198,4
	Number of trips necessary (2018)	14.2	13.9	13.9
	Number of trips necessary (2030)	8.2	11.2	13.6

Table 4.3.3.1 indicates that a vessel owner aiming for an NPV of R 390 000 would have to catch for substantially more people under the 640 t TAC management scenario, than under the 1280 t TAC management scenario, while the numbers of trips change proportionally less.

Given the median community size of around 41 individuals, the economics of owning a vessel suggest that a single vessel owner would have to catch for around two communities in Zone D or E to make an income of R 50 000 annually under the 640 t TAC management scenario, and both Zone B and Zone F would predominantly have only room for one vessel per average community under that TAC management scenario. The numbers of trips that that one vessel owner would have to undertake in order to get the total catch of those combined quotas, is further important to consider, as it is, for example, unlikely for an IRP vessel owner in Zone B to succeed in making the necessary number of trips in a season, estimated at between 37 – 50, given the length of the season and days with appropriate weather conditions. The number of trips calculated to be necessary to make the total catch responds to the different biomass recovery rates under the different TAC scenarios, with the decrease in number of necessary trips being highest under the 640 t TAC scenario.

The total annual catches that would have to be made, however, vary only slightly between the three TAC scenarios, indicating that the decrease in total trip costs with the recovery of the biomass would only slightly affect the overall profitability and would necessitate a similar allowance.

The above scenario only considers vessel owners who catch for themselves and others, as this is the most advocated for model in the IRP sector. Vessel owners could, in principle, include communities, which is likely to become more common in cooperatives under the small-scale fisheries policy. For VQ-CS, see the minimum size of quotas in section 4.3.2, for nearshore commercial vessel owners, as the two models assume the same cost and catch input data.

The above are examples based on broad generalizations, but reveal important issues to consider at a management level.

4.3.3.2 b) NPV 2030/31: Non-vessel owning quota holders (nearshore and offshore sectoral TAC)

NVQs in the IRP sector, while also showing very variable NPV results depending on locality, are estimated to have a NQ NPV ranging from a median of R 18 527 (Zone DE) to R 83 663 (Zone C) under the 640 t TAC scenario, a median NPV between R 32 380 (Zone DE) and R 141 704 (Zone C) under the 1084 t TAC scenario, and a median NPV between R 36 054 (Zone DE) and R 167 326 (Zone DE) under the 1280 t TAC scenario (Figure 4.3.3.4).

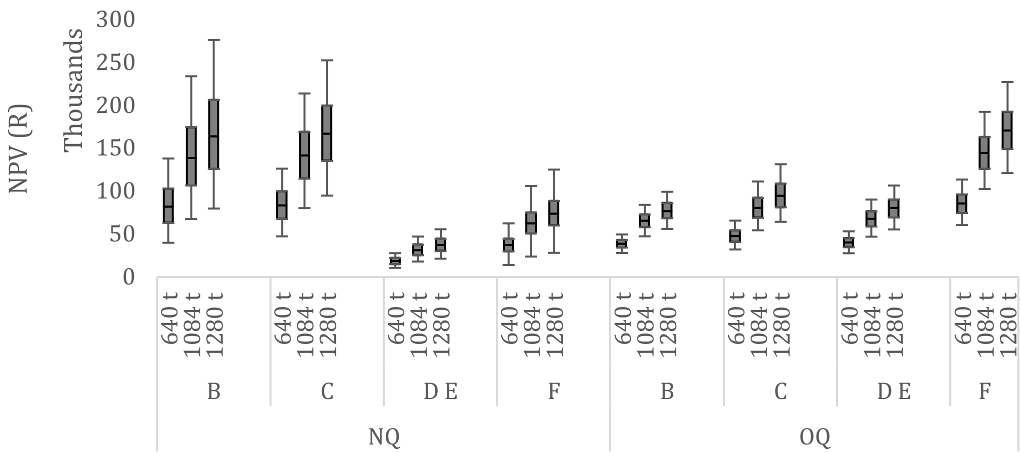

Figure 4.3.3.4. NPV 2030/31 for NVQs in the IRP sector for the different zones (B, C, D+E and F), whose nearshore quota (NQ) and offshore quota (OQ) is caught by someone else for the three different TAC management scenarios. Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the 5the and 95th percentage values.

Overall, those individuals who outsource the catching of their quota generally have a higher NPV than individuals who own a vessel under the three TAC conditions, assuming the vessel owners are catching for themselves and a maximum of 5 other quota holders. The only instances where a VQ+5 can expect a higher NPV 2030/31 than individuals without vessels is in the case of Zone C under TAC management scenarios 1084 t and 1280 t global TAC.

4.3.4 Gross present value 2030/31 of the entire fishery

The Gross Present Value of the entire fishery is estimated to range from a median of R 1 663 651 502 under the 640 t TAC option to R 3 327 303 004 under the 1280 t TAC option. The increase in the median NPV between the 1084 t TAC and the 1280 t TAC scenario is R

581 541 710 while the increase between the median TAC between the 640 t TAC and the 1084 t TAC is R 1 317 369 996,98 (Figure 4.3.4.1).

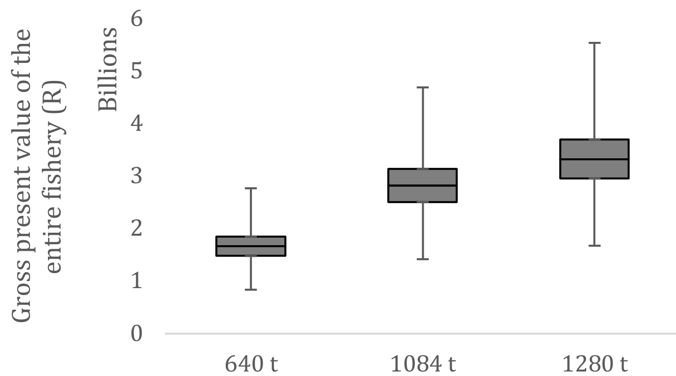

Figure 4.3.4.1. The gross present value of the WCRL exports of the time frame of 2018/19- 2030/31. Horizontal lines indicate medians, boxes give the interquartile range and error bars indicate the 5the and 95th percentage values.

4.4 Discussion

4.4.1 Discussion and comparisons of the net present value of the sectors and actors

The overall patterns found in Chapter 3 are reflected in the trends found in the NPV 2030/31. The recovery of the biomass under the lower TAC scenario appears to affect the profitability of different operations only slightly, within the time frame considered. If the TAC is to be kept at those levels it would therefore be important for the governing authority to mitigate the economic losses through other avenues. The three scenarios explored are only meant to achieve a moderate recovery, and even the 640 t TAC scenario will not allow the biomass to recover to a level recommended for a sustainable and fully utilizable fishery by the end of the timeframe considered here (Johnston and Butterworth 2019b). These options, while precluding any further decline (if IUU fishing does not increase drastically), therefore represent urgent measures to avoid the commercial collapse and necessary closure of the fishery rather than options designed to be favourable to the economics of the fishery in the medium-term.

Offshore commercial sector

The OC sector is forecast to have a lower NPV under the 640 t TAC than the NC and the IRP sectors for that scenario, despite having a substantially higher absolute quota. The sensitivity analysis suggests that this is due to the disproportionate contribution of the total number of vessels in that scenario. According to this analysis, with everything else staying the same, only around 29 vessels (instead of the 47 vessels projected for that scenario) could catch in this TAC scenario while maintaining a similar net income per kilogram as in the other two scenarios. However, the relationship between vessels and TAC used for the projections was based on the number of vessels active over the past six seasons, where the OC sector's TAC experienced its strongest reduction only in the season 2018/19, suggesting that the projections might reflect a delay in an "adaptive" decrease in vessels.

The analysis suggests that final numbers of vessels that can make "sustainable" profits in the fishery (NPV = R 2 million) would depend on the dynamics of the sector. If all vessel owners were only VQ-CSs, this would allow the largest number of vessels to remain active, but would require all those vessel owners to have quotas matching their total catch, which is an unlikely option. Applying the other vessel owner scenarios, (i.e., VQ-50/50 and VO-CO) would reduce the number of viable vessels that could be operated under the different TAC management scenarios, but allow a larger number of NVQs to remain in the sector. Under the presented TAC scenarios, it is a comfortable existence to be a NVQ in the OC sector, as even under the 640t TAC scenario the non-vessel quota holders within the interquartile range of quota sizes can expect a median NPV of roughly R 1 - 2 million each.

The results for vessel owners in this sector suggest that a lot of the vessels making smaller than median total catches will have to exit the fishery due to consistent net losses. A decrease in the total number of vessels would improve the NPV for the entire sector, as there would be lower overall annual costs. While our data suggests that the remaining vessels would realistically be able to catch the entire quota under these reduced numbers, the viability of this into the future does depend on maintaining a sufficient number of seadays for vessels to make the catch, as well as considering whether the permit condition allowing each landing to be made for a single quota code would remain economically sensible under decreased quota sizes. The fishery at present, is operating at a capacity that will have to be adjusted to different future scenarios according to the fishing effort required for ecological and economic objectives. The issue surrounding vessels that are decommissioned and stakeholders and the authority will have to consider how to handle this reduction in active vessels and the costs associated with retired vessels.

Nearshore commercial sector

The results for the NC sector showed similar trends as those discussed in Chapter 3, with great variation between the different super-areas and actors. The majority of VQ-CSs did not have a large NPV (less than 1 million over the projected time frame) and generally a lower NPV than NVQs. The changes in average catches per trip under the different biomass recovery trends were not shown to substantially change the average quota size that a vessel owner would need for their NPV to be 1 million under the three TAC management scenarios, however the availability of quotas of a certain minimum size is affected by the different global TAC options. There are differences between the super-areas, with A3+4 and A8+ not meeting the minimum quota sizes even under the 1280 t TAC scenario under their current proportional allocation, while quotas in A5+6 are larger than the minimum quota sizes even under the 640 t TAC scenario. Since A3+4 and A8+ are by far the most populous super-areas this is a concerning trend. Lastly, since the results suggest that to make a net profit under the different TAC management scenarios vessel owners would benefit from catching other people's quota as well as their own, and given the small quota sizes that can be expected, especially under the lower TAC management scenarios, the permit regulation requiring each trip to be made exclusively for one quota code[28] might need to be adjusted to allow each trip to increase a vessel owners flexibility and profitability per trip by not restraining the catch by the size of a single individual quota.

[28] https://www.nda.agric.za/doaDev/sideMenu/fisheries/21_HotIssues/April2010/FishingPERMITCONDITIONS2010/WCRL%20Nearshore%20Permit%20Conditions%202009_10%20fishing%20seasson%20approved%20on%2011%20Nov%2009.pdf

Interim relief permit sector

The IRP sector was projected to be the sector with the highest total NPV under the 640 t TAC scenario. This is, a result of their total sectoral TAC being substantially higher than the nearshore sectors (as a result of the additional small-scale offshore sectoral TAC) and the fact that little below half of their sectoral TAC (the offshore portion) is unaffected by costs beyond the catching fee, as all of it is necessarily outsourced. Further, the number of vessels is proportionally lower and costs per vessel are cheaper than in the NC and OC sectors respectively.

Despite the stronger economic performance of the sector as a whole, the findings concerning the NPV for vessel owners indicate that this sector at the individual's level is largely unsustainable under the assumptions of this study. Most active fishers catching for five quota holders or less, are projected to have a negative NPV. These results point to the need for a reorganization of this sector and renewed critical evaluation of the rights holders, the interactions between actors in this sector, the quota sizes and potential alternative sources of revenue. While increasing the total catch by catching for more NVQs is a reasonable arrangement in Zone C and Zone F, the low catch-per-trip in Zone B means that to have a similar NPV, a vessel owner in that zone will have to make a very high number of trips (even after taking into account the projected recovery of the biomass by 2030/31) which might be unattainable given the number of viable seadays in a given season and would introduce added risk of making further losses. Further, due to the low "individual" quota allocations in Zone D and E, a vessel owner in those zones would have to catch for a large number of people, exceeding the median number of individuals per community by far.

4.4.2 Thoughts on the future of the fishery

The WCRL fishery presents a wicked problem, as defined by (Rittel and Webber 1973) and applied to fisheries management (Jentoft and Chuenpagdee 2009), in that there are a multitude of conflicting interests, complex and sometimes contradictory objectives, different perceptions of issues, problems can be highly subjective and there is no clear or definite solution that can be divined scientifically or mathematically (Jentoft and Chuenpagdee 2009).

There is a clear conflict between the need to set ecologically sustainable maximum levels for total catches, ensuring economically viable quotas and accommodating goals of social transformation through inclusion of a large number of previously disadvantaged individuals. A critical evaluation of the current dynamics, participants and divisions of the quota and labour has to be undertaken to maximise the possibility of livelihood preservation for the fishers in this industry while safeguarding the future of the resource. The need for preventing overfishing and preserving the lobster resource for future generations means that this objective is paramount (Rogers 2018), while pursuing the goals of transformation including promoting equitable access to marine resources, poverty alleviation, job creation and development, value chain integration and facilitating co-governance, stakeholder representation and participation and alleviating poverty of the previously disadvantaged are intrinsic to the SSFP and the amended MLRA.

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The difficulty of merging the triple "bottom line" was previously remarked upon by Van Sittert et al. (2006) for the South African context. For the timeframe explored in this study, both the social landscape (who is involved and to what proportion) and the ecological aims are unlikely to change, since FRAP 2015, the SSFP and the urgency for biomass recovery are legally entrenched. The economic viability of the fishery and its stakeholders therefore has to be adapted to these states. The discussions on the different sectors show that the future of the fishery will most likely lead to a reduction in the numbers of active vessels and vessel owners, as the decreasing TACs mean that less operations can be viable under the current capacity and quota sizes. This is expected to highlight different conflicts and problems in the different sectors. While the results suggest that there will be some economic drawbacks that will also reflect in the social sphere, there seems to be little possibility to avert these, given the constraints given above. However, some mitigation of the negative effects is possible, with recommendations ranging from, changes in the dynamics between stakeholders, a move towards a co-operative system in the IRP and small-scale sectors and diversification. The limitations of representative examples used to explore within the scope of this study mean that only a generalised discussion of the fishery under different global TAC scenarios is possible.

Wealth and welfare

These projections suggest that the circumstances will lead to the proportion of non- vessel owning quota holders increasing under the diminishing global TAC scenario, with most quota holders likely to only be marginally involved with the harvesting of the resource and whose investment in the fishery will likely be moderate to non-existent.

