National Environmental Research Program

MARINE BIODIVERSITY hub

Community acceptance of marine biodiversity offsets in Australia: a pilot study

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Theme 2: Supporting Management of Marine Biodiversity

4 February 2014

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Acknowledgement

This work was undertaken for the Marine Biodiversity Hub, a collaborative partnership supported through funding from the Australian Government's National Environmental Research Program (NERP). NERP Marine Biodiversity Hub partners include the Institute for Marine and Antarctic Studies, University of Tasmania; CSIRO Wealth from Oceans National Flagship, Geoscience Australia, Australian Institute of Marine Science, Museum Victoria, Charles Darwin University and the University of Western Australia.

Important Disclaimer

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Community acceptance of marine biodiversity offsets in Australia: a pilot study

1. Introduction

Biodiversity offsets are used to account for environmental damages caused by development. In Australia, there are offset policies operating at the State and Commonwealth Government levels. An offset policy becomes relevant when residual environmental damages are likely to result from a proposed development; that is, when damages are likely to remain after all avoidance and mitigation measures have been undertaken. In such a case, the proponent must propose to offset the residual damages by protecting or improving equivalent environmental matter elsewhere. In theory, this should result in no net loss to the environment. If the proponent can reasonably show that the proposed offset will avoid a net loss, then the development may be considered for approval.

The relevant State offset policy applies to any residual environmental damages resulting from development (e.g. Government of Western Australia 2011). In addition, if a matter of national environmental significance is affected, the Commonwealth's Environmental Protection and Biodiversity Conservation (EPBC) Act Offset Policy also applies (Australian Government 2012). Matters of national environmental significance include species listed as threatened or migratory under the EPBC Act.

The EPBC Offset Policy was released in 2012, following a period of comment on a draft version of the policy. In drafting and revising this policy, the science and economic efficiencies of offsetting were addressed. However, little is known about the social acceptability of biodiversity offsets. If offsets are to become common practice in environmental management and policy, it is important that they are designed in a way that satisfies the scientific, economic and social dimensions. This study will examine the preferences of the Australian community with respect to how marine biodiversity offsets are implemented. In particular, community reaction to the following policy characteristics (or attributes) are of interest:

- the proportion of direct versus indirect[1] offset;
- the type of offset activity;
- the location of the offset, relative to the development site;
- the species protected by the offset;
- the implementer of the offset; or,
- whether co-benefits are likely to result from the offset.

[1] The language associated with offsets varies across jurisdictions, and time. The EPBC Offset Policy differentiates between "direct offsets" and "other compensatory measures" where "other compensatory measures" are those actions that do not directly offset the impacts on the protected matter, but are anticipated to lead to benefits for the impacted protected matter, for example funding for research or educational programs" (Australian Government 2012, p.9). To simplify the language within the survey we used the terms "direct" and "indirect" offsets, and will do so within this paper, but our definition of the indirect offset as "research" is consistent with an "other compensatory measure".

There is an emerging literature on the design and implementation of offsets (e.g. ten Kate et al. 2004, Madsen et al. 2010, DEC 2011, Dickie et al. 2013, Hayes and Morrison-Sanders 2007, Middle and Middle 2010, Quétier and Lavorel 2011). However, there is little that has focused on public attitudes towards the process.

There is an extensive literature on the use of survey techniques to elicit community values for non-market, and in particular environmental goods (e.g. see Mitchell and Carson 1989, Bateman et al 2002, Bennet 2011 for reviews of technical issues and applications; Carson 2012 provides a comprehensive bibliography of applications). Choice experiment surveys are one form of non-market valuation approach, which we employ here to determine community preferences for different biodiversity offset packages. In a choice experiment survey, alternative scenarios of possible policy options are developed, which include statements of the outcomes of those policies. These outcomes are described in terms of attributes (e.g. proportion of direct to indirect offset), and each attribute can take on different levels (e.g. 60%, 80% or 100% direct offset). Respondents are asked to make choices between the policy options in each scenario, where each option will present a different combination of the levels of the attributes, and select their preferred option.

Multinomial logit models are used to analyse the data collected from the surveys. These models explain each choice as a function of the weighted utility of the attributes and the levels that appear in each option. Specifically, utility (U) is a function of the vector of attributes (X) of option j, the parameters (β) of option j, and the unobservable utility (ε), or error component, of option j:

$$U_j = \beta X_j + \varepsilon_j$$

The error component is included to acknowledge that we can only explain an individual's preferences in terms of the attributes included in the survey, but there may be other unobservable factors influencing an individual's choices. As specified by Train (2009), in the multinomial logit model, the probability of an option i being chosen by individual n is represented as follows:

$$P_{ni} = \frac{e^{\lambda\beta' x_{ni}}}{\sum_j e^{\lambda\beta' x_{nj}}}$$

where lambda (λ) is a scale parameter. The scale parameter is inversely proportional to the standard deviation of the error term; that is, it scales the attribute coefficients according to the variance (σ) of the unobserved utility (Hensher et al. 2005). It is not possible to separately identify the scale and beta parameters, meaning that the estimated parameters must be interpreted as scaled marginal utilities.

Once a model is estimated, it is then possible to calculate the marginal rate of substitution (MRS) for a given attribute. A MRS shows the willingness to substitute the amount of one attribute for a change in any of the other attributes. It is calculated by specifying one attribute coefficient as the numeraire (β_b), and taking the negative ratio of this to another attribute coefficient (β_a) (Train 2009):

$$MRS = -\frac{\beta_a}{\beta_b}$$

If there is a cost attribute within the design, it is usual to use its coefficient as the denominator in this expression, in which case the MRS can be interpreted as a willingness to pay for a unit change in an attribute.

When conducting choice experiments, an important step prior to conducting a full sample study is to deploy preliminary pilot studies, using relatively small sample sizes, which can test issues of survey design and implementation. The remainder of this study reports the results from a number of pilot surveys designed to investigate community acceptance of marine biodiversity offset attributes, with the intent to use this preliminary analysis to inform a larger survey of community preferences. A subset of the offset policy attributes listed above was investigated in the pilot phase. Two choice experiment surveys were administered to samples of the Perth metropolitan community, each targeting a different matter of national environmental significance. In this regard, the results are relevant to inform both State level and EPBC offset policies.

First, a study investigating community preferences for seagrass offsets was conducted. While seagrass is not protected under the EPBC Act itself, it is an important habitat and food source for other marine species that are protected under the Act. Section 2 reports the results of the pilot study on community preferences for seagrass offsets.

Second, a study investigating community preferences for migratory shorebird offsets was conducted. Migratory shorebird species are protected under the EPBC Act and are thus a matter of national environmental significance. This pilot survey contained two analyses: (1) an analysis of the social license to operate (SLO) of the oil and gas industry in Western Australia; and (2) the choice experiment analysis of community preferences for migratory shorebird offsets. The results of the former are used to help explain preferences of different individuals in the latter. A SLO is an implicit contract between a company (e.g. an oil or gas company) and its stakeholders (e.g. the Australian community) which ensures that the socio-political risk of challenges to a company is reduced if it behaves according to its stakeholders values (Prno and Slocombe 2012). Section 3 reports the results of the SLO analysis, and Section 4 reports the results of the choice experiment.

Section 5 summarises the implications of pilot survey results for the full launch of the choice experiment survey. The next phase of the project is also discussed.

2. Community preferences for seagrass biodiversity offsets

Alexandra Kay[2], Michael Burton, Abbie Rogers

2.1 Seagrass case study

2.1.1 Survey context and attribute descriptions

In the seagrass choice experiment, a hypothetical development is described to respondents. The development is proposed in the vicinity of a beach along the Kimberley coast. Some environmental impacts can be avoided or mitigated but there are residual impacts on seagrass beds in the area. A population of approximately 50 green turtles exist in the location off the Kimberley coast. Green turtles are listed as vulnerable under the EPBC Act. They rely on the seagrass beds for foraging. As a result of the damages to the seagrass bed, it is anticipated that 30 of the turtles will be impacted. As a result, marine biodiversity offsets will be required to ensure no net loss to the turtles.

When constructing the offset packages that would compensate for the residual damage, we considered three attributes:

- The ratio of direct to indirect offsets. We investigated proportions of direct to indirect offsets from 50:50 through to 100:0 in multiples of ten. While the specific definition of what constitutes a direct or indirect offset varies across different offset policies, for the purpose of this survey, a direct offset was defined as a new on-ground intervention aimed at improving the environment. The indirect offset was defined as research to improve existing on-ground management techniques of green turtles in Australia to ensure there is no net loss to the species as a result of the development.

- The type of direct offset, referring to the specific on-ground activity. Three types of direct offset activity were considered.

    - Seagrass beds could be replanted to provide an equivalent area of feeding ground for the green turtles.

    - Nutrient inputs from agricultural practices, residential developments, public spaces and other land uses could be reduced to stop the damaging effects of nutrients on nearby seagrass beds. By controlling nutrient pollution, damaged seagrass sites can return to their original condition and provide feeding areas for the turtles.

    - Green turtle nesting sites could be protected to increase the number of hatchlings reaching the water. Turtle populations are impacted not only by food availability,

[2] The seagrass pilot study was undertaken by Alexandra Kay as part of her Honours dissertation (Kay, 2013) .

but predation on eggs (by dogs, lizards and small mammals) as well as predation on hatchings (by fish, crabs and birds).

- The location of the direct offset. The offset could be implemented a few kilometres away from the development site on the Kimberley coast, or it could protect green turtle populations 800km away on the Pilbara coast, or on the Queensland coast.

The attributes and their levels are defined in Table 2.1. An example of how they appeared in the choice scenarios is shown in Figure 2.1. Note that, in the Kimberley offset location, it was only sensible to employ the 'replanting seagrass beds' or 'nutrient pollution reduction' direct offset activities. If nesting ground management was enacted, while more hatchlings may reach the water, due to the damage to existing seagrass beds there may be an insufficient food source to support the increase in hatchlings.

According to the EPBC Offset Policy, the preferable offset package would comprise a high proportion of direct offsets using seagrass replanting in a nearby location on the Kimberley coast. This form of offset would be the closest reproduction of the damaged environment. However, it might not always be technically feasible to deliver this form of offset, or there might be greater environmental benefits anticipated through other means of implementation. Therefore, it is useful to know whether the general community perceives this as the preferred offset package, and to what extent are they willing to accept different combinations of direct/indirect offsets, offset locations, and types of direct offset activity.

Table 2.1: The offset policy attributes included in the choice experiment, with level specifications and variable labels.

Attribute	Levels	Variable*
Proportion of the offset option in a direct measure	50%, 60%, 70%, 80%, 90%, 100%	per
Location of direct offset measure	Kimberley, WA (site of development)	loc1
	Pilbara, WA	loc2
	Queensland	loc3
Type of direct offset activity	Replanting seagrass beds	pol1
	Nutrient pollution reduction	pol2
	Green turtle nesting ground management	pol3

*For the purpose of estimation, *per* is a continuous variable and the other variables are dummy coded, where they =1 if selected and =0 otherwise.

2.1.2 Survey design and administration

Prior to the construction of the choice experiment survey, focus groups were held to test the language and concepts that would appear in the questionnaire. The focus groups comprised 16 individuals who were members of the general Perth community. Subsequently, the survey was designed to first provide background information on marine biodiversity offsets; then present the attributes and choice experiment questions, along with debriefing questions about the choice task; and last, collect socio-demographic information about the respondents.

The choice scenarios were designed to contain three options (Figure 2.1). Each option provided a different configuration of the attributes and their levels. As the interest of this survey is to determine how people trade off one attribute against another, and not within the acceptability of offsetting as a practice more generally, respondents were informed that all offset options presented to them would lead to a no net loss to the environment.