In a utilitarian sense this scenario, few vessels fishing for a large number of quota holders, would maximize the rent, while ensuring some income for a large number of people through quotas, improving the potential for oversight of the fishery and likely improving the quality of the harvest through greater oversight as found in fisheries governed according to a wealth-based approach (Cunningham et al. 2009). While this would not be the direct result of a management decision, but rather a result of the unsustainability of continuing operations on an individual entity's level, the outcome would be similar. The sectoral economic benefit from a large reduction in vessels is most apparent in the OC sector where, under the assumptions of this study, the economic non-viability of many vessels observed under the 640 t TAC scenario was found to negatively affect the NPV of the sector as a whole.

As the fishery experiences reductions in numbers of vessels the disjunct between the harvest and the income from quotas for the majority of rightsholders is likely to increase. An extreme case, reminiscent of the Fishers Community Trust system in the early 1990s (Isaacs 2011) in recent times is the offshore allocation to the IRP and SSF sectors. Introduced in 2018/19, this is the only area of the fishery where non-participation by quota holders is a direct result of management decisions. This allocation presents a compromise under the necessity of increasing the income of IRP and small-scale fishing communities, while not imposing the reallocation of TAC on the NC sector alone. The allocation of 20% of the OC TAC to the IRP/small-scale was decided upon after the management first published a provisional decision to allocate 90% of the nearshore resource to the IRP/small-scale sectors, but appeals and indignation from NC quota holders reduced this to a 50/50 split with the remaining allocation being deducted from the OC sector[29]. The allocation however presents an anomaly, since the offshore resource is inaccessible to IRP and small-scale quota holders, and OC vessels have to be commissioned and paid a catching fee in order to harvest

[29] https://www.dalrrd.gov.za/docs/media/FRAP2015-16%20West%20Coast%20rock%20lobster%20nearshore%20Final%20Decisions%20on%20Allocation%20of%20Rights%20(Zone%20A%20to%20D).pdf (accessed on 13.3.2021)

it. The necessary exclusion of the main benefactor (IRP quota holder) from the harvesting, creates an alienation between the revenue from the resource, and the resource itself, the equipment and labour attached to the harvesting of the resource, which is likely to expand to other parts of the fishery under the current trajectory.

Poverty prevention and reduction

The argument of poverty prevention versus reduction, as outlined in Béné et al. (2010), is relevant here, as with the poor state of the resource, the fishery is likely to have moved from a possible tool for poverty reduction to one of poverty prevention. In the case of the WCRL fishery this means that under the likely future scenarios, the fishery should at least contribute to poverty prevention (contributing to food-security and offering some form of financial relief) for the majority of rights holders in the IRP and NC sectors, with quotas large enough to provide some income and contribute to financial security if the costs associated with operating a vessel are not carried, while this fishery will likely not contribute to poverty reduction (fostering growth and escape from of poverty) in the majority of cases, as our analysis indicates that most quotas will likely remain too small to encourage investing in, building and using of their assets to further their income or other activities that are likely to raise the status of the quota holder rather than simply maintaining it.

The distinction is an important one to make, as it helps to disentangle the concerns surrounding the different possible trajectories of this fishery and helps to visualize why an income is not simply an income. The situation has long been difficult for IRP fishers, for whom the quotas from this fishery have generally not been large enough to encourage economic growth (Nthane 2015). However, engagement in small-scale fisheries presents large benefits beyond its monetary return to many individuals (Mahon 1997, Pollnac et al. 2012, Weeratunge et al. 2014). To many of the vessel owners, crew, and individuals in local post-harvest activities, fishing represents more than a means of income, but a generational occupation, an inheritance, a distinct source of pride and vehicle for self-actualization (Isaacs 2016, Schultz 2017).

While the data shows that a relatively stable income can be made as a NVQ and that therefore "being forced out of the fishery" could enhance the income of some of the small-time vessel owners, this is counter to the objective of the empowerment of these individuals, and opportunity for entrepreneurship for small-scale fishers (Isaacs et al. 2007, Sowman et al. 2014). Many of those interviewed were aware that their existence as fishers was threatened and that they had to seek alternative or supplementary income opportunities in order to make ends meet. Recognising and respecting the role of vessel owners in the IRP and NC sectors, therefore is critical to poverty reduction as continued harvesting in these communities also allows participation from other community members as crew, as well as through local value adding and other related work by individuals who do not have the resources, expertise or desire for owning a vessel. The outcome of an economically or competition driven reduction in the numbers of active vessels is thus also important to consider in regards to the employment provided – fewer vessels mean fewer opportunities for crew and skippers who depend on the fishery for their livelihoods.

Given the constraints of the quota sizes and the ecologically responsible quantities available for harvest, it is not going to be feasible to preserve active participation in the fishery at the same levels over the next 12 years. It is hoped that the implementation of the SSFP and more collective ownership of quotas and vessels might bring about some much-needed change in the potential for community owned and funded vessels, relieving individuals from carrying all of the costs associated with operating a vessel, and simultaneously empowering individuals with previously limited access. However, the implementation process has proved lengthy and difficult, with a renewed delay announced in February 2021[30]. Despite its benefits, the SSFP envisioned system introduces challenges of its own, which will be further discussed in Chapter 5.

For the foreseeable future, the maintenance and operation of vessels will likely not be possible through quotas in the WCRL fishery alone for a majority of fishers in the IRP and NC sectors. Many vessel owners will most likely have to turn to other species or give up their vessel. The availability of alternative resources depends both on locality and on the sector. The OC sector can hold many different licenses, but while a vessel owner could supplement their income from other quotas, the OC WCRL fishing boats are specialized to this fishery, necessitating some substantial investment to readapt them to another fishery, according to a number of interviewed stakeholders. The NC sector was traditionally prevented from holding quotas in another fishery (Nthane 2015), but the policy released in 2015 gives permission for NC rightsholders to hold other rights (DAFF

[30] https://www.environment.gov.za/mediarelease/creecy_askcourts_reveiwfishingrights (accessed on 14.3.2021)

2015b), while the IRP sector is allocated a "basket" of resources according to their locality. However, apart from abalone *Haliotis midae* (not part of the IRP baskets), most other species, especially those accessible nearshore cannot, at present fill the same high-value niche of the WCRL (Jordan 2016). The recent initiative by Abalobi is of considerable interest here. Through information and communication technology, they are connecting fishers directly to retailers, in many cases high-end and gourmet restaurants or food outlets, which therefore allow fishers to sell species at fair and transparent prices locally, helping to elevate previously "low revenue" species to species that can relay a decent profit, increasing the resilience through diversification of potential avenues of income (Petrik and Raemaekers 2018).

There is no question that many rural coastal communities are in dire need of increased opportunities of income (Isaacs and Sunde 2008, Isaacs 2011, Sowman et al. 2014, Wentink et al. 2017), and the WCRL quotas, even if they are, in most cases, not enough to promote active participation and investment in the fishery, are a lifeline for many quota holders. However, due to limits of the resource's harvestable biomass and the long-term consequences of over-exploitation, the government cannot continue leaning on this species as a means of supporting a population in need, but has to investigate, encourage and support alternative sources of revenue for all involved in this fishery.

4.4.3 Conclusion

The conflicts discussed above are often generalizations, but their implications have to be weighed and considered carefully by management. Although this study is based on a large number of assumptions and generalizations, there are strong trends that suggest that a large proportion of present fishers will not be able to continue their operation under the proposed TAC scenarios, which should provide a strong incentive to government to reexamine current measures and parameters regarding the socio-economic aspects of this fishery. The viable future of this fishery requires the careful development of management strategies that take into account social and economic impacts and approach the problematics of each of the sectors individually.

Chapter 5: Conclusions

The findings presented in Chapter 3 and 4 show important trends in this fishery of considerable importance for future management considerations. The economic assessments demonstrate that a large number of individuals are likely to have experienced economic losses in this fishery over the seasons 2016/17 – 2018/19, particularly vessel owners in the different sectors, while the intended decrease in the global TAC will cause further losses if the sector and individual specific issues are not addressed more effectively by management.

While the net seasonal income (NSI) varied substantially depending on the sector, locality and specifics of individuals, the quota sizes, particularly in 2018/19, meant that only some could make a viable income from their quota and cover the costs of owning and operating a vessel. While the NSI for non-vessel owning quota holders (NVQs) also decreased substantially with decreasing quotas, they were estimated to have made a comparably more stable income as a consequence of not bearing any costs that are not directly linked to the mass caught (catching fee). The difference in revenue is likely to increase the number of active fishers being forced out of the fishery and, in turn, increase the proportion of "arm-chair fishers". Chapter 3 provides some recommendations for increasing equity between stakeholders and potential ways to ensure that a viable income can be achieved by the different actors in this fishery, including increased fostering of co-governance, participation and representation of stakeholders in management, increased training and support, particularly to the IRP sector awaiting the implementation of the SSFP, increased vertical and horizontal integration within the value chain and research into methods of increasing the international market price.

Similar trends were found in Chapter 4, where the data suggests that even with the projected increases of catch per trip as a consequence of the biomass recovering to varying degrees under the different TAC management scenarios (all of which are calculated to encourage at least some recovery by 2030/31), the projected recoveries do not contribute enough to the net present value (NPV) of many fishers to counteract the impact of low quotas under the considered global TAC options. Further, under the low (640 t) TAC scenario, the OC sector as a whole was projected to become even less economically efficient (under the projected number of active vessels) and it is suggested that the total number of vessels would need to be reduced substantially for the entire sector to improve the rent, albeit at a cost to some vessel owners and crew. In the other two sectors the frequency of negative or NPVs estimated for vessel owners, suggest that over the projected time frame more vessels will exit the fishery.

5.1 Transition from the IRP communities to small-scale co-operatives

One of the most important steps towards a more equitable and profitable system for the small-scale fishers is the implementation of the SSFP in the near future, which, it is hoped, will distribute the burden of costs more evenly and allow and incentivise increased active participation in fishing. However, the collective ownership of vessels and collective handling of finances and harvest, creates other issues that require equal, if not stronger governance in partnership with communities.

The importance of good fisheries governance, as acting through both vertical and horizontal mechanisms, cannot be understated (Jentoft 2007). As discussed in Chapter 3, the number of vessels needed is an important factor to consider for a co-operative, as too many vessels drive up costs and reduce economic efficiency and rent optimization while too few vessels might cause undercatching of the quota and unnecessary loss of traditional livelihoods. In addition to finding the balance between economic efficiency and the social transformation goals including preserving and encouraging traditional occupations, it is imperative that co-operatives are supported and incentivized to operate transparently and fairly. Elite capture is common, and a co-operative system could lead to the exclusion of individuals who, for one reason or another, are not desirable to the leadership of the co-operative. It was remarked by some NC vessel owners interviewed that they had experienced pressure to join the program for the small-scale fishing co-operatives, as it was argued that both parties would profit from such an arrangement. Many appeared reluctant to relinquish their individual rights and agency, as they feel that the politics of such a heterogeneous group could negatively impact their financial independence, issues touched upon already in the early stages of development of this policy (Isaacs et al. 2007). Similar thoughts were uttered by apprehensive IRP vessel owners who fear that through the greater dependence on the co-operative (through, for example, collective ownership of the vessels) their activity and income could be dictated more easily by individuals with micropolitical influence, as previously described under the IRP system (Schultz 2017). A group of IRP fishers interviewed, who had incurred some jealousy from other members from their community by having obtained a favourable marketing agreement, reported in interviews that in retribution, other members of their community deliberately delayed them in accessing the harbor, in being received at the landing site or otherwise intentionally inconvenienced them, producing extra costs. These internal conflicts are present in many communities, and collective exertion of control and retribution for political or personal motives can continue to exist and even flourish under a co-operative system, if not governed correctly. In the case of, for example, the co-operative system as applied in Port Nolloth, a fisher who, for some reason, becomes ostracized by other members of the co-operative, might find themselves excluded from fishing on the communal vessels, and thereby deprived of their 50 R/kg received through this avenue. The reluctance of active fishers, who have managed their own operation for years, to enter into such an agreement is understandable and must be addressed.

Implementing the SSFP is both necessary and an important step in increasing the benefits of this fishery for small-scale fishers (Isaacs 2011, 2016, Botha 2020). The afore mentioned observations and concerns are therefore to be taken as areas where the heightened attention and focus of the management authority is needed to avoid problems going forwards. Good governance of such a system needs to address issues on all levels of the fishery through stakeholder representation, distribution of authority and mechanisms of accountability (Ratner and Allison 2012).

5.2 Future directions for research

Both the NSI and the NPV analyses suggest worrying trends regarding the profitability of operating vessels in all three sectors. Individual cases are likely to vary substantially, as a consequence of the actual costs incurred by an individual (running and annual costs), the average catch made by a specific vessel, the number of other quota holders caught for and the total catch, the net price and catching fee obtained and any co-owning or cost-sharing arrangements. The NPV analyses suggests, that under the current variable estimates the majority of operations will become unviable under the 640 t TAC scenario, apparently putting the achievement of the medium-term socio-economic objectives of this fishery at odds with the mandated biomass recovery goals. The scope of this study did not permit an in-depth analysis of any one of the sectors or stages of the value chain or intrasectoral differences between localities in income and expenditure. In the future, it is suggested that more sophisticated modelling of feed-back loops and interactions occurring at different levels of the value chain, as well as potential avenues for increasing the international market price need are studied further and with a higher resolution. Between the sectors, it appears that most recent research has been devoted to the small-scale/IRP sector, and while this is a crucial focus to understand and address the challenges for that sector better and ensure the well-being of historically disadvantaged people, more data has to be collected on the socio-economic parameters of the commercial sectors to ensure that the objectives of the sectors can be balanced equitably. The lack of broader input from and representation of stakeholders, particularly in the offshore commercial sector, in this study is the main source of uncertainty regarding the results presented for that sector, and an area where further study, with a more specific scope, would be highly recommended. Conversely however, the data captured in registration and landing records for the two commercial sectors, essential for good management and analysis of a fishery, is lacking for the IRP sector. This points to a significant problem, in that it appears that the government does not have the technology or capacity to capture this data which would allow them to better answer basic questions about this sector (who is fishing, with what are they fishing, how many are fishing, how much is caught, for whom is it caught). The lack of data appears to greatly impede the authority's capacity to effectively manage the fishery and must be addressed as a matter of urgency, as better oversight, more paper trails and higher accountability would both increase the effectiveness of management measures based on this data while further assisting with the next great point of concern: the reduction of IUU fishing.

While the problems surrounding IUU fishing in this fishery largely fell outside the scope of this project it is very important and has to be considered.. Most notably, this issue was raised by those opposed to lowering the legal catch limit for the season 2017/18 by the then Minister of DAFF. It was argued that it would be unjust to penalize legal fishers for the activities in the large illegal market, which are thought to have contributed substantially to the decline in the resource's biomass, leading to the suggested decrease in TAC (WWF 2018b). While this study did not attempt to address these issues quantitatively or directly, the findings are relevant to solving that on-going crisis. Most notably, the unviability of many quotas found for different kinds of vessel owners in Chapter 3 and 4 provides some additional background to the desperation and "protest-harvesting" that are likely driving some part of the IUU catches (Augustyn et al. 2018). Lastly, the possibility for setting higher TACs in the years to come without putting undue strain on the resource depends substantially on whether enforcement can reign in at least some part of the current IUU fishing, as estimates of the illegally harvested biomass are directly included as parameters guiding the setting of the global TAC (Johnston and Butterworth 2019a). While the reduction of IUU fishing has been touted by management as a priority for many years, it appears that not enough has been done to substantially reduce it (WWF 2018b).This was a point of contention for many stakeholders interviewed and needs to be addressed urgently and vigorously to liberate more of the harvestable biomass for legal rights holders. While this is a subject that has received a fair amount of attention (Brill and Raemaekers 2013, Brandão et al. 2018, Isaacs and Witbooi 2019), further studies into the economic incentives for IUU fishing, interactions and feedback loops between IUU fishing and decreasing quotas, socio-economic variables affecting tendencies for IUU fishing as well as measures towards effectively controlling it, with a specific focus on reconciling the export and catch data for this fishery, are recommended.

5.3 Scope and limitations

The factors outlined in Chapter 3.1.3 are important considerations to take into account when assessing the limitations of this study. This study aimed to create a comprehensive profile for the fishery and investigate aspects across the different sectors and the stages of the value chain, which meant covering a lot of ground and engaging with a wide range of participants. While the aim of answering the two research questions posed for this analysis was accomplished within the limitations of this study, the limited sample sizes for many stages of the value chain meant that these results include substantial uncertainty and require further validation. The diversity and spread of participants, spatially, socio-economically and in their preferred manner of engaging and contributing to the study increased the ratio of time and effort required to achieve responses substantially. The charged nature of this fishery meant that in addition to navigating logistic challenges to enroll participants, efforts were affected by the highly political and volatile state of the WCRL fishery.

Studies have identified two main reasons for potential participants in highly-charged environments not to wish to participate in research studies: i) the fear of being associated with the researchers or ii) fear of becoming identifiable and traceable despite confidentiality measures taken by the researchers (Haer and Becher 2012). Both of these are pertinent to this study and can help to explain the high degree of unwillingness to participate. These considerations affected the sampling efforts in two main ways. Firstly, participant engagement in conflict environments is often primarily achieved through convenience sampling methods such as snowball sampling (Cohen and Arieli 2011). The biggest limitation in such non-probability sampling methods is the potential for the research population to be biased, as they already present a sub-population that is willing to engage with researchers and is familiar and connected to the facilitators, in this case the government authority, associations or NGO's. For this study, for example, it was therefore likelier to get in contact with caretakers versus their constituents, as the caretakers were most often the one's handling the affairs and interacting with government. Nevertheless, the remoteness of communities, suspicion of outsiders, and scientists in particular, as well as maintaining a certain level of safety for the researcher herself necessitated us to follow these sampling methods and thereby risk compromising on potential bias. Secondly, even using these measures to mitigate the apprehension of many stakeholders did not result in large samples of willing participants, especially in the groups that could be classed as more vulnerable, as one email respondent from the NC sector noted: "We have been burned too many times before".

Lastly, since most of the data presented here was collected through in-person interviews, which increased the likelihood of engagement substantially (as compared to completing surveys), collection of supplementary data was hindered in the second year of the study as the nation was in various levels of lockdown due to Covid 19, and interprovincial travel and in-person meetings were strongly discouraged or forbidden, in addition to the economic disaster of the pandemic meaning that many fishers and stakeholders had other concerns and priorities to deal with.

While a large proportion of the variables used in the models, such as quota sizes, catch per trip, numbers of vessels active, total catches made by vessels and proportion of catch for the vessel owners' own quota were derived from the catch records and thus not subject to the same biases as the data derived from participants, the small sample sizes of much of the other data are an important limitation for the results presented in this study. It was attempted to increase the reliability of the variables from the interviews and surveys through discussions with knowledgeable stakeholders and comparisons to relevant literature, which suggested that these cost and price estimates are generally favourable to the rights holders and vessel owners, while the cost estimates presented here appear to be generally conservative. Given these considerations, it is likely that the real NSI and NPV for the sectors and actors are closer to the lower end of the range presented in the results rather than the higher end, thus supporting the concerns expressed here.

5.4 Conclusion

Most of the findings, including the projections of increasing unviability of fishing operations (across sectors), anticipated increasing proportions of non-participating quota holders and overcapacity in a broader sense have been recurring themes in discussions regarding this fishery (Isaacs 2011, Wentink et al. 2017, Schultz 2017, Botha 2020). However, for the commercial sectors in particular, there has been limited recent quantitative data to back up claims and arguments. While a lot more studies will have to be done to verify and investigate in more detail aspects touched on here, the trends indicated by the findings of this study demonstrate that the management of this fishery, in cooperation with rights-holders and stakeholders, has to be mindful and employ mechanisms to counteract the negative short-term economic consequences that will be incurred by quota holders, vessel owners, crew and employees along the value chain while maintaining fishing pressure at levels contributing to the recovery of the biomass.

Analysis of the past three seasons demonstrates that operations are variably profitable but that in many cases owning a vessel is economically more of a liability and loss than a benefit. As the quota sizes decreased in 2018/19 and in the projections regarding possible further decreases, such as under the 640 t TAC management scenario, the costs of operating and owning a vessel are no longer matched by the revenue from a quota, leading to economic unviability of many quotas for vessel owners. There is strong evidence that the lower TAC options are further going to lead to losses of employment opportunities for individuals working as crew or in other aspects of the value chain. The findings strongly suggest that if a reduction of the TAC is to be implemented, it will be crucial that management investigates measures and ways to mitigate the economic struggles and inequities that are likely to be exasperated under lower global TAC options.

The above concerns make it imperative that some supplemental action is taken by management to ensure economic and social sustainability and equity for fishers and others dependent on the fishery, while the biological and ecological goals are pursued. Biomass recovery is paramount to keeping the fishery open and to maintain social and economic welfare for generations to come. To achieve the necessary balance between the three pillars of responsible fisheries management it is therefore important to consider ways that the present fishery can be supported, optimized and certain interactions restructured through improved and strengthened horizontal and vertical governance.

Chapter 6: References

Aronson J, Blignaut JN, Milton SJ, Le Maitre D, Esler KJ, Limouzin A, Fontaine C, de Wit MP, Mugido W, Prinsloo P, et al. 2010. Are Socioeconomic Benefits of Restoration Adequately Quantified? A Meta-analysis of Recent Papers (2000-2008) in *Restoration Ecology* and 12 Other Scientific Journals. *Restoration Ecology* 18: 143–154.

Arreguín-Sánchez F 1996. Catchability: a key parameter for fish stock assessment. *Reviews in Fish Biology and Fisheries* 6.

Atkinson L, Mayfield S, Cockcroft A 2005. The potential for using acoustic tracking to monitor the movement of the West Coast rock lobster Jasus lalandii. *African Journal of Marine Science* 27: 401–408.

Augustyn CJ, Cockroft A, Coetzee JC, Durholtz D, Van der Lingen CD 2018. Rebuilding South African Fisheries: Three Case Studies. *Rebuilding of Marine Fisheries Part 2: Case Studies*. Rome: FAO Fisheries.

Bair J 2008. Analysing global economic organization: embedded networks and global chains compared. *Economy and Society* 37: 339–364.

Barendse J, Basson J, Petersen SL, Sink KJ 2018. The sustainable seafood movement viewed as a maturing social-ecological issue using a South African case-study. *Ocean & Coastal Management* 151: 178–192.

Béné C, Hersoug B, Allison EH 2010. Not by Rent Alone: Analysing the Pro-Poor Functions of Small-Scale Fisheries in Developing Countries. *Development Policy Review* 28: 325–358.

Bergh M 2014. 2014 Status of South African lobster and squid fishery. OLRAC SPS.

Bergh M 2015. An investigation into female in-berry considerations in the management of South Coast rock lobster. Steenberg Office Park: OLRAC SPS.

Beyers CJDB, Goosen PC 1987. Variations in fecundity and size at sexual maturity of female rock lobster *Jasus lalandii* in the Benguela ecosystem. *South African Journal of Marine Science* 5: 513–521.

Blamey LK, Branch GM, Reaugh-Flower KE 2010. Temporal changes in kelp forest benthic communities following an invasion by the rock lobster *Jasus lalandii*. *African Journal of Marine Science* 32: 481–490.

Booth JD 2013. *Lobsters: biology, management, aquaculture and fisheries* (Second edition edn). BF Phillips (ed.). Chichester, West Sussex, UK: John Wiley & Sons, Ltd.

Borgonovo E, Plischke E 2016. Sensitivity analysis: A review of recent advances. *European Journal of Operational Research* 248: 869–887.

Botha M 2020. Reorganising the lobster fishery value chain. *Marine Policy* 120: 104149.

Brandão A, Butterworth DS, Johnston SJ 2018. Refined trends in poaching for West Coast rock lobster based upon information from the DAFF compliance "new" database for the period 2012 to 2017, and final poaching trends used for updated assessments and projections. MARAM/IWS/2018/WCRL/P1. Cape Town: MARAM, University of Cape Town.

Brandão A, Butterworth DS, Johnston SJ, Glazer JP 2004. Using a GLMM to estimate the somatic growth rate trend for male South African west coast rock lobster, Jasus lalandii. *Fisheries Research* 70: 339–349.

Brill G, Raemaekers S 2013. A decade of illegal fishing in Table Mountain National Park (2000–2009): trends in the illicit harvest of abalone *Haliotis midae* and West Coast rock lobster *Jasus lalandii*. *African Journal of Marine Science* 35: 491–500.

Burg M. 2017. Status and management of the South African Squid and West Coast rock lobster. Oceana Group.

Butterworth DS 2018. On options for the basis for future West Coast rock lobster TAC advice. MARAM-IWS-2018-WCRL-P5. Cape Town: MARAM, University of Cape Town.

Christensen V, Steenbeek J, Failler P 2011. A combined ecosystem and value chain modeling approach for evaluating societal cost and benefit of fishing. *Ecological Modelling* 222: 857–864.

Cochrane K, Joyner J, Sauer W, Swan J 2015. An evaluation of the Marine Living Resources Act and supporting legal instruments as a framework for implementation of an ecosystem approach to fisheries in South Africa. *African Journal of Marine Science* 37: 437–456.

Cochrane KL, Eggers J, Sauer WHH 2020. A diagnosis of the status and effectiveness of marine fisheries management in South Africa based on two representative case studies. *Marine Policy* 112: 103774.

Cochrane KL, Garcia S, Food and Agriculture Organization of the United Nations 2009. *A fishery manager's guidebook*. Chichester, West Sussex; Ames, Iowa: Wiley-Blackwell.

Cockcroft A, van Zyl D, Hutchings L 2008. Large-scale changes in the spatial distribution of South African West Coast rock lobsters: an overview. *African Journal of Marine Science* 30: 149–159.

Cockcroft AC 2001. Jasus lalandii 'walkouts' or mass strandings in South Africa during the 1990s: an overview. *Marine and Freshwater Research* 52: 1085.

Cockcroft AC, Goosen PC 1995. Shrinkage at moulting in the rock lobster *Jasus lalandii* and associated changes in reproductive parameters. *South African Journal of Marine Science* 16: 195–203.

Cockcroft AC, Payne AI 1999. A cautious fisheries management policy in South Africa: the fisheries for rock lobster. *Marine Policy* 23: 587–600.

Cohen N, Arieli T 2011. Field research in conflict environments: Methodological challenges and snowball sampling. *Journal of Peace Research* 48: 423–435.

Crosoer D, van Sittert L, Ponte S 2006. The integration of South African fisheries into the global economy: Past, present and future. *Marine Policy* 30: 18–29.

Cunningham S, Neiland AE, Arbuckle M, Bostock T 2009. Wealth-based Fisheries Management: Using Fisheries Wealth to Orchestrate Sound Fisheries Policy in Practice. *Marine Resource Economics* 24: 271–287.

DAFF (Department of Agriculture, Forestry and Fisheries) 2015a. Policy for the allocation and management of commercial fishing rights in the West Coast rock lobster commercial (offshore) fishery: 2015. *Staatskoreant* No. 1134: 13.

DAFF (Department of Agriculture Forestry and Fisheries) 2015b. Policy for the allocation and management of commercial fishing rights in the West Coast rock lobster commercial (nearshore) fishery: 2015. *Staatskoerant* No.1136: 13.

DAFF (Department of Agriculture Forestry and Fisheries) 2012. Policy for Small-scale fisheries sector in South Africa. No.35455: 49.

DAFF (Department of Agriculture Forestry and Fisheries) 2016. Status of the South African marine fishery resources 2016. Cape Town: DAFF.

DEAT (Department of Environment Agriculture and Tourism) 2005. Policy for the allocation and management of commercial fishing rights in the West Coast rock lobster commercial (nearshore) fishery: 2005.

Dijkstra W 1987. Interviewing Style and Respondent Behavior: An Experimental Study of the Survey-Interview. *Sociological Methods & Research* 16: 309–334.

Economic Research Associates Pty Ltd 2015. An analysis of the demands for Western Rock Lobster - A report prepared for the Western Australian Department of Fisheries. Perth, Western Australia.

Fabinyi M 2016. Producing for Chinese luxury seafood value chains: Different outcomes for producers in the Philippines and North America. *Marine Policy* 63: 184–190.

Food and Agriculture Organization of the United Nations (ed.) 2003. *Fisheries management. 2: The ecosystem approach to fisheries*. Rome: Food and Agriculture Organization of the United Nations.

Garbarski D, Schaeffer NC, Dykema J 2016. Interviewing Practices, Conversational Practices, and Rapport: Responsiveness and Engagement in the Standardized Survey Interview. *Sociological Methodology* 46: 1–38.

Garcia SM, Charles AT 2008. Fishery systems and linkages: Implications for science and governance. *Ocean & Coastal Management* 51: 505–527.

Garcia SM, Rosenberg AA 2010. Food security and marine capture fisheries: characteristics, trends, drivers and future perspectives. *Philosophical Transactions of the Royal Society B: Biological Sciences* 365: 2869–2880.

Haer R, Becher I 2012. A methodological note on quantitative field research in conflict zones: get your hands dirty. *International Journal of Social Research Methodology* 15: 1–13.

Haley CN, Blamey LK, Atkinson LJ, Branch GM 2011. Dietary change of the rock lobster Jasus lalandii after an 'invasive' geographic shift: Effects of size, density and food availability. *Estuarine, Coastal and Shelf Science* 93: 160–170.