An efficient experimental design for the choice scenarios was constructed using the Ngene software (Rose et al. 2008). Through an efficient experimental design (Scarpa and Rose 2008), the levels of an attribute can be assigned to each alternative offset option in a systematic manner to provide the greatest amount of information. A total of 24 choice scenarios were constructed, and blocked by a factor of four so that each respondent received six choice scenarios.

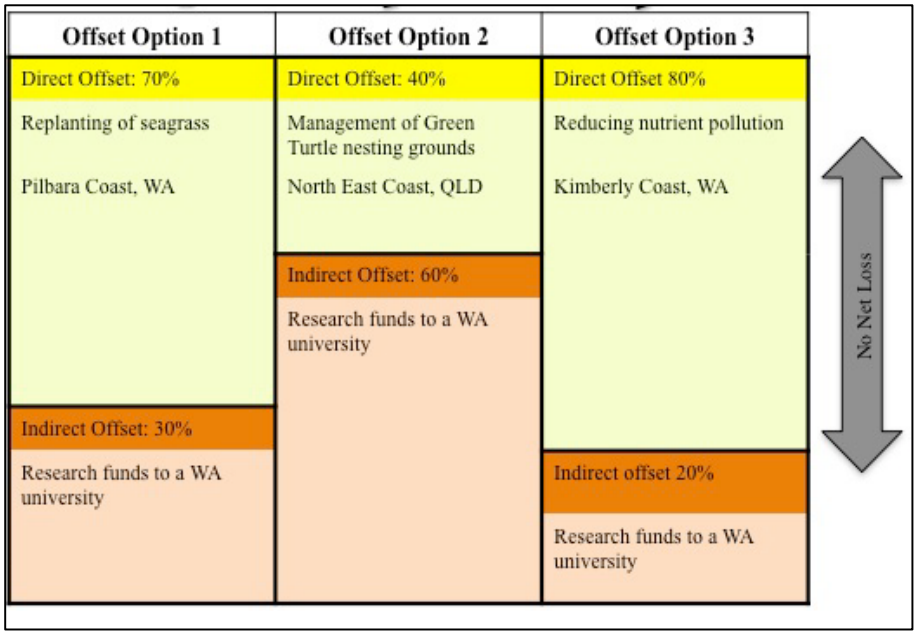

Figure 2.1: Example of a choice scenario in the survey.

The survey was issued to participants who subscribe to an online panel managed by a market research company (The Online Research Unit), during August 2013. Survey data was obtained from 101 respondents: summary statistics of the sample are reported in Table 2.2. In comparison to the Australia Bureau of Statistics (ABS), 2011 Perth Census of Population and Housing data, this survey attracted a higher percentage of participants in the *46-60* age bracket of 36.6% (the ABS suggest a population weighting of 17.7%), and a lower percentage of participants in the *18-30* age bracket at 13.9% (the ABS suggest a population weight of 42.9%). Survey participants are also over represented in education levels of 'trade / technical certificate' at 35.6% respectively (ABS suggests 23%[3]).

[3] Note that ABS data for education are not directly comparable with sample data as they include individuals in the 15+ age group (rather than 18+) and the 'School to year 12' education bracket is defined differently.

Table 2.2: Characteristics of survey respondents compared with those observed in the Perth population.

		Perth sample	Perth population
Gender	Male	50.5%	55.5%
	Female	49.5%	44.5%
Age	18-30	13.9%	42.9%
	31-45	26.7%	25.9%
	46-60	36.6%	17.7%
	61-75	18.8%	10.4%
	Over 75	4%	3.1%
Education	School to yr10	14.9%	7.7%
	School to yr12	10.9%	66.2%
	Trade/ Technical certificate	35.6%	9.4%
	University degree	38.6%	46.2%

2.2 Seagrass results

This section reports the results of the pilot choice experiment for the seagrass case study. First, the results to debriefing questions in the survey are reported, followed by the choice analysis and a discussion of acceptable offset packages.

Respondents are exposed to a novel concept of marine offsetting circumstances, from which they are required to evaluate policy options. Given this situation, an understanding of how confident respondents are in their choices throughout the survey will help in the analysis of results. This information is obtained by asking the respondent debriefing questions after the choice scenarios have been completed (Table 2.3). From these questions, 71% of respondents did not find the offsetting scenarios confusing, 88% think they can make informed choices about the offset strategies based on the information of offsets given, and 73% find the information provided to describe the offset strategies as informative and accurate. The outcomes of these questions allow the survey to be analysed with relative confidence in the responses given by participants.

Table 2.3: Responses to debriefing questions asked at the end of the choice experiment.

Survey Question	Response	% of sample
Do you think the characteristics of offsets described, were what you needed to know in order to make informed choices about offset strategies?	Yes	88%
	No	12%
Do you think the offsetting scenarios were confusing?	Yes	29%
	No	71%
What did you think about the information provided to describe the offset strategies?	It was confusing	24%
	It was inaccurate	3%
	It was informative and accurate	73%
Indicate how certain you were with the answers you gave in the offset scenarios	1 – Not at all Certain	0
	2	3%
	3	9%
	4	20%
	5	30%
	6	30%
	7 – Very Certain	8%

A multinomial logit model is used to estimate model coefficients using the statistical software Stata (StataCorp 2012) (Table 2.4). First, a multinomial logit model is constructed with only the experimental design attributes of percentage of direct offset implemented (*per*) and per squared (per^2), direct offset location (*loc2*, *loc3*; respectively being the Pilbara and Queensland), and the type of direct offset policy implemented (*pol2*, *pol3*; respectively being nutrient reduction and nesting ground management). A quadratic relationship is specified for *per*, as the variable was not significant when assuming a linear specification. For the categorical dummy variables, *loc1* (location in the Kimberley) and *pol1* (direct offset policy of seagrass replanting) are used as the baseline categories, against which the other levels are compared.

Following this a second multinomial logit model is constructed to include individual characteristics that help to explain preferences, such as age, gender or other observed characteristics of the respondents that were revealed through additional survey questions (Table 2.4). These interaction variables are defined in Table 2.5. A chi squared test on the two models log likelihood values demonstrates that the second model, with the inclusion of interaction terms, is the better fit. The chi squared statistic is defined as twice the difference in the log likelihood of the base model and the interaction model ($2 \times (-605.55 — 584.79)$) and gives a value of 41.52, which is then compared against the critical value of 18.48 at the 95% level of confidence and 6 degrees of freedom. Therefore through accounting for the heterogeneity in respondents we can better explain their preferences for the offset policy attributes.

Table 2.4: Multinomial logit models of a base model, with offset policy attributes, and an interaction model, with attributes and explanatory individual characteristics.

	Interaction Model				Base Model			
Variable	Coefficient	Std.Err	Z	P	Coefficient	Std.Err	Z	P
loc2	-0.44	0.19	-2.37	0.02	-0.06	0.11	-0.53	0.59
loc2 x visit	0.17	0.07	2.54	0.01				
loc3	-1.49	0.25	-5.97	0.00	-0.96	0.13	-7.39	0.00
loc3 x confdif	-0.68	0.23	-2.98	0.00				
loc3 x localcom	0.28	0.11	2.49	0.01				
per	0.16	0.03	4.90	$1.0e^{-3}$	0.13	0.03	4.37	0.00
per^2	$-8.8e^{-4}$	$2.0e^{-4}$	-4.35	0.00	$-8.0e^{-4}$	$1.9e^{-4}$	-4.07	0.00
per x WAgovconf	-0.02	$4.8e^{-3}$	-3.20	$1.0e^{-3}$				
per x agem	$3.9e^{-4}$	$1.9e^{-4}$	2.01	0.04				
per x localcom	$6.2e^{-3}$	$3.1e^{-3}$	1.98	0.05				
pol2	-0.29	0.13	-2.35	0.02	-0.28	0.12	-2.24	0.03
pol3	-0.09	0.14	-0.70	0.48	-0.07	0.14	-0.48	0.63
Log Likelihood		-584.79				-605.55		
Number of observations		606				606		
Number of individuals		101				101		

Table 2.5: Description of the selected demographic interaction variables found to be significant and included in the interaction model.

Variable	Description	Coding	Sample mean
visit	Question: Have you visited the Pilbara region before?	1: No and I don't know much about the region 2: No, but I am familiar with the region 3: Yes, I have visited for work/business purposes 4: Yes, I have visited for travel/leisure/recreation 5: Yes, I previously resided there	2.26
WAgovconf	Question: Do you have confidence in the WA government environment department to follow through with its conservation commitments?	1: No 2: To some extent 3: Yes	1.96
QLDgovconf	Question: Do you have confidence in the QLD government environment department to follow through with its conservation commitments?	1: No 2: To some extent 3: Yes	1.95
confdif	Difference in government confidence (between WA and QLD).	WAgovconf-QLDgovconf	0.01
localcom	Question: In your opinion, how important are Local Communities?	-3: Not at all important -2: Very unimportant -1: Somewhat unimportant 0: Neither important or unimportant 1: Somewhat important 2: very important 3: extremely important	5.72
age	Question: Which of the following age brackets apply to you?	24: Age group 18 to 30 38: Age group 31 to 45 53: Age group 46 to 60 68: Age group 61 to 75 80: Age group over 75	49.01
agem	Difference in age relative to the observed average of 49 yrs.	Respondent's age - 49	n/a

Discussion of results and further analysis will be concentrated on the preferred model with interaction variables (Table 2.4). The presence of interaction terms with attributes means that the interpretation of the impact of the attribute on utility has to be considered carefully: size and even sign of the marginal effect will be determined by the level of the interacting variable. For example, with *loc1* (Kimberley) as the baseline, the marginal impact on utility from shifting the offset to the Pilbara (*loc2*) is given by (-0.44 + 0.17*visit)*. Individuals who are more familiar with the Pilbara region (*visit=2*) react less negatively to having the offset in this location, relative to individuals who are unfamiliar with the Pilbara region (*visit=1*). Individuals who have been to the Pilbara before for business, leisure, or to live (*visit*=3,4,5), view offsets in this location favourably, relative to a Kimberley offset location.

In the case of locating the offset in Queensland (*loc3*), there are two significant interaction variables, being *confdif* (Difference in government confidence) and *localcom* (Importance of local

communities). Therefore, the marginal change in utility from *loc3* is calculated with the inclusion of these interactions (-1.49 -0.68$condif$ + 0.28$localcom$). Respondents who hold a positive value for the variable *confdif* (holding greater confidence in the Western Australian government), are expected to experience larger losses in utility if the offset is moved from *loc1* to *loc3*. Those respondents holding a negative value for the interaction *confdif* (greater confidence in the Queensland government) are still observed to forgo utility, although the loss is smaller (-1.49 - 0.68*condif*; *condif*<0), ignoring the interaction between *loc3* and *localcom*.

With respect to preferences for *per* (percentage of direct offset), they are generally more positive as the percentage of direct offsetting is increased (Table 2.4). However, *per* interacts with three observable characteristics of *WAgovconf* (confidence in the local Western Australian government), *agem* (age), and *localcom* (Importance of local communities); therefore, welfare derived from *per* is calculated with the inclusion of these interactions (0.16 -0.02$WAgovconf$ + 0.00*agem* + 0.01$localcom$). The interaction with *WAgovconf* indicates that as confidence in the local government increases, the utility generated from *per* is lessened as the portion of direct offsetting increases. If respondents consider the importance of local communities to be between 'neither important or unimportant' and 'extremely important', then preferences are more positive for increasing levels of *per* (0.16 + 0.*01localcom*; *localcom* ≥ 0) (when the other interaction variables =0). Additional to this, preferences for direct offsetting are positively correlated with *agem*, meaning older individuals have a stronger preference for larger amounts of direct offsetting (0.16 + 3.9e^{-4}*agem*).

In terms of the type of direct offset implemented, *pol3* (nesting ground management) is not significantly different from *pol1* (replanting seagrass). However, there is a significant preference to implement *pol1* rather than *pol2* (nutrient reduction).

In general, these results are as expected. For example, a preference in the offsets being implemented in the Kimberley over the Pilbara or Queensland was also observed within the focus group study conducted. This is thought to reflect individuals' desire to directly fix the cause of the problem in the area it is created. However, there are also some unusual results seen within the interaction model, where respondents who value local community importance are observed to improve their utility, relative to other individuals, if the offset is implemented in Queensland. This is an unexpected outcome due to the survey being issued to residents of Perth, Western Australia. This interaction between *loc3* and *localcom* may have been detected by chance, as a result of the small sample size.

The proportion of the offset implemented in a direct measure does not explain preferences in a linear way. The quadratic form suggests utility is maximized at a level of direct offset between 50% and 100% (depending on the values of the interaction terms). This makes it difficult to use the percentage of direct offset as a basis for identifying conventional marginal rates of substitution, as the marginal utility from direct offsets is not constant. Instead, an alternative metric for identifying the consequences of changing attribute levels is needed. We define a baseline offset package, which can be compared with other packages that are based on all possible permutations of the offset attributes and their levels.

Table 2.6 shows the percentage of people who would prefer a defined offset package compared to a baseline offset package. The baseline policy for this table is 100% of the offset being implemented in

a direct measure, and implemented as seagrass replanting within the Kimberley. In calculating the proportion of respondents who prefer the alternative offset package, the impact of the individual specific variables that are interacted with the attributes is accounted for. Thus, these results are specific to the particular sample.

Table 2.6: The percentage of respondents who prefer various offset packages relative to a baseline offset with a 100% direct offset of seagrass replanting in the Kimberley.

Offset Policy	**Percentage of Direct Offset**					
	100	**90**	**80**	**70**	**60**	**50**
Seagrass replanting in the Kimberley	**BASELINE**	95	89	66	43	22
Nutrient reduction in the Kimberley	0	33	46	42	28	14
Seagrass replanting in the Pilbara	31	75	74	62	42	18
Nutrient reduction in the Pilbara	9	30	42	37	20	13
Green turtle nesting ground management in the Pilbara	24	54	64	50	33	17
Seagrass replanting in Queensland	4	3	2	2	1	0
Nutrient reduction in Queensland	0	1	1	1	0	0
Green turtle nesting ground management in Queensland	1	2	2	2	0	0

Table 2.6 further highlights the non-linearity relationship observed between direct and indirect offsets. In comparison to the baseline policy, we can make the majority of respondents better off by reducing the level of direct offset implemented to 90%, 80% or 70% whilst still holding the offset type as seagrass replanting, and the location of the offset remaining in the Kimberley. However, a minority of respondents would prefer a direct offset level of 60% or 50% for this offset type. This infers that, for a fixed policy type, a majority of respondents will achieve the highest level of utility if the direct offset measure is 70-90% of the offset package implemented.

The study further indicates when the location of the offset is to be moved away from the baseline location (Kimberley), there is never a majority preference of any policy being implemented at 100% direct. To get the majority of respondents to prefer an intra-state change in offset location to the Pilbara, a combination of direct and indirect offsetting with either seagrass replanting or nesting management must be implemented. Relative to the given baseline policy in Table 2.6, nutrient reduction at any location, or moving the offset inter-state to Queensland, will never be preferred by a majority of respondents.

To explore if any conditions existed in which a majority of respondents have a preference for nutrient reduction or an inter-state location change to occur, the baseline policy is set to a 50% implementation of direct offset, still in the form of seagrass replanting within the Kimberley (Table 2.7). It is now evident that in order to attain a majority of people with a preference for nutrient reduction over seagrass replanting in the Kimberley, the proportion of the direct offset must be greater than that of the baseline policy (50% direct offset). The same observation is apparent for the intra-state location of the Pilbara. A majority of respondents are happy to change to a nutrient reduction policy in the Pilbara, as long as there is greater than a 50% direct offset implemented. As seen with the first baseline policy in Table 2.6, there is still less than a majority of people preferring the location change to Queensland (Table 2.7). Given a baseline policy as seen in Table 2.6, then the best option available in Queensland would be to use seagrass replanting with a direct offsetting proportion of 80% to 90% as these combinations are the closest to attaining a majority preference.

Table 2.7: The percentage of respondents who prefer various offset packages relative to a baseline offset with a 50% direct offset of seagrass replanting in the Kimberley.

Offset Policy	Percentage of Direct Offset					
	100	**90**	**80**	**70**	**60**	**50**
Seagrass replanting in the Kimberley	78	92	98	99	100	**BASELINE**
Nutrient reduction in the Kimberley	67	78	86	96	86	0
Seagrass replanting in the Pilbara	69	89	95	98	95	31
Nutrient reduction in the Pilbara	61	74	84	83	56	9
Green turtle nesting ground management in the Pilbara	66	87	93	94	88	24
Seagrass replanting in Queensland	36	40	49	33	8	4
Nutrient reduction in Queensland	24	28	26	12	4	0
Green turtle nesting ground management in Queensland	28	37	38	27	5	1

Through comparing offset packages to a set baseline policy, it has further highlighted the level of utility that will be foregone if offsets are implemented inter-state relative to where the direct environmental impacts are occurring. The comparison also supported that an intra-state change will generate higher levels of utility if it can provide preferable levels (70-90%) of direct offsetting than when low levels of direct offset are proposed at the site of development.

2.3 Discussion of seagrass results

If environmental offset polices are to govern the development of offset packages in such a way that they will result in positive social welfare outcomes, then they require input from the general public. This study set out to determine the values the metropolitan community of Perth, Western Australia place on varying levels of offset attributes. The attributes examined were the proportion of offset package implemented as a direct to indirect measure, the type of direct offset measure implemented, and the location the direct offset measure is implemented. Through the choice experiments given to respondents, two multinomial logit models were generated: one with and one without interaction terms. Through a chi squared test it is determined that the inclusion of interaction terms into the multinomial logit model significantly improves fit. This allows for a better understanding around explanatory characteristics behind preferences for offset attributes. For example, individuals will receive greater utility if the offset is to be implemented in a location that they have previously visited by the general public, in comparison to a site that has not been visited. In addition, if the offset is to be implemented during a time of weak confidence in the local government, then the general public will benefit from higher proportions of indirect offsetting to direct offsetting. This may be a result of doubt in the government's ability to monitor and enforce the direct offsets implemented.

As the marginal utility from direct offsets (*per*) is not linear, it cannot be used as a basis for identifying conventional partworths. Instead, baseline offset policies are identified to compare how alternative packages of the offset attributes perform in terms of public preference. The comparison of offset packages clearly highlights three main outcomes of this study: utility will be reduced as the direct offset measure is moved away from the site of development; percentage of direct offset implemented is most favourable between 70% and 90%; and nutrient reduction is the least

preferred policy outcome. Given the examined baseline offset policies in this study, which comprise of seagrass replanting in the Kimberley, there is never a preference for the offset to be implemented interstate. The best option available when implementing an offset interstate would be to use the policy of seagrass replanting with direct offsetting percentages of 80% to 90%.

Changes to the location and activity type of the direct offset are examined in this study without simultaneous changes to the location or activity type of the *indirect* offset. Therefore, it is not known how such changes to the indirect offset would impact on the general public's acceptability to changes in the direct offset. For example, if the indirect proportion of the offset package was research conducted by a university in Queensland rather than a university in Western Australia, would there be a stronger desire for the direct proportion of offset to stay within the Western Australian state? Additionally, if the type of indirect offset is to be implemented in the form of education rather than research, will this change the public's desired level of direct offset?

This study is limited by its sample size, and some unexpected interactions observed between attributes and respondent characteristics may have occurred due to chance. Further, the sample size of this study restricts the number of attributes investigated and the geographic scope of respondents. Therefore, a similar investigation into varying levels of offset attributes, needs to be conducted with significantly larger sample sizes, and with respondents from a larger geographic scope. Additional offset attributes (for example, varying levels of indirect offset measures, the implementer behind direct offsets, and the timing in implementation of offsets) could be included, in order to better represent the preferences of the Australian general public.

Based on the findings of this study, decision makers involved in developing future marine biodiversity offsets are advised to implement direct offsets as close to the site of development as feasibly possible, and consider their offset package to consist of 70% to 90% direct offsetting. In doing so they will increase the social acceptability generated from implementing the offset package, based on the findings under the baseline policies used within this study of seagrass replanting in the Kimberley.

3. Marine biodiversity offsets and a Social License to Operate: the case of the oil and gas sector in Western Australia

Claire Richert[4], Michael Burton, Abbie Rogers

3.1 Introduction

A Social License to Operate (SLO) can be defined as a tacit contract which ensures that the socio-political risk of challenges to a company is reduced if it behaves according to its stakeholders values: the stronger the SLO, the lower the risk (Prno & Slocombe, 2012). The focus of this section is the acquisition and retention of a SLO with respect to environmental impacts by the oil and gas industry in Western Australia (although SLO may be relevant for any area of corporate social responsibility). In particular, the relationship between biodiversity offsets and SLO is explored.

The apparent incompatibility between most economic activities and the preservation of a sound environment can lead to opposition between market-centric and eco-centric attitudes. On the one hand, people who believe that free-market economies are the most efficient to meet human needs also tend to minimize the consequences of anthropogenic activities on the environment (Heath & Gifford, 2006). On the other hand, people more concerned about environmental issues often argue for sustainable growth: they prefer to foster less resource intensive activities to ensure long-term outcomes even if industries more harmful to the environment can be more profitable in the short-term. The Degrowth movement even supports a shrinking of global production and consumption to preserve the environment (Demaria, Schneider, Sekulova, & Martinez-Alier, 2013).

The case of the resource industry in Western Australia illustrates the competition between economic interests and the environment. For example, this sector accounted for 35% of the Gross State Product (GSP) in 2011-2012 (Government of Western Australia - Department of State Development, 2013). However, mining can have unavoidable and lasting impacts on the environment, such as habitat destruction or soil contamination. The State of Western Australia, which includes one of the 34 global biodiversity hotspots, is especially sensitive to such threats (Mittermeier, et al., 2000).

To preserve the function of biodiversity while enabling development, the Commonwealth Government of Australia released a policy in 2012 regarding environmental offsets. According to this policy, companies have to compensate for their residual impacts on the environment by implementing biodiversity offsets to ensure no net environmental loss. It refers to any impacts on items (e.g. endangered species) listed as matters of national environmental significance under the Environment Protection and Biodiversity Conservation Act of 1999 (EPBC Act) (Australian Government 2012).

Offsets provide a valuable lens through which to view the tensions between development and environmental protection. The requirement under an offset is to achieve no let loss in environmental function as a result of the development project. However, some members of the public may view offsets as a means to avoid taking responsibility for environmental damage. Furthermore, there are potentially a number of ways in which offsets could be implemented to achieve the same outcome. Any given implementation approach might be viewed as more or less

[4] The SLO analysis was undertaken by Claire Richert as part of her Masters dissertation (Richert, 2013).

favourable than others. Thus, the use of offsets and the particular form of implementation may lead to public opposition to the development, even when the offset satisfies the no-net-loss criterion on an ecological basis. On the other hand, the use of biodiversity offsets could be interpreted by the population as a sign that the companies care about the environment.