Hamilton-Hart N, Stringer C 2016. Upgrading and exploitation in the fishing industry: Contributions of value chain analysis. *Marine Policy* 63: 166–171.

Hartnoll RG 2001. Growth in Crustacea – twenty years on. *Hydrobiologia* 449: 111–122.

Heydorn AEF, South Africa., Division of Sea Fisheries. 1969. *The rock lobster of the South African west coast Jasus lalandii (H. Milne-Edwards). 2. Population studies, behaviour, reproduction, moulting, growth and migration*. Cape Town: Division of Sea Fisheries.

Hilborn R 1992. Current and future trends in fisheries stock assessment and management. *South African Journal of Marine Science* 12: 975–988.

Isaacs M 2011. Individual transferable quotas, poverty alleviation and challenges for small-country fisheries policy in South Africa. *MAST* 10.

Isaacs M 2015. The Governability of Small-Scale Fisheries Food System in South Africa – The Case of Snoek and West Coast Rock Lobster. In: Jentoft S, Chuenpagdee R (eds), *Interactive Governance for Small-Scale Fisheries* (13 vol.). Cham: Springer International Publishing. pp 245–262.

Isaacs M 2016. Multi-stakeholder process of co-designing small-scale fisheries policy in South Africa. *Regional Environmental Change* 16: 277–288.

Isaacs M, Sunde J 2008. *Marine conservation and coastal communities: who carries the costs? A study of Marine Protected Areas and their impact on traditional small- scale fishing communities in South Africa*. Chennai, India: International Collective in Support of Fishworkers.

Isaacs M, Witbooi E 2019. Fisheries crime, human rights and small-scale fisheries in South Africa: A case of bigger fish to fry. *Marine Policy* 105: 158–168.

Isaacs M, Hara M, Raakjær J 2007. Has reforming South African fisheries contributed to wealth redistribution and poverty alleviation? *Ocean & Coastal Management* 50: 301–313.

Jentoft S 2007. Limits of governability: Institutional implications for fisheries and coastal governance. *Marine Policy* 31: 360–370.

Jentoft S, Chuenpagdee R 2009. Fisheries and coastal governance as a wicked problem. *Marine Policy* 33: 553–560.

Johnson DS. 2010. Institutional adaptation as a governability problem in fisheries: patron–client relations in the Junagadh fishery, India. *Fish and Fisheries* 11: 264-277.

Johnston SJ 2018. West Coast rock lobster allocation for the 2017/18 season. FISHERIES/2018/MAR/WCRL/TT01. Cape Town: MARAM, University of Cape Town.

Johnston SJ, Butterworth DS 2005. Evolution of operational management procedures for the South African West Coast rock lobster (*Jasus lalandii*) fishery. *New Zealand Journal of Marine and Freshwater Research* 39: 687–702.

Johnston SJ, Butterworth DS 2018a. A summary of the West Coast rock lobster fishery. MARAM/IWS/2018/WCRL/BG1. Cape Town: MARAM, University of Cape Town.

Johnston SJ, Butterworth DS 2018b. Further 2018 West Coast rock lobster assessments and associated biomass projection results. FISHERIES/2018/AUG/SWG/WCRL/25. Cape Town: MARAM, University of Cape Town

Johnston SJ, Butterworth DS 2018c. The Consequences of Different Inshore/Offshore splits of the WCRL TAC. MARAM/IWS/2018/WCRL/BG3. Cape Town: MARAM, University of Cape Town.

Johnston SJ, Butterworth DS 2019a. Final updated 2019 assessments and projections of West Coast rock lobster for different poaching scenarios. FISHERIES/2019/AUG/SWG/WCRL/20. Cape Town: MARAM, University of Cape Town.

Johnston SJ, Butterworth DS 2019b. Summary of past recovery targets for west coast rock lobster. FISHERIES/2019/AUG/SWG/WCRL/21. Cape Town: MARAM, University of Cape Town.

Jordan T 2016. *An assessment of the amall-scale fisheries in the Kogelberg District of the Western Cape, South Africa*. MSc Thesis, Rhodes University, South Africa.

Khan AS, Neis B 2010. The rebuilding imperative in fisheries: Clumsy solutions for a wicked problem? *Progress in Oceanography* 87: 347–356.

Kleinschmidt H, Sauer WHH, Britz P 2003. Commercial Fishing Rights Allocation in Post-apartheid South Africa: Reconciling Equity and Stability. *African Journal of Marine Science* 25: 25–35.

Kriesberg L 1998. *Constructive conflicts: from escalation to resolution*. Lanham, MD: Rowman & Littlefield Publishers.

Lallemand P, Bergh M, Hansen M, Purves M 2016. Estimating the economic benefits of MSC certification for the South African hake trawl fishery. *Fisheries Research* 182: 98–115.

Mahon R 1997. Does fisheries science serve the needs of managers of small stocks in developing countries. *Canadian Journal of Fisheries and Aquatic Sciences* 54: 2207–2213.

Mayfield S, Atkinson LJ, Branch GM, Cockcroft AC 2000. Diet of the West Coast rock lobster Jasus lalandii: influence of lobster size, sex, capture depth, latitude and moult stage. *South African Journal of Marine Science* 22: 57–69.

Melville-Smith R, van Sittert L 2005. Historical commercial West Coast rock lobster *Jasus lalandii* landings in South African waters. *African Journal of Marine Science* 27: 33–44.

Muñoz-Nuñez D 2009. *The Caribean spiny lobster fishery in Cuba: An approach to sustainable fishery management*. MSc Thesis, Duke University, North Carolina.

Ngqongwa A 2015. *Small-scale fisheries governance in South Africa using Information Management Systems*. MSc thesis, Department of Environmental and Geographical Science, University of Cape Town, South Africa.

Nthane TT 2015. *Understanding the livelihoods of small-scale fishers in Lamberts Bay: Implications for the new Small-scale Fisheries Policy*. MSc thesis, University of Cape Town, South Africa.

Oceana group 2019. People - Remuneration policy. South Africa: Oceana group limited.

O'Murcheataigh C, Campanelli P 1998. The relative impact of interviewer effects and sample design effects on survey precision. *Journal of the Royal Statistical Society: Series A (Statistics in Society)* 161: 63-77.

Pereira G, Josupeit H 2017. The world lobster market - Globefish Research Programme - Volume 123. Rome, Italy: Food and Agriculture Organization of the United States.

Petrik M, Raemaekers S 2018. The Case for Supporting Small-Scale Fisheries Governance Through ICT - Policy Briefing 177. SAIIA (South African Institute of International Affairs).

Pikitch EK 2004. ECOLOGY: Ecosystem-Based Fishery Management. *Science* 305: 346–347.

PLAAS 2017. Smallscale Fisheries Policy implementation; Fishing Rights Allocation Process 2020: DAFF progress report. Parliamentary Monitoring Group.

Plagányi ÉE 2008. Further results using the 2008 abalone assessment model for Zones A, B, C and D. MCM 2008 NOV SWG-AB 20. Cape Town: MARAM, University of Cape Town.

Plagányi ÉE, van Putten I, Thébaud O, Hobday AJ, Innes J, Lim-Camacho L, Norman-López A, Bustamante RH, Farmery A, Fleming A, et al. 2014. A Quantitative Metric to Identify Critical Elements within Seafood Supply Networks. *PLoS ONE* 9: e91833.

Pollnac R, Bavinck M, Monnereau I 2012. Job Satisfaction in Fisheries Compared. *Social Indicators Research* 109: 119–133.

Pollock DE 1986. Review of the Fishery for and Biology of the Cape Rock Lobster Jasus lalandii with Notes on Larval Recruitment. *Canadian Journal of Fisheries and Aquatic Sciences* 43: 2107–2117.

Pollock DE, Beyers CJDB 1981. Environment, distribution and growth rates of West Coast rock lobster Jasus lalandii (H.Milne Edwards). *Transactions of the Royal Society of South Africa* 44: 379–400.

Pollock DE, Cockcroft AC, Groeneveld JC, Schoeman DS 2000. The Commercial Fisheries for Jasus and Palinurus Species in the South-East Atlantic and South-West Indian Oceans. In: Phillips BF, Kittaka J (eds), *Spiny Lobsters*. Oxford, UK: Blackwell Science Ltd. pp 105–120.

Pollock DE, Cockroft AC, Goosen P C 1997. A note on reduced Rock Lobster growth rates and related environmental anomalies in the Southern Benguela, 1988 - 1995. *South African Journal of Marine Science* 18: 287–293.

Ratner BD, Allison EH 2012. Wealth, Rights, and Resilience: An Agenda for Governance Reform in Small-scale Fisheries. *Development Policy Review* 30: 371–398.

RFA 2012. RFA: Statement by the Responsible Fisheries Alliance, concerned about governement's West Coast rock Lobster decision. *Polity*.

Rittel HWJ, Webber MM 1973. Dilemmas in a general theory of planning. *Policy Sciences* 4: 155–169.

Rogers J 2018. *Judgement in the matter between WWF South Arica and Minister of Agriculture, Forestry and Fisheries*.

RSA (Republic of South Africa) 1998. Act 18 1998. Marine Resources Act.

RSA (Republic of South Africa) 2012. Department of Agriculture, Forestry and Fisheries, Government Notice 474. Policy for the Small Scale Fisheries Sector in South Africa.

RSA (Republic of South Africa) 2014. Marine Living Resources Amendment Act (Act No. 5 of 2014).

Sauer W, Hecht T, Britz P 2003. *Economic and sectoral study (ESS) of the South African fishing industry. Volume 2: Fishery Profiles.*

Ruddle K. 2011. "Informal" Credit Systems in Fishing Communities: Issues and Examples from Vietnam. *Human Organization 70*(3): 224-232.

Schultz OJ 2017. The micro-politics of small-scale fisheries governance in South Africa: a case study of community-based political representation as a form of brokerage. *Maritime Studies* 16: 7.

van Sittert L, Branch G, Hauck M, Sowman M 2006. Benchmarking the first decade of post-apartheid fisheries reform in South Africa. *Marine Policy* 30: 96–110.

Sowman M 2006. Subsistence and small-scale fisheries in South Africa: A ten-year review. *Marine Policy* 30: 60–73.

Sowman M 2011. New perspectives in small-scale fisheries management: challenges and prospects for implementation in South Africa. *African Journal of Marine Science* 33: 297–311.

Sowman M, Sunde J, Raemaekers S, Schultz O 2014. Fishing for equality: Policy for poverty alleviation for South Africa's small-scale fisheries. *Marine Policy* 46: 31–42.

Sumaila UR 2004. Intergenerational cost-benefit analysis and marine ecosystem restoration. *Fish and Fisheries* 5: 329–343.

Swain D 2000. Effect of water temperature on catchability of Atlantic cod (Gadus morhua) to the bottom-trawl survey in the southern Gulf of St Lawrence. *ICES Journal of Marine Science* 57: 56–68.

Symes D, Phillipson J 2009. Whatever became of social objectives in fisheries policy? *Fisheries Research* 95: 1–5.

Teh LSL, Teh LCL, Rashid Sumaila U 2014. Time preference of small-scale fishers in open access and traditionally managed reef fisheries. *Marine Policy* 44: 222–231.

Wang O, Somogyi S, Charlebois S 2019. Mapping the value chain of imported shellfish in China. *Marine Policy* 99: 69–75.

Weeratunge N, Béné C, Siriwardane R, Charles A, Johnson D, Allison EH, Nayak PK, Badjeck M-C 2014. Small-scale fisheries through the wellbeing lens. *Fish and Fisheries* 15: 255–279.

Wentink CR, Raemaekers S, Bush SR 2017. Co-governance and upgrading in the South African small-scale fisheries value chain. *Maritime Studies* 16: 5.

Westman WE 1977. How Much Are Nature's Services Worth? *Science* 197: 960–964.

Winzer A 2007. Market Investigation of the Impact of Rock Lobster Aquaculture. FRDC Final Report 2007/249. Western Australia: Western Rocklobster Council.

Woodworth P 2006. What price ecological restoration? *Scientist* 20: 38–45.

Worm B, Hilborn R, Baum JK, Branch TA, Collie JS, Costello C, Fogarty MJ, Fulton EA, Hutchings JA, Jennings S, et al. 2009. Rebuilding Global Fisheries. *Science* 325: 578–585.

WWF SA 2012. WWF-SA casts critical net over government's West Coast Rock Lobster decision. *WWF news*.

WWF SA 2018a. *Founding Affidavit In the matter between WWF South Africa and Minister of Agriculture, Forestry and Fiisheries*.

WWF SA 2018b. *Replying Affidavit In the matter between WWF South Africa and Minister of Agriculture, Forestry and Fisheries*.

van Zyl D, Glazer JP, Butterworth DS 2017. Analyses of trends in West Coast Rock Lobster poaching and policing effort data. MARAM/IWS/2017/WCRL/BG4. Rondebosch, Cape Town: MARAM, University of Cape Town.

Appendix 1: Participant forms, information and surveys

1.1 Informed consent declaration

RHODES UNIVERSITY
PO Box 94 • Grahamstown 6140 • South Africa
DEPARTMENT OF ICHTHYOLOGY & FISHERIES SCIENCE (DIFS)
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INFORMED CONSENT DECLARATION
(Participant)

Project Title: **Quantifying the ecological and socio-economic implications of a future recovery or collapse of South Africa's West Coast rock lobster fishery**

Profs Kevern Cochrane and Warwick Sauer and Ms Jessica Eggers from the Department of Ichthyology and Fisheries Science, Rhodes University have requested my agreement to participate in the above-mentioned research project.

The nature and the purpose of the research project and of this informed consent declaration have been explained to me in a language that I understand (See the description of the project at the end of this document and please contact Kevern Cochrane or Jessica Eggers if you have any questions before signing this form).).

I, as an individual or representing a company, am aware that:

1. By participating in this research project I will be contributing towards an improved understanding of the social and economic consequences and implications of future management decisions in the West Coast rock lobster fishery (WCRL).

2. I will participate in the project by taking part and answering the questions on the survey to the best of my ability.

3. My participation is entirely voluntary and should I at any stage wish to withdraw from participating further, I may do so without any negative consequences.

4. My views and knowledge will not be associated with me as an individual therefore there should be no foreseeable risks or comebacks to me as an individual.

5. The researcher intends on publishing the research results in the form of a report/ conference presentations / peer-reviewed papers. However, confidentiality and anonymity of records will be maintained and my name and identity will not be revealed to anyone but the three people from Rhodes University conducting this research.

6. By signing this informed consent declaration, I am not waiving any legal claims, rights or remedies.

7. A copy of this informed consent declaration will be given to me, and the original will be kept on record.

I, ……………………………………………………………………….. have read the above information and I am aware of this document's contents. I have asked all questions that I wished to ask and these have been answered to my satisfaction I fully understand what is being asked of me in completing this questionnaire.