To evaluate the economic efficiency of biodiversity offsets, it is important to understand whether they have a positive or negative impact on SLO. Indeed, in a democratic country such as Australia, civil society's protests can lead, for example, to the non-issuance or retraction of government exploitation permits, and thus threaten the activities of the resource industry. Therefore, companies often seek to acquire, maintain or improve a SLO, in addition to any formal approvals.

The question we raise here is the impact of the use of offsets on the SLO. In this work we focus on the oil and gas sector in Western Australia. An immediate issue is how one can measure SLO in this context. A questionnaire was designed by Boutilier and Thomson (2011) in order to measure the SLO granted by a community to a mining company. In their application of this questionnaire the SLO has been measured in relation to a specific mining company, for a particular community. However, in many cases the environmental impacts of the oil and gas sector impinge on ecological assets that will be valued by a much wider community (at a state, national or possibly international level).

Given the observations made above, we explore a number of questions. First, is it possible to adapt Boutilier and Thomson's (2011) questionnaire to evaluate the SLO of the whole oil and gas sector in Western Australia, as it relates to the general public within Western Australia? Second, to what extent is the West Australian community expected to challenge the oil and gas industry's activities? Third, is the use of biodiversity offsets likely to improve the SLO of the sector by reducing the opposition between economic and environmental interests? Since most of the oil and gas developments in Western Australia occur offshore, we focus on marine biodiversity offsets.

In the following Section 3.2, we define the concept of SLO and assess the importance of this concept in the context of the oil and gas sector in Western Australia and the possible role of marine biodiversity offsets. In Section 3.3 we describe the questionnaire designed by Boutilier and Thomson (2011) and how we adapted it to our context. After that, we report results regarding the validity of our questionnaire, the evaluation of the SLO of the oil and gas sector, and the effect of marine biodiversity offsets on SLO. Finally, we discuss our results before concluding.

3.2 The origin of SLO and its implications for the West Australian oil and gas sector

The concept of SLO emerged to explain why some companies try to meet their stakeholders' expectations in terms of social and environmental performances, even if they are more demanding than that which is legally required. Indeed, failure to behave according to the civil society's ethical standards can lead to the depreciation of a firm's image and reduce its market shares (Gunningham, Kagan, & Thornton, 2004). A SLO can be defined as a tool for a company to manage socio-political risk by conforming to a set of implicit rules imposed by their stakeholders. In exchange, the stakeholders do not hinder the competitiveness of the company. It is both a goal to be reached and a set of guidelines to follow.

According to Prno and Slocombe (2012), the growing need to acquire, maintain or improve a SLO originates from two main mechanisms. First, the observable shifts in governance from State to non-

State actors have given more power to the civil society to inform decision-making. Second, people's concerns have been influenced by the spreading of the sustainability paradigm, which emphasizes in particular the importance of preserving our natural capital. Incidentally, Boutilier (2009) argues that SLO can be a tool for the public, private and civil sector to collaborate toward sustainability. The particular attention paid by mining companies to public opinion can also be explained by a series of chemical spills and conflicts between local communities and mining companies which became the focus of media attention in the 1990s, thus increasing the civil society mistrust in this industry (Thomson & Boutilier, 2011).

We suggest that companies of the oil and gas industry in Western Australia could be interested in improving their SLO, as their activities are likely to come with significant socio-political risk. This view is supported by a range of observations.

On the one hand, the oil and gas sector can be held responsible by the population for some environmental and social damages. Indeed, according to a review of 18 referral documents[5] related to offshore oil and gas projects in Western Australia, companies themselves identified the threats their activities can cause to marine biodiversity. Three categories of possible impacts were apparent: 1) oil and gas exploitation can cause pollution through oil spills and disposal of putrescible wastes and grey water; 2) the presence of a workforce and infrastructure in previously uninhabited areas can disturb the marine life; and, 3) oil and gas developments generally lead to a loss and disruption of marine habitats.

In addition, Hajkowicz et al. (2011) argue that social tensions could arise in Western Australia due to the unequal distribution of the benefits created by the mining industry. Indeed, half of the workers employed by mining companies in 2012 lived and spent their incomes in metropolitan Perth while they used temporary accommodations on extraction sites, which are often located in remote areas (Chamber of Minerals and Energy of Western Australia, 2013). As a result, remote communities endure the greater part of the environmental costs whereas the exploitation activity mostly profits urban employees. It is worth noting, for example, that remote mining areas in Western Australia are mostly occupied permanently by indigenous communities, which are largely under-represented in the mining industry workforce in Australia (Tiplady & Barclay, 2007). Moreover, Hajkowicz et al. (2011) demonstrate that, even if mining activities have a globally positive socio-economic impact on mining regions, they increase the disparities between people who work in this sector and the others, in particular in the case of the Pilbara region in North-Western Australia.

On the other hand, petroleum products accounted for 24% of the outputs of the mining sector in the State in 2012-2013 (Government of Western Australia - Department of Mines and Petroleum, 2013). Thus, the oil and gas industry remains highly profitable in Western Australia and it is reasonable to assume that this sector has a significant incentive to reduce its potential socio-political risk.

As a result, a second issue of interest is whether the use of marine biodiversity offsets by the oil and gas sector in Western Australia would change the level of SLO that they benefit from. According to an IUCN report on biodiversity offsets, the acquisition of a SLO is one of the advantages provided by

[5]Referral documents are available on the website of the Department of Sustainability, Environment, Water, Population, and Communities of the Australian government: http://www.environment.gov.au/epbc/notices/index.html

biodiversity offsets to the firms (IUCN, 2004). However, this assertion needs to be tested: it may be the case that offsets are seen as a means of circumventing environmental responsibilities, and undertaking offsets may reduce SLO.

3.3 Methodology

For a SLO to be an effective and efficient risk management tool, companies must first be able to measure it. This evaluation can then allow them to diagnose the degree of socio-political risk they currently face and the effort needed to reduce it to an acceptable level. Boutilier and Thomson (2011) studied the relationships between mines and their stakeholders' networks in Australia, Bolivia and Mexico, in order to conceptualize the SLO, and divided the SLO into four levels. These are defined as follows: 1) "Economic legitimacy", which leads to the acceptance of a project if the stakeholders believe that they could economically benefit from the development; 2a) "Socio-political legitimacy", which is achieved when the stakeholders perceive that a company or project can improve the well-being of the region in general and respects people's expectations and values; 2b) "Interactional trust", which describes a situation where the company and the stakeholders perceive their relationships are based on mutual dialogue and reciprocity; and 3) "Institutionalized trust", which is reached when the stakeholders believe that their relations with the company are built on the real consideration of each other's interests. It is hypothesized that there is a hierarchical relationship between these levels (see Figure 3.1). Economic legitimacy is the easiest to achieve and is necessary for a project to be accepted. It is followed by socio-political legitimacy and interactional trust. If a company or project is granted both of these, it is likely to be approved. The highest level is institutionalized trust: if a company can achieve this level, then the public see a congruency between the companies and their interests, and hence little reason to oppose the actions of the company.

Figure 3.1: The four levels of SLO as described by Thomson and Boutilier (2011).

The questionnaire designed by Boutilier and Thomson (2011) aimed to measure the degree of SLO in all four of these areas. The survey consisted of 15 questions (see Table 3.1), each of them associated with one of the four levels (2 questions for economic legitimacy, 4 for interactional trust, 4 for socio-political legitimacy, and 5 for institutionalized trust). Respondents had to rate each item on a 5-point likert scale measuring agreement, which, when aggregated, allows one to identify the *extent* of the

SLO in each of the four levels. This tool allows companies to evaluate their socio-political risk and consequently take action.

In our study, we adapted Boutilier and Thomson's (2011) questionnaire in order to estimate the SLO granted by the West Australian population to the whole oil and gas sector, rather than a specific company. The adaptation consisted of rephrasing the items to make them compatible as far as possible with our context, leading to a set of 18 new questions (see Table 3.1). The number of questions used in the adaptation did not always match exactly to the original set of questions. For example, to measure economic legitimacy, one of the original questions – "We can gain from a relationship with the mine" – was mapped into "Western Australia can economically benefit from the oil and gas sector". However, the second economic legitimacy question – "We need to have the cooperation of the mine to reach our most important goals" – was mapped into four related questions, each dealing with a specific goal (i.e. Western Australia needs the cooperation of the oil and gas sector to: protect the environment / maintain or improve its economic performances / maintain or improve the wellbeing of local communities / guarantee the wellbeing of the future generations) (see Table 3.1). In this way we can identify which elements of the respondents' goals the SLO related to, given that we have a particular interest in the environment. Because we are only interested in responses to goals that respondents think are important to them, we identified the respondents' most important goals by asking them to rate from "Not at all important" to "Extremely important" the following areas: the environment, the economy, the local communities, and the future generations.

Table 3.1: Statements designed to measure the different levels of SLO

Original statement to measure levels of SLO from Thomson and Boutilier (2011)	**Adapted statement designed to measure levels of SLO of the oil and gas sector in Western Australia**	**Statement designed to measure the impacts of the use of marine biodiversity offsets on levels of SLO of the oil and gas sector in Western Australia**
Items measuring the level of "Economic legitimacy"		
Economic legitimacy 1 "We can gain from a relationship with the mine"	**EL 1.1** "Western Australia can economically benefit from the oil and gas sector"	**Imp-EL 1** "In your opinion, how would the use of marine biodiversity offsets affect the ability of the oil and gas sector to contribute to the Western Australia economy?"
Economic legitimacy 2 "We need to have the cooperation of the mine to reach our most important goals"	**EL 2.1** "Western Australia needs the cooperation of the oil and gas sector to protect the environment" **EL 2.2** "Western Australia needs the cooperation of the oil and gas sector to maintain or improve its economical performances" **EL 2.3** "Western Australia needs the cooperation of the oil and gas sector to maintain or improve the well-being of local communities" **EL 2.4** "Western Australia needs the cooperation of the oil and gas sector to guarantee the well-being of the future generation"	**Imp-EL 2.1** "In your opinion, how would the use of marine biodiversity offsets affect the ability of the oil and gas sector to protect marine biodiversity?" **Imp-EL 2.2** "In your opinion, how would the use of marine biodiversity offsets affect the ability of the oil and gas sector to contribute to the goals of the West Australian community?"
Items measuring the level of "Interactional trust"		
Interactional trust 1 "The mine does what is says it will do in its relations with our organization"	**IT 1** "Companies in the oil and gas sector do what they say they will do in the media"	
Interactional trust 2 "We are very satisfied with our relation with the mine"	**IT 2** "I am very satisfied by the oil and gas sector in Western Australia"	**Imp-IT 1** "How would the use of marine biodiversity offsets affect your opinion of the oil and gas sector in Western Australia**?"**
Interactional trust 3 "The presence of the mine is a benefit to us"	**IT 3** "The presence of the oil and gas sector is Western Australia is a benefit to the Western Australian population"	
Interactional trust 4 "The mine listens to us"	**IT 4** "Companies from the oil and gas sector listen to the Western Australian population concerns"	**Imp-IT 2** "The use of marine biodiversity offsets would show that the oil and gas sector listens to the concerns of the West Australian population"

Table 3.1: *Continued*

Original statement to measure levels of SLO from Thomson and Boutilier (2011)	**Adapted statement designed to measure levels of SLO of the oil and gas sector in Western Australia**	**Statement designed to measure the influence of the use of marine biodiversity offsets on levels of SLO of the oil and gas sector in Western Australia**
Items measuring the level of "Socio-political legitimacy"		
Socio-political legitimacy 1 "In the long term the mine makes a contribution to the well-being of the whole region"	**SPL 1** "In the long-term, the oil and gas sector makes a contribution to the well-being of Western Australia"	**Inf-SPL 1** "In the long-term, the use of marine biodiversity offsets would contribute to improving the well-being of Western Australia "
Socio-political legitimacy 2 "The mine treats everyone fairly"	**SPL2** "The oil and gas sector in Western Australia treats everyone fairly"	**Inf-SPL 2** "The use of marine biodiversity offsets would lead the oil and gas sector to treat the marine environment more fairly."
Socio-political legitimacy 3 "The mine respects our way of doing things"	**SPL3** "The oil and gas sector respects the Western Australian population way of doing things"	**Inf-SPL 3** "I approve the use of marine biodiversity offsets"
Socio-political legitimacy 4 "Our organization and the mine have a similar vision for the future of this region"	**SPL 4** "The Western Australian population and the oil and gas sector have a similar vision for the future of Western Australia"	
Items measuring the level of "Institutionalized trust"		
Institutionalized trust 1 "The mine gives more support to those who it negatively affects"	**InstT 1** "Companies of the oil and gas sector give more support to those it negatively affects"	
Institutionalized trust 2 "The mine shares decision-making with us"	**InstT 2** "The oil and gas sector shares decision-making with the Western Australian government"	
Institutionalized trust 3 "The mine takes account of our interests"	**InstT 3** "The oil and gas sector takes into account the interests of the Western Australian population"	**Inf-InstT 1** "Through the use of marine biodiversity offsets, the oil and gas sector would take the West Australian population interests into account."
Institutionalized trust 4 "The mine is concerned about our interests"	**InstT 4** "The oil and gas sector is concerned about the Western Australian population"	
Institutionalized trust 5 "The mine openly share information that is relevant to us"	**InstT 5** "Companies of the oil and gas sector openly share information that is relevant to the Western Australian population"	**Inf-InstT 2** "How would the use of marine biodiversity offsets affect the transparency of operations of the oil and gas sector?"

Given our specific interest in marine offsets, we also developed a set of 10 questions (Column 3, Table 3.1) which investigated the specific impact of the use of marine offsets on the SLO of the oil and gas sector. Each of these questions aims to estimate the influence of the use of marine biodiversity offsets on the respondents' SLO, as reflected in the measures of "Economic legitimacy", "Interactional trust", "Socio-political legitimacy", or "Institutionalized trust". For example, question Inf-EL 1 – "In your opinion, how would the use of marine biodiversity offsets affect the ability of the oil and gas sector to contribute to the Western Australia economy?" (Table 3.1) – measures the influence of the use of marine biodiversity offsets on one aspect of the economic legitimacy of the oil and gas sector in Western Australia.

The whole set of 25 new questions was included in a larger online survey that investigated the public's attitudes towards the implementation of marine offsets. The SLO questions were asked after detailed information was given on the definition and implementation of marine offsets. The SLO questions were coded from 1 to 5 depending on the level of agreement of the respondents: 1 indicating a strong disagreement with the statement, 2 a disagreement, 3 a neutral point of view ("neither agree nor disagree"), 4 an agreement, and 5 a strong agreement. For each question used to measure the influence of marine biodiversity offsets on the SLO of the oil and gas sector, the respondents could choose on a 5 point scale ranging from "The use of offsets would strongly decrease my agreement with the statement" to "The use of offsets would strongly strengthen my agreement with the statement". These answers were coded -2 to 2, with a value of zero implying the use of offsets has no impact on their opinion about oil and gas companies' activities.

3.4 Results

The survey was completed by a representative sample of 325 West Australians[6], during August 2013. All completed the SLO section of the survey, although some of the sample is not available for the analysis of the impact of offsets on SLO (see below).

3.4.1 Identifying importance of issues for SLO

Recall that respondents were required to answer four questions (Table 3.1, EL2.1-2.4) relating to the role of cooperation of the oil and gas industry to achieve different goals. One could average responses over all four questions to get an overall score, but ideally one should only include scores from questions relating to issues that respondents felt were important. As reported in Table 3.2 and Figure 3.2, a large majority of the respondents consider that all the proposed areas are important, but approximately 10% consider only two or three of the areas as important.

[6] Chi square tests were conducted to verify the sample's representativeness in terms of age and gender distributions: the Pearson chi square statistics indicate that the probabilities that the distributions in age and gender are the same in the adult Western Australian population and in the sample are 0.30 and 0.16 respectively. Thus, these hypotheses cannot be rejected and we concluded that the sample studied is representative of the Western Australian population.

Table 3.2: Percentage of the respondents who found important the environment, the economy, the local communities, and the future generations. An area is considered important for a respondent if they declared it was "Somewhat important", "Very important", or "Extremely important".

The environment	The economy	The local communities	The future generations
89.23	91.08	89.54	91.69

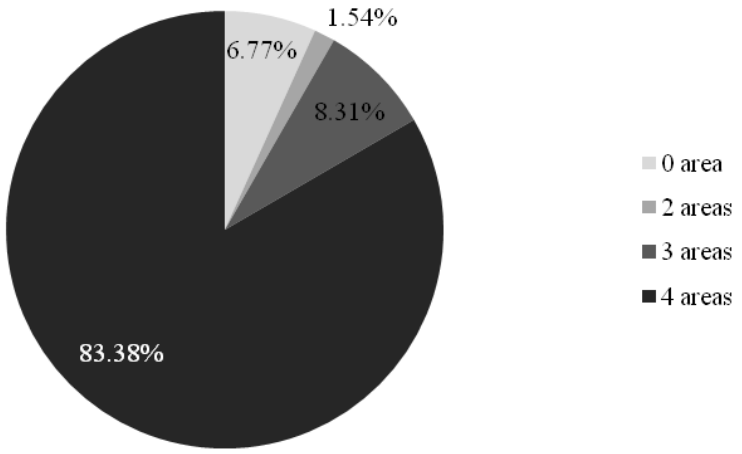

Figure 3.2: Percentages of the sample who found important 0, 1, 2, 3, or 4 of the proposed areas (environment, economy, local communities, and future generations).An area is considered important for a respondent if he declared it was "Somewhat important", "Very important", or "Extremely important".

We only retained the answers to questions EL2.1-2.4 if respondents indicated the issue was "Somewhat important", "Important" or "Extremely important" to them. For these cases, we averaged the scores to give a single measure of EL2.

3.4.2 Measuring SLO

In order to test the validity of our modified questionnaire aimed at measuring the four levels of SLO identified by Boutilier and Thomson (2011), we proceeded to an exploratory factor analysis based on our equivalents to the original 15 questions. We applied Kaiser's criterion to define the significant factors; that is, we kept the factors with an eigenvalue greater than 1 (Kaiser, 1960). In the original analysis, Boutilier and Thomson (2011) found that the 15 questions could be categorized by four significant factors, each relating to a level of SLO. However, we find that our items load on only two factors, as reported in Table 3.3.

Table 3.3 : Estimated weights for two significant factors obtained from an exploratory factor analysis

	Item	Factor 1	Factor 2
Level 1	EL 1	0.1271	**0.8660**
	EL 2	0.0008	**0.8095**
Level 2a	IT 1	**0.6909**	0.1577
	IT 2	**0.7376**	0.3161
	IT 3	0.3391	**0.7920**
	IT 4	**0.8485**	0.2230
Level 2b	SPL 1	0.4593	**0.6653**
	SPL 2	**0.8210**	0.1828
	SPL 3	**0.8735**	0.1620
	SPL 4	**0.8563**	0.1965
Level 3	InstT 1	**0.6580**	0.2768
	InstT 2	**0.5302**	0.2093
	InstT 3	**0.8779**	0.1968
	InstT 4	**0.8385**	0.2188
	InstT 5	**0.8854**	0.0374

Note: The values written in bold in the "Factor 1" and "Factor 2" columns indicate that the corresponding items belong to factor 1 or factor 2 respectively.

Factor 2 contains the two items designed to evaluate the economic legitimacy of the oil and gas sector. However, one statement originally conceived as relating to "Interactional trust" (IT 3): "The presence of the oil and gas sector is a benefit to the Western Australian population") and one relating to "Socio-political legitimacy" (SPL 1: "In the long term, the oil and gas sector makes a contribution to the well-being of Western Australia") appear to also be related to this factor, although not strongly. Since the verb "to benefit" and the term "well-being" also belong to the economic vocabulary, they could be interpreted as economic qualifying terms of a situation. As a result, it would be consistent that the items IT 3 and SPL 1 load onto the same factor as the economic legitimacy questions. The remaining 11 items load onto a single factor, which appears to be a more generalized measure of the three higher order forms of SLO identified by Boutilier and Thomson (2011). The divergence from the Boutilier and Thomson's (2011) original results, where the items loaded onto four factors, may be due to the more generic nature of the relationship between the respondents, who are drawn from the West Australian population, and "the oil and gas industry", rather than a specific company.

We now proceed with two measures of SLO: "Extended economic legitimacy", which is the average of EL 1, EL 2, IT 3 and SPL 1; and "Social legitimacy", which is the average of the 11 other items. We then estimated the internal consistency of these two levels by calculating their Cronbach alpha coefficient. This measure estimates the part of the variance shared by the items and is an indicator of their homogeneity (Cronbach, 1951). It is generally accepted that a value of Cronbach alpha above 0.7 indicates that the items measure a single construct (Nunnally & Bernstein, 1994). We found a

value of the Cronbach alpha coefficient of 0.82 for the "Extended Economic legitimacy" and 0.95 for the "Social legitimacy", which confirms that it makes sense to treat the items within each of these categories as measuring a single construct.

3.4.3 Characterization of the SLO of the oil and gas sector in Western Australia

We start with a simple summary of the "Extended Economic legitimacy" and the "Social legitimacy" measures. The results are presented in Table 3.4. We observed that the respondents tended to agree (i.e. an average score of 3.78) that the oil and gas sector contributed to the wealth of Western Australia, whereas they neither agree nor disagree on average (i.e. mean = 3.02) with the items of the "Social legitimacy". Student's T-tests confirmed that the means of the "Extended Economic legitimacy" and the "Social legitimacy" are significantly different at the 99% level.

Table 3.4: Summary of the "Extended Economic legitimacy" and the "Social legitimacy" SLO measures in the sample

	Mean	**Standard deviation**	**Number of observations**
Extended economic legitimacy	3.78	0.79	325
Social legitimacy	3.02	0.74	325

Although this information at the sample mean is useful, the original theory suggests that at the individual level one should seldom see a score for "Social legitimacy" which exceeds that of "Extended Economic legitimacy". We therefore plot the individual scores of the two measures in order to unravel the relationship between these two categories. Figure 3.3 visually confirms that the respondents generally rated the items of the "Extended Economic legitimacy" higher than those of the "Social legitimacy" and that the first level is thus easier to achieve for the companies of the oil and gas industry. This finding is consistent with Boutilier and Thomson's (2011) conceptualization of the SLO, which claims that companies acquire an economic legitimacy more easily than the other levels.