I have not been pressurised in any way and I voluntarily agree to participate in the above-mentioned project.

………………………………….   ………………………………….

Participant's signature   **Date**

1.2 Project description provided to participants

PROJECT DESCRIPTION

Title	Quantifying the ecological and socio-economic implications of recovery/collapse of South Africa's WCRL fishery
Description	
Project objectives	To determine the likely social and economic implications of different trajectories in the future biomass and yields of the West Coast rock lobster resource, including different, feasible rates of recovery and ongoing over-exploitation, resulting from management decisions and strategies.
Outputs from the Project	The main outputs from this project will be a report, and a Masters degree thesis by Ms Jessica Eggers. Both will demonstrate the likely social and economic consequences of different management options for the West Coast rock lobster fishery. The study will combine the forecasts and management options developed by the WCRL Scientific Working Group (SWG) and the results obtained from the social and economic survey to which you are contributing to examine how the social and economic benefits of the fishery will change depending on future management decisions and how those will affect the future biomasses of the lobster stock. Separate social and economic models will be developed for the three primary sub-sectors (small-scale, near shore commercial and offshore commercial) so that the total benefits can be determined. The main focus of the study will be to determine the total benefits with the existing proportions allocated to the three sub-sectors, but it will also be possible to use these results to estimate the social and economic consequences of different allocations between the three sub-sectors.
Reasons for undertaking this project	It is well known that the WCRL fishery is in a crisis at present. The stock is seriously depleted and recent decisions by DAFF (now DEFF) to set TACs higher than the scientific recommendations have increased the risks to this stock. Illegal fishing also represents a serious threat to the future of the resource and the fishery for it. The consequences of management decisions and a failure to control illegal fishing on the stock now and in the future are well understood but the actual consequences, in terms of jobs and livelihoods, for the companies and people are only poorly understood. This project is intended to estimate these consequences, and how they will depend on different management decisions in the future. This information should help to

	inform DEFF managers, fishers and fishing companies and other people affected by the fishery, and could help them to make decisions that aim for sustainable use of the resource in a way that gets the best social and economic benefits for stakeholders.
Timing of the Project.	Planning and review of existing knowledge and information on the WCRL fishery in South Africa started earlier this year, and collection of social and economic information on the sub-sectors started in June. The project is expected to be complete and the report published by the end of 2020.

1.3 Survey to commercial vessel owners and/or processing and marketing companies

The below survey is the complete version, however it was slightly adapted to the different sector's and participants, depending on which roles they fulfilled.

Quantifying the socio-economic implications of the recovery or collapse of South Africa's West Coast rock lobster fishery.

Survey

For Queries please contact:

Prof Kevern Cochrane
E-mail: k.cochrane@ru.ac.za
Telephone: 072 103 95 47

Jessica Eggers
E-mail: jessi_eggers@yahoo.de
Telephone: 060 871 6022

Name of respondent:
Name of company:
Position within company (optional):
Sector: Nearshore commercial/Offshore commercial:

Would you like to remain anonymous: Yes No

Please answer the following questions for the seasons 2018/19, 2017/18 and 2016/17.

Section 1: Rights and vessels:

- Are you or your company a quota holder (Y/N)?
- Zone for which rights allocated:
- Are you/your company a vessel owner (Y/N)?
- How many vessels do you/your company own?

Section 2: General

Please answer the below for the season 2016/17, 2018/19 and 2019/2020

	2016/17	**2017/18**	**2018/19**
Quota as % of zonal TAC	……………	……………	……………
How large was your quota (kgs)?	……………	……………	……………
How many vessels fished for your quota?	……………	……………	……………
How many quota holders did your vessel or vessels catch for?	……………	……………	……………
What was the total catch of your vessels or vessels?	……………	……………	……………

- Do you/your company have a processing and/or marketing company (Y/N)
- For how many quota holders do you/your company process lobster?
- For how many vessels do you/your company process lobster?
- What was the total mass that you/your company processed?

Please complete the tables below for a) the vessels that you own. Indicate percentage of ownership as well, (i.e if you have complete ownership put "100%" if you have only a part share in the vessel give the percentage you own) or b) for any other vessels that fish for your quota. Please indicate a) or b) in the first column to denote the nature of the vessel described.

2016/17

Percent-age owned	Vessel name or number	Size (LOA in metres)	Main offloading harbour	No. of crew	% time used for lobster	Number of trips per season	Average duration of trips	Average landings per trip (kg)
a)								
b)								
n/a								

2017/18

Percent-age owned	Vessel name or number	Size (LOA in metres)	Main offloading harbour	No. of crew	% time used for lobster	Number of trips per season	Average duration of trips	Average landings per trip (kg)
a)								

b)
n/a

2018/19

Percent-age owned	Vessel name or number	Size (LOA in metres)	Main offloading harbour	No. of crew	% time used for lobster	Number of trips per season	Average duration of trips	Average landings per trip (kg)
a)								
b)								

n/a

Section 3: Income: Vessel owners

	2016/17	2017/18	2018/19
Total Landings for year of own quota (kgs)	……………	……………	……………
Price received per kg of lobster	……………	……………	……………
Do you catch WCRL for other quota holders (Y/N)?	……………	……………	……………
Number of quota holders caught for: a) offshore commercial quotas and b) small scale quotas or offshore allocations	………….	………….	………….
a) other offshore commercial quotas total mass caught (kgs):	……………	……………	……………
o Catching fee charged per kg	……………	……………	……………
b) small scale quotas/offshore allocations total mass caught (kgs):	…………..	……………	……………
o Catching fee charged per kg	……………	……………	……………

If the vessel or vessels are shared, please explain how the revenue from the catching fees is handled (ie. Is it split between the skipper, the boatowners and the maintenance of the boat and what percentages are allocated to whom?).

If the vessel or vessels are shared, please explain how the revenue from the different vessel owners' quotas is handled (e.g. does a part owner of a vessel have to pay a catching fee to the other vessel owners? Is this in proportion to the size of his share in the vessel?).

Does the amount landed per trip vary over the season? If so, please explain.

Does the price per kg of lobster vary over the season? If so, please explain.

Processing and Marketing Company Owners

If you are buying lobster from other quota holders, do you buy the lobster for the same price over the entire season or does your over-the-scale price change with the international market price (or for other reasons)?...

What prices did you pay for a) 2016/17, b) 2017/18, c) 2018/19? If the price varied, please provide the average price for the season and the minimum and maximum prices

If you calculate the fisher's price from the market price what deductions do you make to arrive at the over the scale price?

- marketing fee (as percentage or per kg)?
- processing fee (as percentage or per kg)?
- NCRS fee?
- Insurance fees?
- export fee?
- air freight fee?
- any other deductions?

- Or please explain how you arrive at the price if some other approach is used

If you are buying lobster from other quota holders please indicate the number of quota holders in the different sectors, as well as the total mass processed from the different sectors:

	2016/17	**2017/18**	**2018/19**
Number of quota holders from offshore commercial:	……………	……………	……………
o Total mass processed (kgs)	……………	……………	……………
Number of quota holders from nearshore commercial	……………	……………	……………
o Total mass processed (kgs)	……………	……………	……………
Number of community quotas/offshore allocations from IRP	……………	……………	……………
o Total mass processed (kgs)	……………	……………	……………

Section 4: Costs

4I): Capital Costs

Sea-based property

Vessel name or number	Current value	Replacement value
…………………	………….	…………………
…………………	………….	…………………

Number and cost of transport vehicles (if applicable):

Cost of at-sea equipment:

Describe major at-sea equipment required (e.g., traps, safety equipment, etc).

- How often does equipment have to be replaced?

Cost of landing site (if bought or rented):

Land-based property (where applicable)

Purpose in relation to WCRL (e.g., freezing, holding and packing live etc.)

Is it used for purposes apart from WCRL?

If yes, % of time and space used for WCRL

Current value of buildings:

Current value of land-based equipment (tanks, pumps, thermo-regulators):

Current value of vehicles for transporting lobster:

4ii) Running Costs (per year)

	2016/17	2017/18	2018/19
Sea going			
Total annual salary costs (including salary and other financial benefits)	……………	……………	……………
Cost of permit(s)	……………	……………	……………
Annual maintenance cost (or give a total):			
o Boat	……………	……………	……………
o Vehicle	……………	……………	……………
o Equipment	……………	……………	……………
Annual depreciation cost	……………	……………	……………
Monthly insurance costs for:			
o Boat	……………	……………	……………
o Vehicles	……………	……………	……………
o Equipment	……………	……………	……………
o Employees	……………	……………	……………
o Other	……………	……………	……………
Average running costs per trip per vessel			

o Fuel	……………	……………	……………
o Bait	……………	……………	……………
o Crew salaries	……………	……………	……………
o Skipper salary	……………	……………	……………
o Other (specify what for)	……………	……………	……………
Total per year:	……………	……………	……………

Do you need to transport your own catch by road to a buyer? If yes:			
o What distance is the round trip?	……………	……………	……………
o How many trips do you make per year?	……………	……………	……………
o Average fuel cost per trip?	……………	……………	……………

If the vessel/s are shared, please explain how the capital, maintenance and running costs are shared among vessel owners.
……………………………..……………………………..……………………………..…………
……………………..……………………………..………………………………..

Land-based (processing and marketing)

Total annual salary costs (including salary and other financial benefits)	……………	……………	……………

Cost per year for:			
o Electricity	……………	……………	……………
o Water	……………	……………	……………
o Containers and ice for export	……………	……………	……………
o Other consumables	……………	……………	……………
o Rent of any other offices/property?			
Total:	……………	…………….	…………...

Maintenance cost :			
o Facilities	…………..	……………	……………
o Equipment	……………	……………	……………
o Vehicles	……………	……………	……………

If responsible for exporting:

Total cost for export permits	……………	……………	……………
Costs of exporting/kg	……………	……………	……………

Section 5: Social parameters

Do any quota holders without vessels participate on your vessel/s as crew or skippers?

If yes, how many, in which positions and from which of the sectors?

			Crew	Skipper	Factory worker	Factory Supervisor	Admin	Manager
Average benefits per year for different categories of employees	16/17	Salary Insurance Pension						
	17/18	Salary Insurance Pension						
	18/19	Salary Insurance Pension						
How many employees are employed full time and temporarily/seasonally?	16/17	Full time Temporary						
	17/18	Full time Temporary						
	18/19	Full time Temporary						

1.4 Survey for IRP Quota holders

<u>Questions for Interim Relief Permit holders</u>

1. What community do you belong to?...
2. What was your quota for West Coast rock lobster in the last season?............................
3. What marketer did you sell your quota to? ....
4. What was the price that you received per kilogram? ....
5. What percentage of your total annual income is derived from the West Coast rock lobster harvest? ....
6. What other resources do you fish for and what percentages of your total income do you get from those? ....
7. Do you get income from any activities apart from fishing and how much of your income comes from those activities. ....
8. Do you own a boat?

   a. **If you have a boat:**

      1. What is the value of your boat?..
      2. How many crew do you take out to sea?..

3. Do you have insurance on your boat? How much does insurance cost you per month?..
4. Do you have insurance on your Towing vehicle? How much does insurance cost you per month?...
5. How much West Coast rock lobster do you catch per trip on average?...
6. Do you catch West Coast rock lobster for other members of the community? If yes, for how many did you catch for in the last season?..
7. How many trips did you make for catching West Coast rock lobster in the last season?...
8. Estimate your expenses **per trip**:

    1. Bait ……………………………………………………………
    2. Fuel ……………………………………………………………
    3. Oil …………………………………………………………….
    4. Tow/Vehicle costs ……………………………………………
    5. Crew salaries ………………………………………………….

9. Estimate your expenses **per year:**

    1. Boat maintenance …………………………………………
    2. Survey costs ………………………………………………
    3. Permit costs ………………………………………………
    4. Safety equipment …………………………………………
    5. Nets ……………………………………………………….
    6. Tow vehicle maintenance …………………………………
    7. Any other expenses? ………………………………………

b. **If you don't have a boat:**

i. If you go out as crew on another boat, what crew fee do you receive?...

ii. If you don't go out to sea, how much is the catching fee for your quota (per kilogram)? ……………………..

9. Have you taken out a loan in the last years? How much? How many times were you paid?
10. What was the catching fee for the offshore quota?...
11. Has all of the offshore quota been caught?..
12. How many dependents do you have?...
13. What options do you have, apart from the harvest and sale of West Coast rock lobster, to generate an income large enough to sustain yourself and your dependents?...

Appendix 2: Calculation of the input variables for Chapter 3

2.1 Weighted averages

In most cases the averages calculated from the estimates given by different respondents for costs or incomes are weighted by either the numbers of vessels per respondent, quota size, total mass caught or by other factors. In every instance where an average was weighted, the according weighting variable is explicitly stated. The weighting was done following the standard equation given below. For these averages, variances and standard deviation were weighted as well, according to Equation 7.2.1.

$$\underline{x} = \frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i}$$

Eq 7.2.1

Where: $\underline{x}$= the weighted mean

n = the number of data points in the sample

w_i = the weights applied to the data values

x_i = the data values that are averaged

Weighted standard deviation was calculated using the Equation 7.2.2:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} w_i \, (x-\underline{x}^*)^2}{\sum_{i=1}^{n} w_i - 1}}$$ Eq 7.2.2

Where: σ = Weighted standard deviation

2.2 Depreciation

Annual depreciation was calculated using a standard annual depreciation rate (Dpc) of 10% following equation 7.2.3.

$$Csdp_s = Cptc_{s-1} \times Dpc$$

Eq.7.2.3

Where: $Csdp_y$ = Annual depreciation cost per vessel per season (R/season)

$Cptc_{y-1}$ = the capital value of the previous season (R)

Dpc = Depreciation rate (%/season)

2.3 CPUE and catch per trip data

For the purpose of calculating the income and expenses for vessel owners in the different sector's, the model requires an estimate as to the mass that can be expected to be caught in one trip. This is important for calculations regarding the income of a vessel owner per trip, as well as how many trips a vessel owner needs to make in order to land their total catch or quota, thus allowing an approximation of how much a vessel owner spends on fishing alone over a season. For the OC and the NC sector total numbers of trips and total catches were available from the DEFF data, but in instances where it was not possible or sensible to use the total number of trips (for the IRP sector where such data was not available or for calculating the economic income of individual groups within the sectors) the approximate number of trips required to catch a given total catch, was calculated using the mean catch per trip derived from the DEFF landing records (discussed below) for the different sectors (Equation 7.2.4):

$$nTr_s = \frac{Tc_s}{CaTr_s}$$

Eq 7.2.4.

Where: nTr_s = Number of trips made in season (trips/ season)

Tc_s = Total catch made in season (kgs/ season)

$CaTr_s$ = Catch per trip (kgs/trip)

2.4 Offshore individual examples

Calculating the net seasonal income for offshore commercial vessel owners followed Equation 7.2.5:

$$NSI_y = ((TC_s \times Pfs \times NPr) + (TC_s \times Pfo \times Cfe(OC))) - ((nTr_s \times Cstr) + nV_s \times (Csan + Csdp))$$

Eq 7.2.5

Where: Pfs = Percentage of the total catch that is caught for the VQs own quota (catch for self/ Total catch)

Pfo = Percentage of the total catch that is caught for another's quota (catch for other/ Total catch)

Terms given in previous equations remain as above

Calculating the net seasonal income for offshore commercial non- vessel owners followed Equation 7.2.6:

$$NPI_y = Qt_s \times (Npr - Cfe\ (OC))$$

Eq 7.2.6

Where: Qt_s = The quota holder's quota size in a given season (kgs)

Terms given in previous equations remain as above

2.5 Nearshore commercial and IRP sector individual examples:

The net seasonal income for vessel owning nearshore commercial quota holder was calculated following Equation 7.2.7:

$$NSI_s = \ (Qt_{s\,SA} \times (Npr - Cwf) + (nQt \times \left(Qt_{s\,SA} \times (Ctfe - Cwf)\right)) - ((nTr_s \times Cstr) + Csan + Csdp)$$

Eq.7.2.7

Where: nQt = number of other quota holders caught for by the vessel owner (n)

Terms given in previous equations remain as given above

The net seasonal income for vessel owning IRP quota holders was calculated following Equation 7.2.8:

$$NSI_s = \ (QtNQ_{s\,SA} \times (Npr - Cwf) + \left(nQt \times \left(NQQt_{s\,SA} \times (Ctfe - Cwf)\right)\right) + \ ((QtOQ_{s\,SA} \times (NPr - CfeOC)) - ((nTr_s \times Cstr) + Csan + Csdp + TLv)$$

Eq 7.2.8

Where: Terms given in previous equations remain as above

The vessel owner is assumed in these calculations to not be claiming any crew fees for him/her self, meaning that the crew fee is subtracted from the entire catch made (which reflects the arrangement most common among the respondents). This means that while the difference between numbers of individuals employed as crew is important for the social considerations and financial opportunities in these sectors and affects the typical income for each crew member, it bears little importance for the economic calculations per vessel owner, as the crew fee is subtracted from every kg that is caught by the vessel and the number by which this is then divided (the number of crew) and is therefore irrelevant for the vessel owner’s over all income.

2.6 NC and IRP sector: Non- vessel owners

No NC quota holders without their own vessel were interviewed, but a large number of non-vessel owning IRP quota holders and communities were reached. The net income for a particular season for a non-vessel owning quota holder is calculated from their quota size (available from DEFF records), catching fee and the market price (estimates of which are available from IRP NVQ, IRP and NC VQ and other stakeholders)).

The net seasonal income for non-vessel owning nearshore commercial quota holders was calculated following Equation 7.2.9:

$$NSI_s = Qt_{s\,SA} \times (NPr - Cfe)$$

Eq 7.2.9

Where: Terms given in previous equations remain as above

The net seasonal income for the Non-vessel owning IRP nearshore quota holders was calculated following Equation 7.2.10:

$$NSI_s = QtNQ_{s\,SA} \times (NPr - CfeNC)$$

Eq 7.2.10

Where: Terms given in previous equations remain as above

The net seasonal income for the Non-vessel owning IRP offshore quota holders was calculated following Equation 3.6.11:

$$NSI_s = QtOQ_{s\,SA} \times (NPr - CfeNC)$$

Eq 7.1.11

2.7 NC and IRP sector crew members

The income per crew member was calculated on a per trip basis, assuming the median number of crew members per vessel owner derived from the interview and survey data, from which further generalizations can subsequently be made given different scenarios concerning the number of trips that a crew member might partake in in a given season. The income per trip per crew member was calculated according to Equation 7.2.12

$$TrInc_{s\,SA} = \frac{CaTr_{s\,SA}}{Ncw} \times Cwf$$

Eq 7.2.12

Where: Ncw = Number of crew on a given vessel

Terms given in previous equations remain as above

Appendix 3: NSI model input summary of variables

3.1 Offshore commercial sector summary of variables for the economic analysis of the seasons 2016/17-2018/19

Table 7.3.1. Summary of the input variables for the offshore commercial sector, used to calculate the net seasonal Profit for the seasons 2016/17-2018/19 for A) the entire sector, B) Non-vessel owning quota holders, and C) Vessel owning quota holders

	Normal distribution		Distinct values (from DEFF catch records)			
A)	μ	σ	2016/17	2017/18	2018/19	
					OC	IRP OQ
TC_s = Total catch made season (kgs/season)			941 924	872 366	459 849	
$TCIRp_s$ = Total catch for IRP OQ (kgs) made in season s						110 285
NPr = Net value to the vessel owner of a kilogram of lobster (after deductions) (R/kg)	322.45	50.79				
$Cfe\ (OC)$ = Catching fee for other quota holders (R/kg)	82,11	12				
nTr_s= Number of trips made in season s (n)			2696	2171	1114	370 $(methods)$
nV_s = number of vessels active in season s (n)			64	60	52	

$Cstr$ = Cost per trip (R/trip)	6 098.10	1 526.37			
$Csan$ = Annual cost per vessel (R/season)	1 760 426	67 492.47			
$Cptc$ =Capital cost (R)	2 500 000	500 000			
Dpr = Depreciation rate			0.1	0.1	0.1
B)	Normal distribution		2016/17	2017/18	2018/19
Qt_s = Range of quota sizes for OC NVQ (kgs)	First Quartile:		1051.9	1989.568	749.7
	Median:		2603.597	2581.977	1170.71
	Third quartile:		4172.487	2920.038	1662.94
C)	Normal distribution μ	σ	2016/17	2017/18	2018/19
TC_s = Total catch made by one vessel (kgs)	First Quartile:		4 954.175	3 938.625	3 311.825
	Median:		**13 389.5**	**12 424.35**	**7 294.4**
	Third quartile:		20 346.33	20 074.68	11 195
Pfs_s = Proportion of total catch for self	Scenario 1: 0				
	Scenario 2: 0.5				
	Scenario 3: 1				
Pfo_s = Proportion of total catch for others	= 1- Pfs_s				
$Catr_{OC}$ = Catch per trip (kgs/trip)	Predicted mean:		278.3	300.0	297.5
	SE		0.0644	0.0646	0.0657

3.2 Nearshore commercial sector summary of variables for the economic analysis of the seasons 2016/17-2018/19

Table 7.3.2 Summary of the input variables for the nearshore commercial sector, used to calculate the net seasonal Profit for the seasons 2016/17-2018/19 for A) the entire sector, B) Non-vessel owning quota holders, and C) Vessel owning quota holders

	Normal distribution		Distinct values (from DEFF catch records)		
A)	μ	σ	2016/17	2017/18	2018/19
TC_s = Total catch (kgs)			341 474	243 049	151 825
NPr = Net price (after deductions) (R/kg)	282.7462	31.37			
$PIRP$ = Proportion of quota caught for IRP	Scenario 1:	0			
	Scenario 2:	0.8			
$Qt_{IRP\ NQ}$ = Nearshore IRP quota (kgs)			233 305	220 611	127 804
Cfe = Catching fee (R/kg)	94.16	31.11			
nTr_s= Number of trips made (n)			4300	2743	2430
nV_s = number of vessels active (n)			346	201	264
$Cstr$ = Cost per trip (R/trip)	1741.81	577.5			

$Csan$ = Annual cost per vessel (R)	23453.26	6104.44
$Cptc$ =Capital cost (R)	165590.5	39842.43

B)	Normal distribution			Distinct values (from DEFF catch records)		
	μ	σ		2016/17	2017/18	2018/19
$Qt_{s\,SA}$ = Individual quota per sector per SA (kgs)			1+2	615.4	1250	626.6
			3+4	501.5	773.2	229.7
			5+6	443.1	1728	1091.1
			8+	438.8	629.5	217.4

C)	Normal distribution			Distinct values (from DEFF catch records)		
	μ	σ		2016/17	2017/18	2018/19
$Catr_s$ = Catch per trip for each season and SA (kgs/ trip)	Predicted mean		1+2	21.35	22.76	41.13
	SE			0.0450	0.0910	0.0539
	Predicted mean		3+4	39.91	27.86	21.87
	SE			0.0527	0.0625	0.0723
	Predicted mean		5+6	123.41	169.58	172.53
	SE			0.0680	0.0716	0.0702
	Predicted mean		8+	101.66	122.36	84.38
	SE			0.1175	0.1176	0.1189
	Predicted mean		Entire area	63,74	73,13	55,08
	SE			0,05416	0,105535	0,106274
Cwf = Crew fee (R/kg)	17.3	5.8				
nQt = Number of other quota holders caught for (n)		Scenario 1		0	0	0
		Scenario 2		2	2	2

3.3 IRP sector summary of variables for the economic analysis of the seasons 2016/17-2018/19

Table 7.3.3 Summary of the input variables for the Interim Relief Permit sector, used to calculate the net seasonal Profit for the seasons 2016/17-2018/19 for A) the entire sector, B) Non-vessel owning quota holders, and C) Vessel owning quota holders

A	Normal distribution		Distinct values (from DEFF catch records)			
	μ	σ	2016/17	2017/18	2018/19 NQ	OQ
TC_s = Total catch (kgs) in season s			Not available, using the IRP NQ quota instead			110 285
$Qt_{IRP\,NQ}$ = Nearshore IRP quota (kgs)			233 305	220 611	127 804	
NPr = Net price after deductions (R/kg)	282.7462	31.37				
$Cfe\ (NC)$ = Catching fee (R/kg)	94.16	31.11				
$Cfe\ (OC)$ = Catching fee (R/kg)	81,4	12				

$PIRP$ = Proportion caught by IRP		Scenario 1	0.2
		Scenario 2	1
PNC = Proportion caught by NC		Scenario 1	0.8
		Scenario 2	0
nV_s = number of vessels active in season s	Scenario 1:	32	
	Scenario 2:	156	
$Catr_s$ = Catch per trip (kgs/ trip) NPr = Net price after deductions (R/kg) $Cfe\ (NC)$ = Catching fee (R/kg) $Cstr$ = Cost per trip (R/trip) $Csan$ = Annual cost per vessel (R) $Cptc$ =Capital cost (R)	See corresponding part in the nearshore commercial variable summary table.		

B

		2016/17		2017/18		2018/19 NQ		2018/19 OQ	
		μ	σ	μ	σ	μ	σ	μ	σ
$Qt_{s\,SA}$ = Individual quota for each zone and season (kgs/person)	B	125.92	3.6	125.39	2.5	97.69	25.1	41.75	0.8
	C	127.24	18.8	124.00	19.5	95.98	15.2	51.78	6.9
	D								
	E	54.98	2.1	52.32	8.3	22.46	2.4	44.57	1.2
	F	108.23	8.5	99.75	14.4	45.33	6.6	92.68	7.9

C		2016/17	2017/18	2018/19 NQ	2018/19 OQ
Cwf = Crew fee (R/kg)	See corresponding part in the nearshore commercial variable summary table.				
nQt = Number of other quota holders caught for (n)		Scenario 1	0	0	0
		Scenario 2	5	5	5

3.4 Small-scale summary of variables for the economic analysis of the seasons 2016/17-2018/19

Table 7.3.4 Summary of the input variables for the Port Nolloth small-scale fisher's co-operative, used to calculate the net seasonal Profit for the season 2018/19.

		NQ	OQ
Scenario 1	TC_s = Total catch (kgs)	1 100	1 700
Scenario 2	Qt_{PN} = Port Nolloth quota (kgs)	9 100	4 308
Npr = Net price after deductions (R/kg)		250	235
$Sasg$ = salary for sea- going individuals (R/kg)		50	
$Saad$ = salary for admin (R/kg)		30	
Sap= Pension (R/kg)		30	

Inv = Investment into maintenance (R/kg)		40
$ncoop$ = number of individuals in the co-operative (n)		69
$npens$ = number who are on a pension (women, disabled and old) (n)		22
nsg = number of individuals who are sea- going (n)		47
Ncw = Number of crew per trip (n)		3
nV = number of active vessels (n)		9
$Csan$ = Annual cost per vessel (R) (NC and IRP Values)	23453.26	6104.44

3.5 PMC summary of variables for the economic analysis of the seasons 2016/17-2018/19

Table 7.3.5 Summary of the input variables for PMCs, used to calculate the gross seasonal Profit for the seasons 2016/17- 2018/19.

	Normal distribution		Distinct values (from DEFF catch records)		
	μ	σ	2016/17	2017/18	2018/19
Entire PMC component of the value-chain					
Tmp = Total mass processed (kgs) of OC caught			795106.9	739 237.9	569170.9
Tmp = Total mass processed (kgs) of NC caught			427 374.5	378 931.7	232 338.4
Employees and salaries					
$Sanf$ = Monthly salary to personnel employed in the factory (R/month)	7392	1726			
$Sanm = Monthly$ salary to personnel employed in management and support positions (R/month)	18 894	4442			

Appendix 4: Net value of lobster (per kilogram) approximation

4.1 Background

The “net value” is a standard way of discussing prices in the IRP and NC sector, where many fishers are paid “over-the- scale” prices, and the marketer handles all further deductions. The offshore sector quota holders, and especially vessel owners, are more often closely linked to the PMCs and their revenue is therefore often discussed before deductions, which means, that in order to understand what the net value of a kilogram of lobster is to the catching sector deductions for the different sectors and to understand the processes around how marketers might calculate the “over the scale” prices further calculations had to be made.

Prices received depend on the time of landing (explored in Figure 3.2.5.2 and Table 3.2.5.3) and on the export “categories” (frozen, tails or live) (explored in Table 3.2.5.2). Further deductions are made on a per kilogram basis by PMCs and exporters (Table 3.2.5.4) as well as in the forms of levies and fees paid per landing, shipment or transaction which are referred to as “bulk fees” here. These were not explored in Chapter 3, but are important to discuss here to understand their contribution to the final net price estimates.