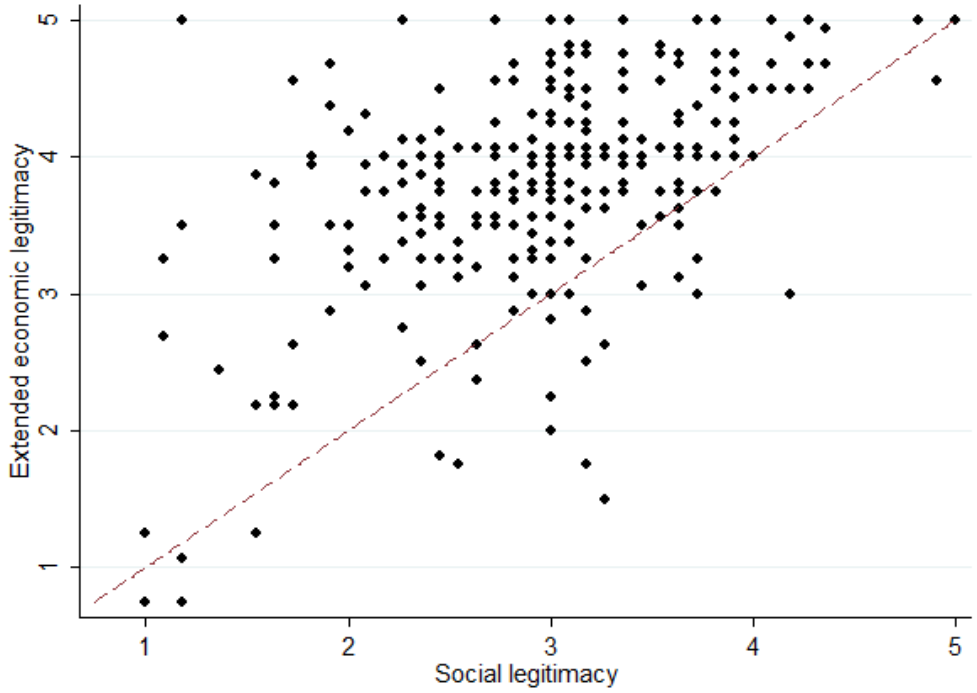

Figure 3.3: Scatter plot of "Extended Economic legitimacy" against "Social legitimacy"

3.4.4 Impact of the use of marine biodiversity offsets on SLO

The items used to measure the impact of marine biodiversity offsets on the SLO of the oil and gas sector were either linked to an item of the "Extended Economic legitimacy" or the "Social legitimacy". Accordingly, we grouped them together either under the label "Influence on the economic legitimacy" or "Influence on the social legitimacy" as presented in Table 3.5.

Table 3.5: List of the items averaged to calculate the "Influence on the extended economic legitimacy" and the "Influence on the social legitimacy" measures. The items are defined in Table 3.1.

Items of the "Influence on the extended economic legitimacy" measure	**Items of the "Influence on the social legitimacy" measure**
Inf-EL 1	Inf-IT 1
Inf-EL 2.1	Inf-IT 2
Inf-EL 2.2	Inf-SPL 2
Inf-SPL 1	Inf-SPL 3
	Inf-InstT 1
	Inf-InstT 2

Since this set of questions was quite difficult, people were allowed to say that they did not know what to answer, and these responses were omitted. We only kept the data from people who gave an answer to all the items for each category: 215 observations for the "Influence on the extended economic legitimacy", and 243 for the "Influence on the social legitimacy".

We calculated the Cronbach alpha coefficient of the items in "Influence on the extended economic legitimacy" and the "Influence on the social legitimacy" subscales. Since they have a value of the Cronbach alpha coefficient of 0.74 and 0.90 respectively, we can reasonably assume that they each measure a single construct.

We then analyzed the average scores of the two categories as a measure of the extent to which the two measures of SLO are influenced by the use of marine biodiversity offsets. The results are summarized in Table 3.6. We also conducted several Student's T-tests in order to compare the different measures. The tests indicated the means of both categories are significantly higher than zero at the 99% level of confidence, suggesting the use of marine biodiversity offsets will have a positive effect on the SLO of the oil and gas sector in Western Australia. The tests also indicate that the mean value of the "Influence on the Social legitimacy" is significantly higher than the one of the "Influence on the Extended Economic legitimacy". This finding suggests that the use of marine biodiversity offsets would have a greater impact on the "Social legitimacy" than on the "Extended Economic legitimacy" of the petroleum companies. This result is consistent with the fact that people seem to already believe that the activities of the sector provide them with economic benefits.

Table 3.6: Descriptive statistics of the "Influence on the extended economic legitimacy" and of the "Influence on the social legitimacy"

	Mean	**Standard deviation**	**Number of observation**
Influence on the extended economic legitimacy	0.56	0.69	215
Influence on the social legitimacy	0.70	0.74	243

Therefore, oil and gas companies could be incentivized to use marine biodiversity offsets in order to reduce their socio-political risk. Hence, the use of these measures could be beneficial for the oil and gas sector in two ways: first, they enable companies to implement projects that would not have been accepted by the authorities otherwise because of their impact on the environment; and, second, they can improve the SLO of the companies.

3.5 Discussion

Our results suggest that our adaptation of Boutilier and Thomson's (2011) questionnaire is able to evaluate the SLO granted by the Western Australian community to the oil and gas sector in this State. The results indicate that the population tends to agree that this industry provides the State with economic benefits. However, people do not seem to believe that oil and gas companies contribute to their well being, share their values, and are generally trustworthy. As a result, oil and gas projects are likely to be accepted, but not receive a binding SLO. To put it differently, the majority of West Australians would probably not oppose oil and gas projects, but they're also unlikely to support them. Therefore, if some people protest against a particular project, it will not find much support from the rest of the population. This finding is consistent with our initial hypothesis that the oil and gas sector face a significant socio-political risk in Western Australia. The

decision of Woodside to abandon a $45 billion gas hub project in northern Western Australia in April 2013 after public disapproval illustrates this situation (The Wilderness Society (2013), Woodside (2013)).

On the other hand, the wealth of Western Australia in terms of petroleum products makes it an attractive region for oil and gas companies (Chamber of Minerals and Energy of Western Australia, 2013). That is why these firms can have a strong interest in improving their SLO to secure their activities.

Our results indicate that the use of marine biodiversity offsets could increase the "Extended Economic legitimacy" of the oil and gas sector in Western Australia and, to a greater extent, its "Social legitimacy". This confirms in the context of this study that the use of marine biodiversity offsets by oil and gas companies could improve their SLO in general, and in particular to be viewed as trustworthy and a contributor to the population's well-being.

These results seem to support the use of marine biodiversity offsets as a means to reconcile economic and environmental interests in Western Australia. However, the uncertainty inherent to the issue of biodiversity protection raises several concerns. First, ecosystems are complex and the environmental efficiency of marine biodiversity offsets is questionable (Quétier & Lavorel, 2011). Moreover, the use of biodiversity offsets could increase the number of projects approved by the government. Since environmental damages are often irreversible and the scientific uncertainty about the interactions between components of ecosystems is still high, it is difficult to recreate environments. Consequently, allowing more developments to impact the environment locally while compensating for the loss of environmental features somewhere else is in contradiction with the precautionary principle. According to this point of view, biodiversity offsets should rather be used to improve the environmental outcomes of developments which would have been accepted without them.

In addition, if people trusted the oil and gas sector more, it would also mean that they would pay less attention to its activities and impacts on the well-being of the population and on the environment. Thus, the use of marine biodiversity offsets could result in the companies implementing more damaging projects because they would fear less the risk of social disapproval. Hence, Owen and Kemp (2013, p. 29) argue that the concept of SLO "serves to limit discussion and debate" between mining companies and their stakeholders. Therefore, biodiversity offset policies should ensure that companies' environmental and social performances are controlled.

Furthermore, the general public is still unfamiliar with the concept of biodiversity offsetting and it is likely that its opinion will change if usage becomes more common. Conversely, oil and gas developments are long term investments and companies need a durable guarantee that their activities will not be compromised. Therefore, they cannot rely on biodiversity offsets to secure their SLO in the long-term. These measures can only support the building of a relationship based on trust between the oil and gas sector and the population of Western Australia.

4. Community preferences for migratory shorebird biodiversity offsets

Claire Richert[7], Michael Burton, Abbie Rogers

4.1 Migratory shorebird case study

4.1.1 Survey context and attribute descriptions

In the migratory shorebird choice experiment, a hypothetical development was described to respondents. Specifically, it is proposed that an oil and gas exploration and production company is planning to construct and operate a gas plant in the vicinity of a beach on the Kimberley coast. Some environmental impacts can be avoided or mitigated but there are residual impacts on the use of the beach as a feeding ground by 1000 Ruddy Turnstones. Ruddy Turnstones are protected under the EPBC Act as a migratory species. The impacts of the development include artificial lighting and an increase in the number of people using the beach, which will disturb the birds. Frequent disturbance reduces the birds' ability to feed and store energy, leading to a higher mortality rate during their migration north. The 1000 Ruddy Turnstones won't be able to feed on the beach anymore. The developer will have to offset these impacts if the project is to go ahead, and ensure that there is no net loss to the species.

When constructing the offset packages that would compensate for the residual damage, we considered three attributes:

- The ratio of direct to indirect offsets. We investigated proportions of direct to indirect offsets from 50:50 through to 100:0 in multiples of ten. For the purpose of this survey, a direct offset was defined as a new on-ground intervention aimed at improving the environment. Specifically, a substitute beach would be identified that could support the birds and be fenced off so that the birds are not disturbed. The indirect offset was defined as research to improve existing on-ground management techniques of the birds. It was hypothesised that people would prefer a higher percentage of direct offsets relative to indirect.

- The location of the direct offset. The offset could be implemented a few kilometres away from the development site on the Kimberley coast in Western Australia, or it could be located in the Northern Territory, New Zealand or China. In each case, the relevant environment department (e.g. of the State or Territory Government) would be responsible for overseeing and implementing the offset. It was anticipated that people would have stronger preferences for the offset to be implemented closer to the site of impact.

- The species protected by the offset. The offset could be designed to protect the impacted Ruddy Turnstones, or it could be used to protect a more endangered species of migratory shorebird – the Eastern Curlew. While the EPBC Offset Policy requires the offset to address

[7] The migratory shorebird pilot study was undertaken by Claire Richert as part of her Masters dissertation (Richert, 2013).

the species affected, in the case where that species is not endangered, it is possible that the public might accept offsets that protect another species[8].

The attributes and their levels are defined in Table 4.1. Note that there is no site of international significance for the Eastern Curlew in New Zealand, so this species and location were never associated together in the choice scenarios.

Table 4.1: The offset policy attributes included in the choice experiment, with level specifications.

Attribute	Levels
Proportion of indirect measures	50%, 40%, 30%, 20%, 10%, 0%
Location	Western Australia (Kimberly, site of development) Northern Territory New Zealand China
Type of direct offset activity	1000 Ruddy Turnstones 1000 Eastern Curlews

According to the EPBC Offset Policy, the preferable offset package would comprise a high proportion of direct offsets protecting the Ruddy Turnstone in a nearby location on the Kimberley coast. This form of offset would be the closest reproduction of the damaged environment. However, it might not always be technically feasible to deliver this form of offset, or there might be greater environmental benefits anticipated through other means of implementation[9]. Therefore, it is useful to know whether the general community perceives this as the preferred offset package, and to what extent are they willing to accept different combinations of direct/indirect offsets, offset locations, and types of direct offset activity.

In addition to examining individuals' preferences for the offset policy attributes, an objective of this pilot study was to also examine preferences for the practice of biodiversity offsetting more generally. That is, does the community find this solution acceptable in terms of addressing residual impacts on the environment? To answer this question, a split design was used in the survey, where some respondents were given the option to opt-out of the development being allowed to go ahead. The design is discussed in more detail in the following section.

2.1.2 Survey design and administration

As for the seagrass choice experiment, focus groups were held to test the language and concepts that would appear in the questionnaire. The resulting survey contained background information on marine biodiversity offsets, a description of the offset policy attributes, the choice scenarios and debriefing questions about the choice experiment, and socio-demographic questions.