4.2 Input variables not explored in Chapter 3: Levies and bulk fees

The “bulk fees” are difficult to generalize, since they generally are incurred per landing or per export, and can thus be applied differently depending on the mass a quota holder is exporting at a given time, the number of quota holders contributing to one shipping, the number of clients that are shipped to and the individual company’s rates regarding insurance of banking fees. To give some examples, an export permit can be held for 3 months and for 10 quota holders at a time and costs 690 R. How many export permits one company obtains (and how it might charge the quota holders for this expense) depends on the time of landing of the different quota holders, the size of each quota holders catch, the number of quota holders involved, the length of the season ect. Further every shipment requires an NRCS health certificate, costing 724 R, which has to be obtained for every client separately (shipments generally being of an average mass of 700 kgs, but one shipment can be directed at more than one client). Lastly, there are levies incurred by traders in export products determined by the National Regulator for Compulsory Specifications (NRCS). In the case of the WCRL different levies apply to exports of whole live, whole frozen, and frozen parts. These additional levies are incurred by commercial lobster traders, and the cost for these is often subtracted from the price paid per kilogram to the quota holders. The levies for the season 2018/19 sourced from the NRCS official call for return of commodities to which levies apply are detailed in Table 7.4.1.

Table 7.4.1 Tariffs and units for the Commercial sectors for different lobster related products (NRCS [31] 2019).

	Unit (kgs)	Tariff per unit
Whole live rock lobster	1000	R 526
Whole frozen lobster	30	Sliding scale: R422,00 per unit for 1st ten (10) units; R26,00 per unit for each subsequent unit.
Frozen rock lobster tails, leg and breast meat	10	Sliding scale: R422,00 per unit for 1st ten (10) units; R26,00 per unit for each subsequent unit.

Since all of the above explored bulk costs are difficult to apply to the price of a small landing by one quota holder, an example of bulk deductions is reported here (Table 7.4.2) for a single landing given to us by one PMC concerning the export of a 132 kg landing, reduced to a 120 kg export due to anticipated water loss.

Table 7.4.2 Example of rounded bulk deductions given by one PMC. Since these figures are based on the example of a single shipment (PMC stakeholder pers comm. 2019)

Charge	Fee (R/shipment)
Insurance	200.00
Banking fees	500.00
Permit	150.00
Transport permit	50.00
NRCS fees	250.00
Total charges ($TBch$)	1150
Size of shipment ($Shsz$)(kgs/shipment)	120
Bulk charges (R/kg) (Bch)	**9.5833**

4.1 Net value calculations

The mean international market price received per kilogram of lobster destined for export ($IntMpr$)were estimated for each season by weighing the monthly average international market prices by the amount of lobster caught in that month (for the two commercial sectors combined and for the OC and the NC catch separately). The overall average international market price was

[31] https://www.nrcs.org.za/siteimgs/Levy/Levy%20Returns%2019B/Electrotechnical%2019B.pdf

then calculated by weighting each season's average by the total catch made for the season ($IwMpr$).

The average price paid per kilogram exported accounting for the different products and predictable damages and losses was calculated according to Equation 7.4.1.

$$AdMpr = IwMpr \times (Pl + (Pwf \times WfPMpr) + (Ptf \times TfPMpr) + (Pop \times OpPMpr) + (Plst \times LstMpr))$$

Eq. 7.4.1

Where: $AdMpr$ = Average value per kilogram of lobster after deduction of predictable losses and damages (R/kg)

$IwMpr$ = The weighted average of the international market price ($IntMpr$) (R/kg)

Pl = Proportion of total export that is exported live

Pwf = Proportion of the total export that is exported whole frozen

$WfPMpr$ = Proportion of the international market price obtained by whole frozen export

Ptf = Proportion of the total export that is exported as frozen tails

$TfPMpr$ = Proportion of the international market price obtained by frozen tail export

Pop = Proportion of the total export that is lost due to overpacking

$OpPMpr$ = Proportion of the international market price obtained by frozen tail export

$Plst$= Proportion of the total export that is lost due to death or extreme damage

$LstMpr$ = Proportion of the international market price obtained by lost (death or damage) lobster

After the deductions described above due to damages, quality loss and deaths, the following fees and charges are subtracted to arrive at an approximation of the net price that a quota holder might expect per kilogram of landed lobster, these were given in Table 3.2.5.4.

Bulk deductions were added in addition to the "per kilogram" fees (processing, marketing and airfreight fees), as deductions generally applying to a quota holder's shipment, rather than on per kilogram basis, including some administrative charges (such as insurance and bank charges), and some permit related charges (including the export, NRCS and transport permit charges). For these purposes these will be based on the example of the export given in Table 7.4.2. and are calculated on a per kilogram basis, following equation 7.4.2.

$$Bch = \frac{TBch}{Shsz}$$

Eq 7.4.2

Where Bch = Bulk charges (R/kg)

$TBch$ = Total bulk charges (R/shipment)

$Shsz$ = Shipment size (kgs/ shipment)

The net price per kilogram of lobster to the quota holder could then be calculated following Equation 7.4.3.

$$NMpr = AdMpr - (Prf + Af + Lvs + Bd) - (IwMpr * Mkf)$$

Eq 7.4.3

Where: $AdMpr$ = The average value of a kilogram of lobster after the deductions concerning mortality and loss of quality (R/kg) considering the different proportions of the original price received per different product categories

Prf = Processing fee (R/kg)

Af= Air freight fee (R/kg)

Lvs = Levies (R/kg)

Bd = Bulk deductions/tariffs (R/kg)

Mkf = Marketing fee (proportion of international Marketing price)

4.3 Market price input variable summary

Table 7.4.3 Summary of the input variables for calculating an approximate net value of lobster per kilogram to quota holders, after predictable loss of quality, damages and after standard fees and deductions at the processing, marketing and exporting level for the seasons 2016/17- 2018/19.

	Both sectors		NC sector		OC sector	
	μ	σ	μ	σ	μ	σ
$IntMpr$ = International market price (R/kg)	539.70	74.61	526.14	70.04	544.00	76.55
Pl = Proportion exported live	=1-($Pwf + Ptf + Pop + Plst$)					
Pwf = Proportion exported whole frozen	0.0325	0.5	Pwf_{all}		Pwf_{all}	
$WfPMpr$ = Proportion of live market price obtained for frozen whole exports	0.4					
Ptf = Proportion exported as frozen tails	0.049	2.99	Pwf_{all}		Pwf_{all}	
$TfPMpr$ = Proportion of live market price obtained for frozen tail exports	0.25					
Pop = Proportion overpacked	0.02333333	1.154701	Pwf_{all}		Pwf_{all}	
$OpPMpr$ = Proportion of market price obtained for overpacked lobster	0					
$Plst$ = Proportion lost due to death or extreme damage	0.04	1.41	Pwf_{all}		Pwf_{all}	
$LstMpr$ = Proportion of market price obtained for dead or damaged lobster	0					
Mf = Market fee (% of I$ntMPr$)	0.08					
Pf = Processing fee (R/kg)	62.18	10.68				
Af = Airfreight fee (R/kg)	58.15	1.83				
Lv = Levy (R/kg)	4.5					
TBd = Total bulk costs (R/shipment)	1150	300				
$mshp$ = Mass of a general shipment (kgs/ shipment)	120	20				

4.4 Market price results

The calculations were made combining the 3 seasons given in Table 7.4.4 and using a Monte Carlo simulation to account for the uncertainty within the different input variables. For these calculations all variables were assumed to be normally distributed.

Table 7.4.4 Mean and interquartile range of the net value of a kilogram of lobster, calculated overall and for the offshore and nearshore commercial sector separately.

Net	OC and NC combined	NC	OC
Mean net value of a kilogram of caught lobster	295.34 ± 61.26	284.38 ± 58.55	298.91±63.60
Interquartile range after deductions			
1st Quartile	252.86	244.37	256.51
Median	296.010	285.96	298.04
3rd Quartile	336.38	324.01	341.86

Comparing these estimated “net price received” to the “ over the scale” prices reported by OC, NC and IRP quota holders, it appears that the calculated average net value for the NC sector of 284.38 +- is very similar to the weighted average net price received per kilogram after all deductions reported across the interviewed NC fishers and IRP communities (average 282.79 +- 31.33) as well as the average net prices reported by individual NC fishers over the seasons in surveys (weighted average 301.58 +- 18.71 and 289.79 +- 4.66).

The above deduced average net price received by the OC sector (298.91 ± 63.60) is lower than the weighted average net price reported by one NVQ OC quota holder (average 322.45 +- 50.79 R/kg over seasons 2016/17-2018/19), however, the reported net value comfortably falls within the interquartile range of the deduced net value. Given the difference in the price received as a result of the time of catching, PMC, quality of catch, size of shipment ect, it is not surprising that these two values would vary to some extent.

The tornado sensitivity analysis revealed that by far the largest contributor to the outcome of the net price per kilogram was the international weighed market price, with its contribution ranging between 90 and 94 % for the three calculated result variables. Given that the calculations of the average international market prices were derived from sound and detailed data, giving developments over three seasons, and were weighted using official catch per month figures, this is a high confidence variable. Due to the overwhelming contribution of the average international market prices to the variation in the result variable, the variation in the results can therefore also, to a large part, be attributed to the natural variance of the market price rather than methodological uncertainty. Since the “bulk deductions” are the area of highest methodological uncertainty, their relatively small contribution across the board (the variation in cost per shipment and size of shipment together contributing to less than 0.5% of the result variable for all calculations) the weakness of this variable does not appear to bear too much weight on the final results.

Since the data collection found a decent sample of price approximations for the NC and IRP fishers and quota holders, it is more appropriate to use those figures for the further calculations regarding the socio-economic dimensions of this fishery. The proximity between the reported and calculated net prices received however, can contribute to confidence in the net prices used in the calculations for the OC sector, where the interview and survey response regarding this variable was much poorer.

Appendix 5: NPV Monte Carlo simulations input variables summary

5.1 Offshore commercial sector summary and model inputs

Table 7.5.1 Summary of the input variables for the offshore commercial sector, used to calculate the Net Present Value for the timeframe 2018/19-2030/31 for A) the entire sector, B) Non-vessel owning quota holders, and C) Vessel owning quota holders.

A)			
$P\,TAC_{OC}$ = OC TAC as a proportion of the global TAC	0.5202		
$PTAC_{IRP\,OQ}$ = IRP OQ as a proportion of the global TAC	0.1299		
nV_s = number of vessels active in the OC In relation to the total TAC (n)	Vessels active in the OC sector (n)	OC MSE	OC RMSE
640 t TAC scenario	47	13.950	3.73
1084 t TAC scenario	52		
1280 t TAC scenario	55		
	Average	Stdev	
q = catchability coefficient for OC vessels in the entire fishing area (kgs/t)	0.01715	0.00299	

B)

$PQt_{NVQ\ OC}$ = *I*ndividual quota size of a NVQ as a proportion of the global TAC (kgs)	First Quartile	0.00069
	Median	0.00108
	Third quartile	0.00153

C)

Tct_{OC} = Total catch made by a single vessel (kgs)

	640 t	1084 t	1280 t	MSE	RMSE
First Quartile	3242.3	5030.7	5820.1	741048.347	860.842
Median	8040.0	12797.6	14897.9	2157452.083	1468.827
Third quartile	13087.4	19361.2	22130.7	2167152.360	1472.125

5.2 Nearshore commercial sector summary and model inputs

Table 7.5.2 Summary of the input variables for the offshore commercial sector, used to calculate the Net Present Value for the timeframe 2018/19-2030/31 for A) the entire sector, B) Quota holders.

A)	Normal distribution		
$P\ TAC_{NC}$ = NC TAC as a proportion of the global TAC	0.1571		
$PTAC_{IRP\ NQ}$ = IRP NC as a proportion of the global TAC	0.1571		
nV_s = number of vessels active in NC		MSE	RMSE
640 t TAC scenario	193	3121.9	55.87
1084 t TAC scenario	230		
1280 t TAC scenario	246		

Q = catchability coefficient (kgs/t)	Average	Stdev
	0.038151	0.009571
	0.011671	0.005039
	0.040724	0.017457
	0.017896	0.005593
B)		
$PQt_{s\ SA}$ = Individual quota size as a proportion of the global TAC	1+2	0.000578
	3+4	0.000212
	5+6	0.001007
	8+	0.000201

5.3 IRP sector summary and model inputs

Table 7.5.3 Summary of the input variables for the IRP sector, used to calculate the Net Present Value for the timeframe 2018/19-2030/31 for A) the entire sector, B) Quota holders. All variables not presented here are presented in Appendix 3.6.2.3.

A)	
$PTAC_{IRP\ NQ}$ = IRP NC as a proportion of the global TAC (t/season)	0.1571

$PTAC_{IRP\ OQ}$ = IRP OC as a proportion of the global TAC		0.1299	
nV_s = number of vessels active NC (kgs) In relation to global TAC scenarios(n)		α (slope)	β (y intercept)
Equation given in methods		0.519	141.19
B)			
$PNQt_{IRP\ SA}$ =		Average	Stdev
Individual quota size as a proportion of the global TAC	B	0.00009012	0.00002313
	C	0.00008854	0.00001403
	D+ E	0.00002008	0.0000031
	F	0.00004182	0.00000613
$POQt_{IRP\ SA}$ = Individual quota size as a proportion of the global TAC	B	0.00003852	0.00000073
	C	0.00004776	0.00000641
	D+ E	0.00003998	0.00000408
	F	0.0000855	0.00000734

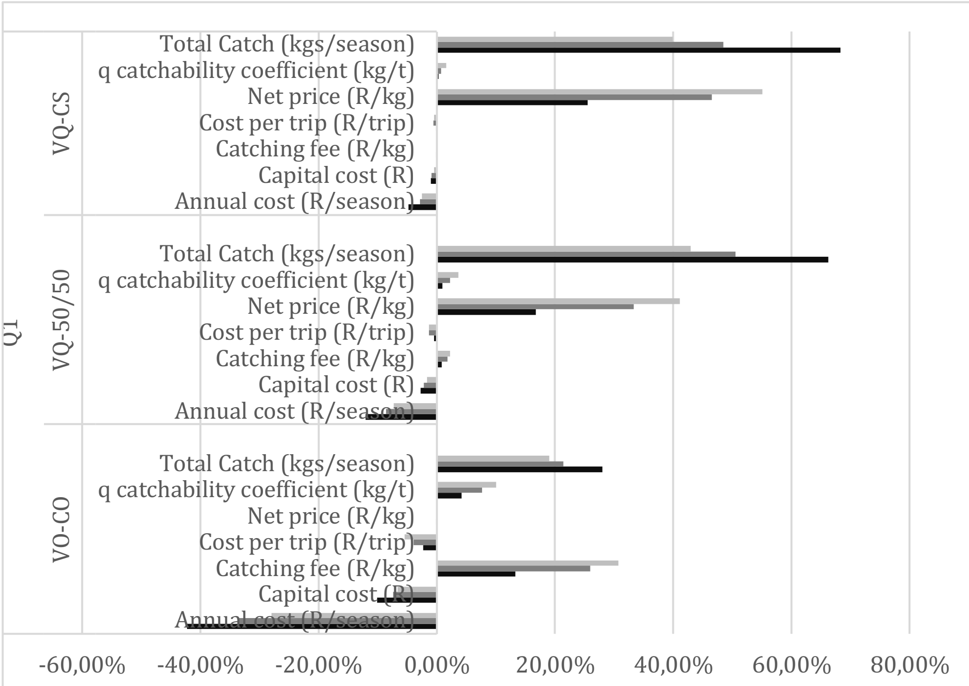
5.4 Gross present value of WCRL exports model inputs

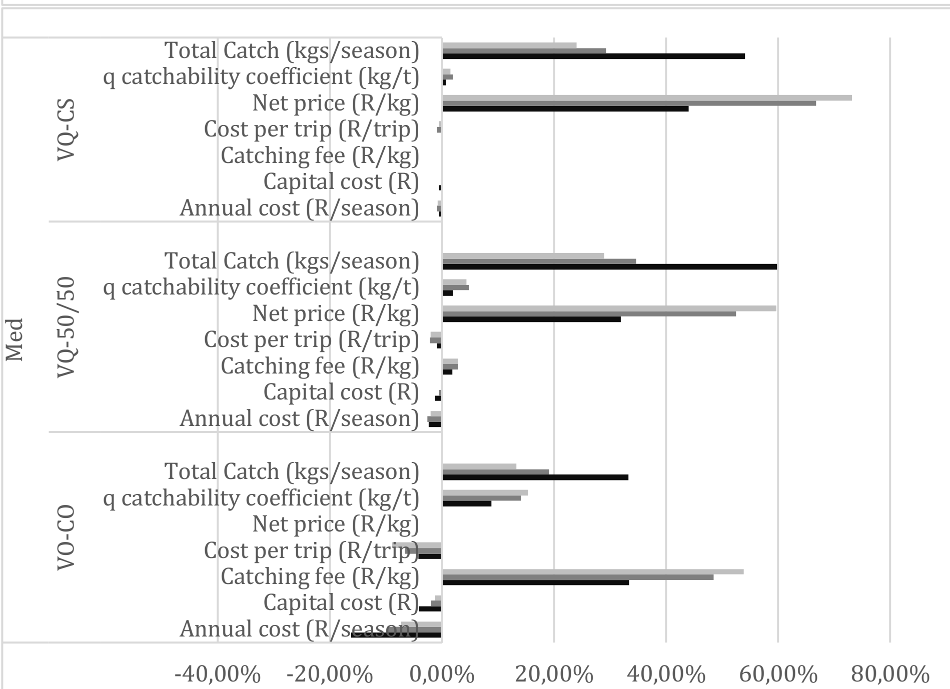
Table 7.5.4 Summary of the input variables used to calculate the Gross Present Value for the timeframe 2018/19-2030/31 for total WCRL exports

	Average	Stdev
Average international market price (R/kg)	473.5 ± 67	67
Average proportion of TAC exported	0,7056	0,05

Appendix 6: Tornado sensitivity analysis for the NPV Monte Carlo results

6.1 Offshore commercial sector


Q1
VQ-CS
VQ-50/50
VO-CO
Total Catch (kgs/season)
q catchability coefficient (kg/t)
Net price (R/kg)
Cost per trip (R/trip)
Catching fee (R/kg)
Capital cost (R)
Annual cost (R/season)
-60,00%
-40,00%
-20,00%
0,00%
20,00%
40,00%
60,00%
80,00%


Med
VQ-CS
VQ-50/50
VO-CO
Total Catch (kgs/season)
q catchability coefficient (kg/t)
Net price (R/kg)
Cost per trip (R/trip)
Catching fee (R/kg)
Capital cost (R)
Annual cost (R/season)
-40,00%
-20,00%
0,00%
20,00%
40,00%
60,00%
80,00%

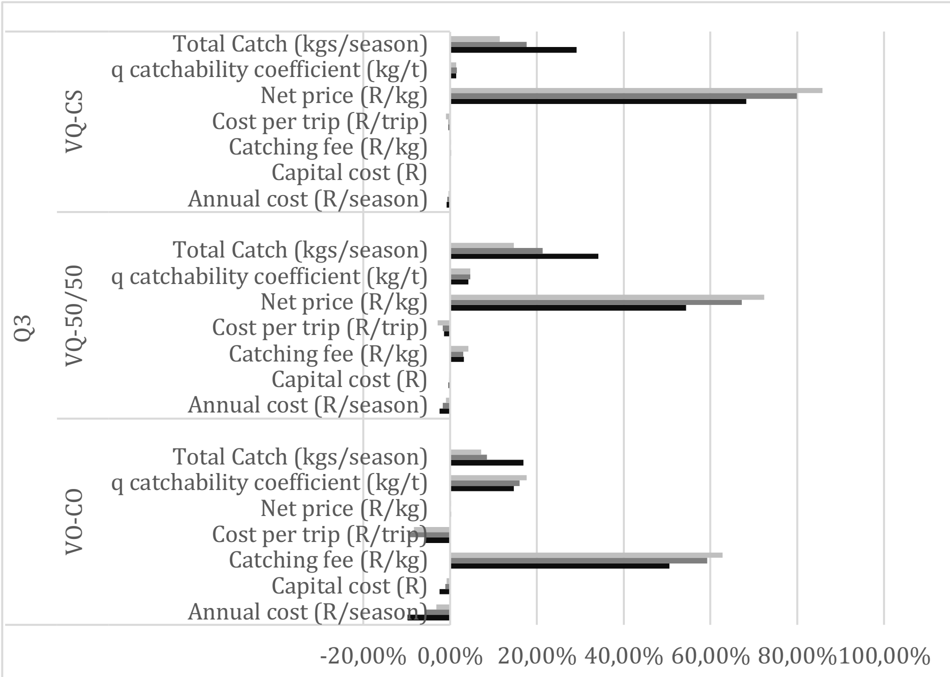


Figure 6.1 Tornado sensitivity chart for models calculating the NPV of Vessel owners (VO-CO, VQ-50/50 and VQ-CS) in the offshore commercial sector of the WCRL fishery, for vessels catching at the first quartile (A), the median (B) and the third quartile (C) of the range of total catches made per vessel under the three TAC management scenarios (640t TAC: Black bars, 1084 t TAC: dark grey bars, 1280 t TAC: light grey bars).

6.2 Nearshore commercial sector

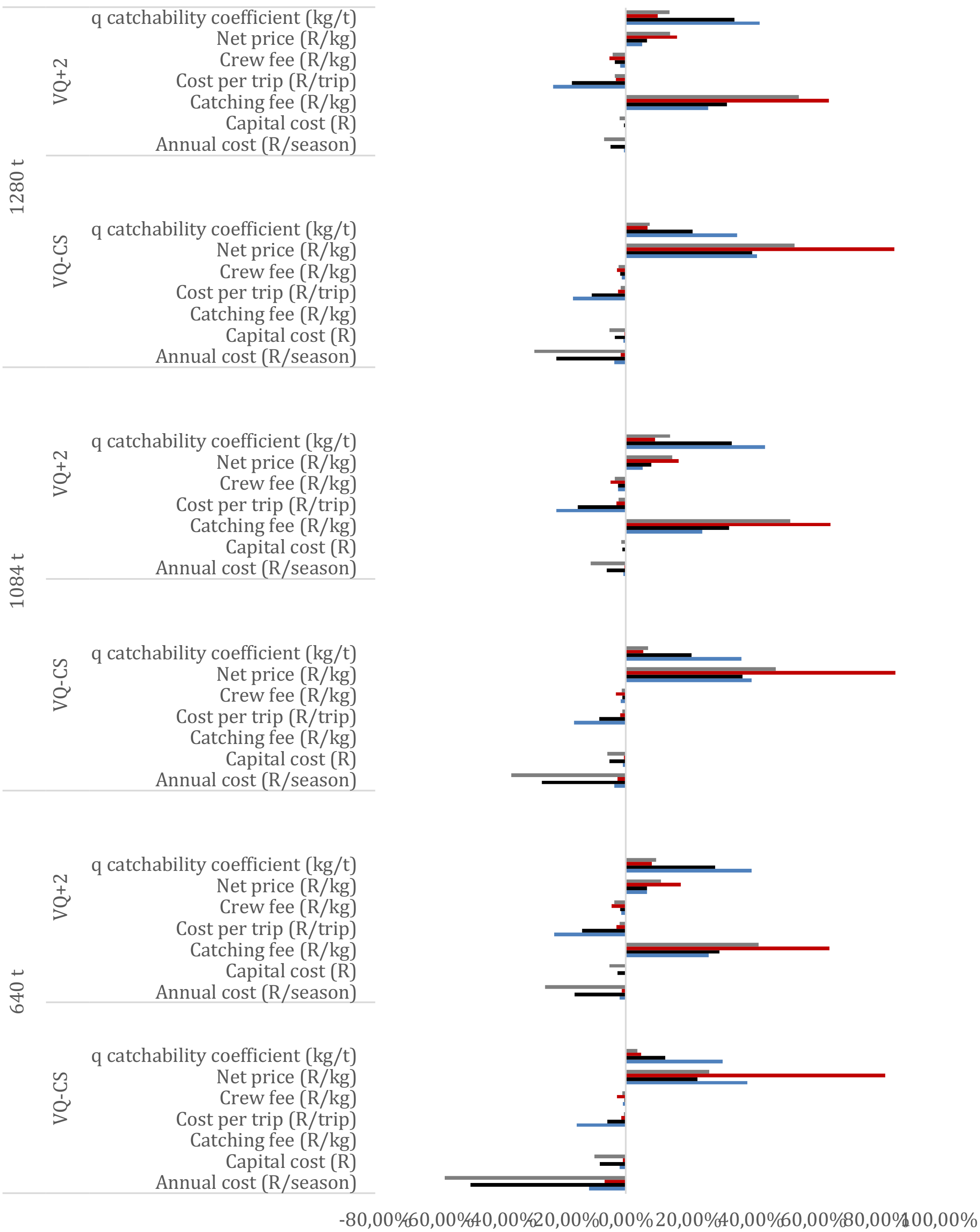


Figure 6.2 Tornado sensitivity chart for models calculating the NPV of Vessel owners in the nearshore commercial sector of the WCRL fishery for fishers fishing only for their own quota (VQ-CS) and fishers fishing for their own and 2 other quota holder's quotas (VQ+2) under the three TAC management scenarios and for the four different zones (SA 1+2: Blue. SA 3+4: Black, SA 5+6: Red, SA 8+: Grey).

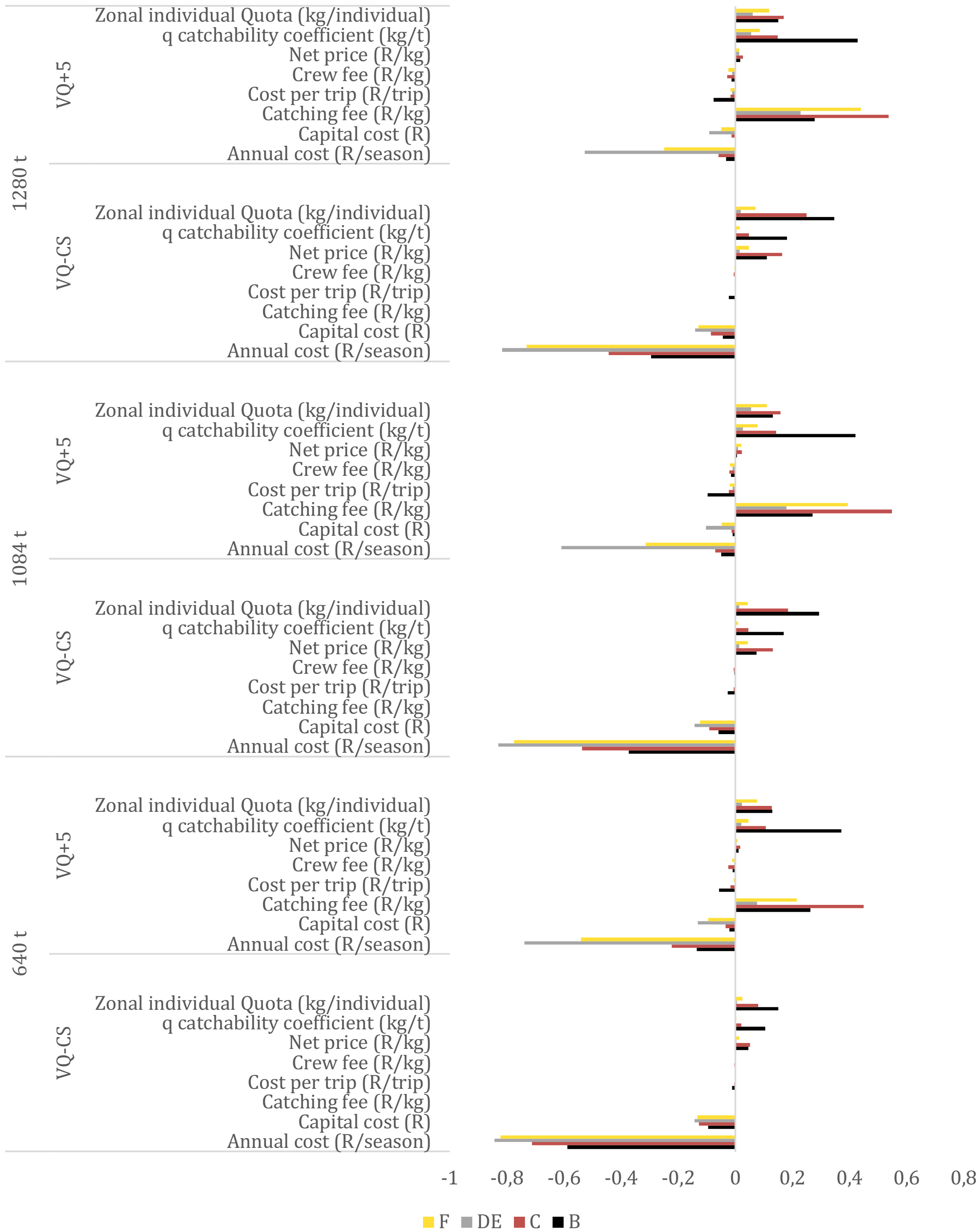


Figure 6.3 Tornado sensitivity chart for models calculating the NPV of Vessel owners in the IRP sector of the WCRL fishery for fishers fishing only for their own quota (Scenario 1) and fishers fishing for their own and 5 other people's quotas (Scenario 2) under the three TAC management scenarios and for the four different zones (Zone B: Black, Zone C: Red, Zone D & E: Grey, Zone F: Yellow).