[8] The WA offsets policy opens up the possibility of some substitution between values: "Environmental offsets relate to the environmental value that is being impacted. In some instances it may be necessary to offset a value with a similar, but not identical, value." (Government of Western Australia 2011, p.3). "As a last resort an alternative asset that is more threatened or covers a larger area but has different values may be an acceptable offset."(Government of Western Australia 2012, p.7).

[9] It has been suggested in personal discussions with ecologists familiar with the matter that the greatest opportunity for conservation gains for migratory birds in the East-Asian-Australasian flyway lie outside of Australia, even if the development impact occurs within Australia.

A split survey design was used to identify preferences for offsetting generally, and preferences for the offset attributes. Specifically, three choice experiment surveys were created:

- A forced version: where respondents were presented with three offset options, and asked to select their most preferred offset package.
- An unforced version: where respondents were presented with three offset options plus a fourth option of 'no development', allowing them to opt out of the offset going ahead and prevent development approval if that was their preference.
- A dual choice version: where respondents were presented with an equivalent of the unforced version, but if respondents chose to opt-out with no development they were asked a follow up question as to which of the three offset options they would choose in the event that the development did go ahead.

Examples of the choice scenarios are presented in figures 4.1 and 4.2.

	Option 1	Option 2	Option 3
Species protected	**Ruddy Turnstone**	**Eastern Curlew**	**Eastern Curlew**
Location	**China**	**Western Australia**	**Northern Territory**
Proportion of direct and indirect offset	Indirect: **20%**	Indirect: **40%**	Indirect: **10%**
	Direct: **80%**	Direct: **60%**	Direct: **90%**

No net loss to the environment

Figure 4.1: Example of a forced version choice scenario.

	Option 1	Option 2	Option 3	Option 4
Species protected	**Ruddy Turnstone**	**Eastern Curlew**	**Eastern Curlew**	**No development**
Location	**China**	**Western Australia**	**Northern Territory**	
Proportion of direct and indirect offset	Indirect: **20%**	Indirect: **40%**	Indirect: **10%**	
	Direct: **80%**	Direct: **60%**	Direct: **90%**	

No net loss to the environment

Figure 4.2: Example of an unforced or dual version choice scenario.

An efficient experimental design for the choice scenarios was constructed using the Ngene software (Rose et al. 2008). A total of 24 choice scenarios were constructed, each containing three offset options, and a fourth 'no development' option where relevant. The design was blocked by a factor of four so that each respondent received six choice scenarios.

The survey was issued to participants who subscribe to an online panel managed by a market research company (The Online Research Unit), during July-August 2013. Survey data was obtained from 325 respondents, with 121 answering the forced version of the survey, 104 answering the unforced version, and 100 responding to the dual choice survey. Tables 4.2 and 4.3 report the age and gender distribution of the samples collected, respectively. The three samples were compared for equivalence. The Pearson chi square statistic used to test the hypothesis that the age structures are equivalent across the samples follows a chi squared distribution with 8 degrees of freedom. As it is equal to 5.2, this hypothesis has a probability of 0.735 to be true and cannot be rejected. The gender structures can also be considered equivalent since the Pearson chi square statistic has a value of 0.9, following a chi squared distribution with 2 degrees of freedom with a probability of 0.635.

Table 4.4 reports the age and gender distribution of the West Australian population for comparison with the samples collected. The data available for the distribution of age in the adult population in Western Australia were not divided in the exact same age categories as in our survey. However, we assumed they were close enough to compare them. The Pearson chi square statistics indicate that the probabilities that the distributions in age and gender are the same in the adult Western Australian population and in the whole sample are 0.30 and 0.16 respectively. Thus, these hypotheses cannot be rejected. We conclude that the sample studied is representative of the Western Australian population.

Table 4.2: Age distribution.

Age	Whole sample	Sample from the forced version	Sample from the dual version	Sample from the unforced version
18-30	22%	21%	23%	22%
31-45	28%	28%	26%	30%
46-60	25%	21%	28%	25%
61-75	20%	25%	19%	15%
Over 75	5%	5%	4%	8%

Table 4.3: Gender distribution.

Gender	Whole sample	Sample from the forced version	Sample from the dual version	Sample from the unforced version
Male	46%	44%	50%	45%
Female	54%	56%	50%	55%

Table 4.4: Age and gender distribution in the Western Australian population in 2011. Source: Australian Bureau of Statistics.

Age	Adult Western Australian population 2011
20-29	21%
30-44	29%
45-59	27%
60-74	16%
75 and over	7%
Gender	
Male	50%
Female	50%

4.2 Migratory shorebird results

The first stage of the analysis was to examine answers to some of the questions in the survey that might be useful to help explain preferences in the choice model. Those that were found to be significant explanatory factors in the choice model are reported here (Section 4.2.1). Following this, the impact of the different survey versions on respondents' preferences is discussed (Section 4.2.2). The choice experiment results are then reported (Section 4.2.3).

4.2.1 Explanatory factors

A large number of supplementary questions were asked in the survey, some of which are significant explanatory factors for the choice analysis. In the debriefing questions following the choice experiment, respondents were asked to state how certain they were of the answers they gave in the choice experiment on a scale that ranged from 1: "Not certain at all", to 7: "Very certain". On average, respondents were more confident than doubtful that they chose the option they liked the most in each choice scenario (Figure 4.3).

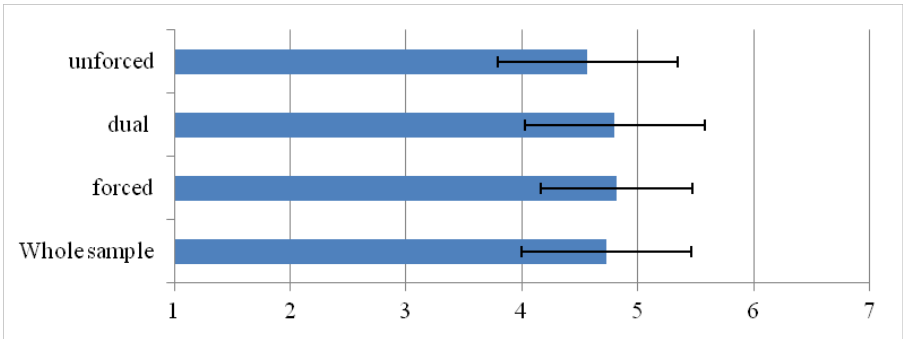

Figure 4.3: Certainty of the answers given in the choice sets, measured on a scale from 1 ("Not certain at all") to 7 ("Very certain"), with bars representing standard deviations.

Respondents were also asked whether they thought it was important to protect the Ruddy Turnstone (Figure 4.4). The scale used to measure their opinion on this matter ranged from 1 ("Not at all important") to 7 ("Extremely important"). The respondents seem rather concerned by the issue the survey dealt with; that is, the loss of marine biodiversity.

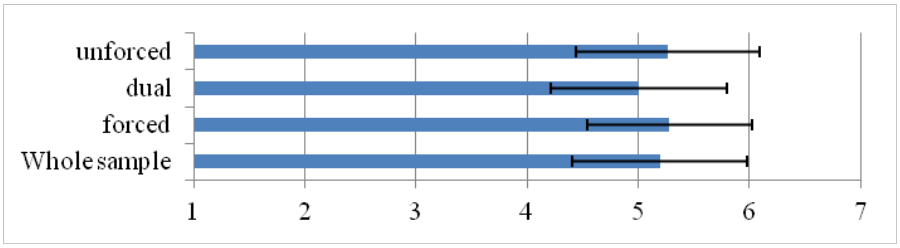

Figure 4.4: Importance to protect the Ruddy Turnstone, measured on a scale from 1 ("Not at all important") to 7 ("Extremely important"), with bars representing standard deviations.

The analysis of SLO reported in Section 3 provided input to the choice analysis. In particular, the SLO measure of "Social legitimacy" (p.26) was a significant explanatory factor of preferences.

The final explanatory factor relates to a question about the importance of four different areas that encompass the pillars of sustainable development; that is, the environment, the economy, and the social well-being in terms of both local communities and future generations' harmony. Respondents had to rate the importance of these areas from 1 ("Not at all important") to 7 ("Extremely important") (Figure 4.5). The areas were all rated on average between 5: "Somewhat important" and 7:"Extremely important" and are well balanced. This finding supports the idea that biodiversity offsets, by attempting to protect the environment without damaging the economic dynamism, can be useful to address the population willingness to foster both the environment and the economy. The importance of local communities was found to be a significant explanatory factor in the choice model.

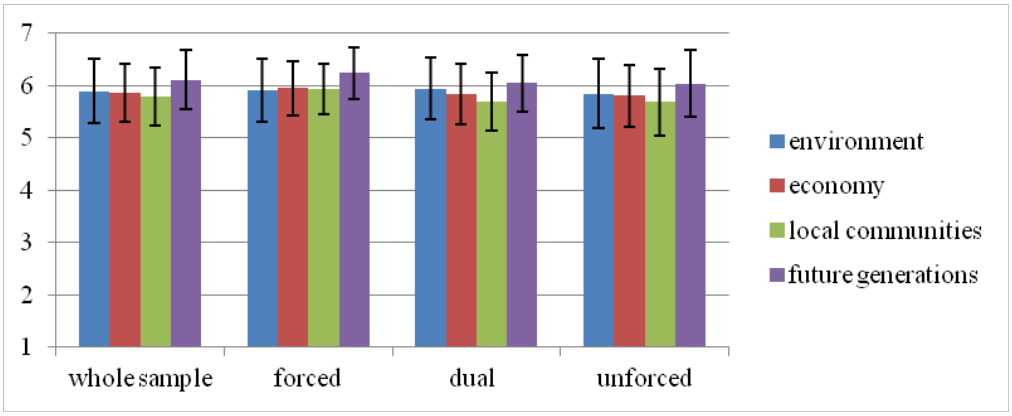

Figure 4.51: Priorities of the respondents with respect to the environment, economy, local communities and future generations, where each area was rated on a scale from 1 ("Not at all important") to 7 ("Extremely important"), and the bars represent the standard deviations.

4.2.2 Acceptance of marine biodiversity offsets

As noted above, 3 versions of the design were administered, differing only by the treatment of the opt-out alternative. The three choice experiments were first compared, using the approach outlined in Rose and Hess (2009). This step was necessary not only to better understand the effect of the inclusion of an opt-out option in the survey, but also to know whether it was possible to combine samples for later analysis.

Two estimated models can be considered equivalent if the set of parameters in each are not significantly different. As noted in Section 1, the utility parameters cannot be isolated from the scale parameter and vice versa. As a result, comparing two models a and b comes down to testing the null hypothesis H_0, such as:

$$H_0: \beta_a = \beta_b \ and \ \lambda_a = \lambda_b$$

Where: β_a and β_b are the vectors of utility parameters of model a and model b, respectively; and λ_a and λ_b are the scales of model a and model b, respectively.

Therefore, only the equivalence of the observed parameters can be tested directly. The null hypothesis associated with this test is:

$$H_{01}: \tilde{\beta}_a = \tilde{\beta}_b = \tilde{\beta}_1$$

Where:

- $\tilde{\beta}_a = \beta_a \times \lambda_a$
- $\tilde{\beta}_b = \beta_b \times \lambda_b$
- $\tilde{\beta}_1 = \beta_1 \times \lambda_1$

with β_1 the vector of utility parameters and λ_1 the scale of the model1 that combines the observations used for the model a and the model b and where the variance of the error terms is

constrained to be the same between the two original data sets. As the scale of the model is inversely proportional to its variance, it is also fixed in model1.

H_{01} can be tested by first calculating the log likelihoods of the models a and b separately, noted respectively LL_a and LL_b. It is also necessary to know the log likelihood LL_1 of the estimated model1. A test statistic T_1 can then be calculated:

$$T_1 = -2[LL_1 - (LL_a + LL_b)] = \ln \frac{(L_a \times L_b)^2}{{L_1}^2}$$

As a representation of the data, model1 is nested within the more general representation of separate models for each segment. A likelihood function is defined as the probability that the data are effectively observed given the model specified. Thus, if the data are as well explained by the combined model as by the two separate ones, T_1 is close to 0. If the probability that T_1 takes the calculated value under the hypothesis that it is chi-squared distributed with K degrees of freedom is less than the chosen level of significance, H_{01} is rejected. K is defined as the difference in the number of parameters estimated in model1 and models a and b combined. In the case where there are two samples being compared, this will equal the number of parameters in model1.

Of the three versions of the survey that were completed by the respondents, five samples were constructed (with the number in the name indicating the number of alternatives):

- Forced3: representing the sample collected in the forced version of the survey, where each choice scenario comprised of three offsets strategies and no opt-out option
- Unforced4: representing the sample collected in the unforced version of the survey, where each choice scenario was made up of three offset strategies and one opt-out option, and all responses across the four alternatives are used
- Unforced3: representing the sample collected in the unforced version of the survey, but where responses to the opt-out alternative are dropped from the data set, and only responses to the three offset options are analysed. This means that the number of observations is less than that for Unforced4, given the choice occasions where the opt-out is selected are dropped completely from the sample.
- Dual4: representing the dual choice version of the survey, where the respondents were first presented with an unforced choice scenario consisting of three offset strategies and an opt-out option. In this data set, the answers to this first stage of the question were analysed.
- Dual3: representing the dual choice version of the survey, where if the respondent selected the opt-out option, they were presented with a second question asking them to choose between the three offset strategies. In this data set, the answers to the first stage were kept if the respondents chose one of the offset strategies, and this was combined with the choice made at the second stage for the people who initially selected the opt-out option.

The reason for constructing Unforced3 and Dual3 is that it provides a mechanism for comparing the utility parameters derived from alternative designs, while holding the number of alternatives constant. This obviously relies on an assumption of Independence of Irrelevant Alternatives across alternatives (see Train 2009).

The same simple model has been estimated for each of the five subsets. In this model, the choices are explained by the three attributes. In this case, the representative utility V_{ni} provided by an alternative i to a respondent n can be expressed as follows:

$$V_{ni} = \beta_0 \times SQ_i + \beta_1 \times species_i + \beta_2 \times perc_i + \beta_3 \times China_i + \beta_4 \times NZ_i + \beta_5 \times NT_i$$

Where:

- $\beta_i, i \in [\![1,5]\!]$ are the parameters associated with each explanatory variable
- $species$ is a variable that takes the value 0 if the species protected by the offset is the Ruddy Turnstone, and 1 if it is the Eastern Curlew
- $perc$ is the percentage of direct offset used to offset for the loss of the birds
- $China$ is a dummy variable that takes the value 1 if the offset strategy is located in China and 0 otherwise
- NZ is a dummy variable that takes the value 1 if the offset strategy is located in New-Zealand and 0 otherwise
- NT is a dummy variable that takes the value 1 if the offset strategy is located in the Northern Territory and 0 otherwise
- SQ is a dummy variable that takes the value 1 if the alternative is the opt-out alternative.

The parameters of the three location variables are thus estimated relative to the situation where the offset strategy takes place in Western Australia and targets the Ruddy Turnstone.

For each comparison, the first test statistic T_1 follows a chi-squared distribution with five degrees of freedom. The critical value at the 95% significance level is equal to 11.07. The results of the comparisons are described in Table 4.5. The hypothesis that the parameters are equivalent in each comparison cannot be rejected.

Table 4.5: Comparisons of the forced, dual forced, dual unforced and unforced samples

Compared subsets		T_1	**Probability that T_1 is observed under H_{01}**
Forced/Dual forced	(Forced3/Dual3)	5.89	0.32
Unforced/Dual unforced	(Unforced4/Dual4)	7.09	0.31
Forced/Unforced without opt-out	(Forced3/Unforced3)	4.16	0.53
Dual forced/Unforced without opt-out	(Dual3/Unforced3)	6.16	0.29

Subsequently, a test statistic T_3 can be computed to know if the observed parameters are equivalent across the three samples that have three alternatives:

$$H_0: \tilde{\beta}_{C3} = \tilde{\beta}_{F3} = \tilde{\beta}_{D3} = \tilde{\beta}_{U3}$$

$$T_3 = -2[LL_{C3} - (LL_{F3} + LL_{D3} + LL_{U3})]$$

Where

- $\tilde{\beta}_{C3}, \tilde{\beta}_{F3}, \tilde{\beta}_{D3}, \tilde{\beta}_{U3}$ are the vectors of observed parameters of the model where the 3 samples are combined and models where the observations come only from the forced, dual forced or unforced (without the opt-out) sample.
- LL_{C3}, LL_{F3}, LL_{D3} and LL_{U3} are the log likelihoods of the model where the 3 samples are combined and models where the observations come only from the forced, dual forced or unforced (without the opt-out) sample.

This statistic is chi-squared distributed with 10 degrees of freedom. Therefore, values of T_3 above 18.3 have a probability of less than 0.05 to be observed under H_0. In this case, $T_3 = 10.75$ and has a probability of 0.38 to be found if H_0 is true. Hence, the vector of observed parameters can be considered equivalent across the three samples that have three alternatives, and we use the combined sample (Combined3 = Forced3, Unforced3, Dual3) for further analysis of preferences for attributes of the offset policy, without considering the opt-out option. Since seven people always chose the opt-out in the unforced version, Combined3 comprises the data from 318 respondents.

While the data sets defined over three alternatives (Forced3, Unforced3, Dual3) from the three versions of the survey can be combined because the vector of utility parameters does not significantly vary across them, it is still useful to analyse the choice of the opt-out option in the unforced and dual unforced designs (Unforced4, Dual4) further. This offers an insight to the extent to which people are willing to accept the concept of an offset to compensate for the impacts caused by the oil and gas sector on the marine environment.

Approximately one quarter of the respondents in these two surveys chose the no development option at least for one of the six choice scenarios they were presented with (Table 4.6). On the other hand, less than 7% always preferred the opt-out option. We can thus hypothesize that even if only a few people find the use of marine biodiversity offsets unacceptable in this context, a quite substantial proportion of the population would be likely to reject a project if the features of the offset strategy proposed do not suit them. Hence, the results of this survey can help companies to adapt their offset strategies to the expectations of the Western Australian population.

Table 4.6: Frequency of choice of the opt-out option and percentage of respondents involved

	Frequency of choice of the opt-out option	**Percentage of the respondents who chose the opt-out at least once**	**Percentage of the respondents who always chose the opt-out option**
Dual unforced sample (Dual4)	10%	26%	5%
Unforced sample (Unforced4)	11.5%	21.2%	6.7%
P-value of the Pearson chi square test	0.39	0.42	0.60

The type of design (i.e. whether people were aware that they would be asked to re-state their choice if they initially selected the opt-out) had no impact on the choice of the no development option

(Table 4.6). Indeed, the frequency of choice of the opt-out option, the percentage of the respondents who chose the opt-out at least once, and the percentage of the respondents who always chose the opt-out are not significantly different in the dual unforced and unforced samples according to the Pearson chi square tests.

4.2.3 Preferences for biodiversity offset attributes

The variables used in this section were recoded to facilitate the interpretation, and are defined in Table 4.7. The first step in the analysis was to define a simple model where the levels of the attributes are the only explanatory variables of the respondents' choices. This was done using the Combined3 data set, which takes into account the observations of the forced, dual forced and unforced without opt-out samples (Forced3, Unforced3, Dual3). The representative utility function of a respondent n provided by an alternative i is defined as follows:

$$V_{ni} = \beta_1 \times species_i + \beta_2 \times perc_i + \beta_3 \times China_i + \beta_4 \times NZ_i + \beta_5 \times NT_i$$

This function is expressed relative to the utility provided to the respondent n by an offset strategy implemented in Western Australia, aimed at protecting the Ruddy Turnstone with a 75% direct and 25% indirect offset. The base level chosen for the percent (*perc*) attribute is the mean of the proposed levels. The estimated coefficients in that case give an indication of the way the attributes influence people's choice.

The results of the regression are reported in Table 4.8. The percentage of direct offset is the only attribute that does not appear to influence people's choices overall. For the species attribute, the positive value of the parameter indicates that people prefer to protect the more endangered Easter Curlew, rather than the species directly impacted by the development. The estimated parameters associated to the location levels are consistent with our expectations since people's preferred location is Western Australia, followed by the Northern Territory, New Zealand and China.

Table 4.7: Definition of the variables used in the analysis of the choice experiment.

Definition	Notation	Values
Species	$species$	It is a dummy variable that takes the value 0 if the offset strategy aims at protecting the Ruddy Turnstone and 1 if the offset strategy aims at protecting the Eastern Curlew
Percentage of direct offset included in the offset strategy	$perc$	It ranges from -25 (if the offset strategy includes 50% of direct offset) to 25 (if the offset strategy includes 100% of direct offset)
Offset strategy located in China	$China$	It is a dummy variable that takes the value 1 if the offset strategy is located in China and 0 otherwise
Offset strategy located in New-Zealand	NZ	It is a dummy variable that takes the value 1 if the offset strategy is located in New-Zealand and 0 otherwise
Offset strategy located in the Northern Territory	NT	It is a dummy variable that takes the value 1 if the offset strategy is located in the Northern Territory and 0 otherwise
Offset strategy located in Western Australia	WA	It is a dummy variable that takes the value 1 if the offset strategy is located in Western Australia and 0 otherwise
Certainty of the answers given in the choice scenarios	$cert$	It ranges from -3 (“Not at all certain”) to 3 (“Very certain”)
Opinion about the importance of protecting the Ruddy Turnstone	RT	It ranges from -3 (“Not at all important”) to 3 (“Very important”)
Score on the “Social legitimacy” scale	SLO	It ranges from -2 (“Strongly disagree” on average with the items used the measure the “Social legitimacy”) to 2 (“Strongly agree” on average with the items used to measure the “Social legitimacy”)
Opinion about the importance of supporting the local communities	LC	It ranges from -3 (“Not at all important”) to 3 (“Extremely important”)

Table 4.8: Conditional logit model with the attributes as explanatory variables of the choices.

Attribute	Notation	Coefficient (standard error)
Species	$species$	**0.2990***** (0.561)
Percentage of direct offset	$perc$	**-0.0008** (0.0020)
Location: China	$China$	**-1.7030***** (0.0960)
Location: New Zealand	NZ	**-1.1258***** (0.0966)
Location: Northern Territory	NT	**-0.7235***** (0.0785)

Note: Log likelihhod = -1838.98. Observations: 1878. ***: significance at 99% level of confidence.

This simple model gives us an overview of people's overall preferences regarding the use of marine biodiversity offsets. Nevertheless, as seen before, the sample studied is not homogenous. Therefore, it is of particular interest to examine the effect of people's characteristics on their choices. Since the respondents' features do not vary across the alternatives and choice scenarios, they can only be taken into account by considering the way they interact with the attributes. We were especially interested in understanding the influence of people's knowledge about the topic, opinions on the survey, environmental concerns, priorities, confidence in the different governments to implement the offset strategies, and levels of SLO they were willing to grant the oil and gas sector with. We also studied the effect of the age and gender of the respondents. Not all of these factors resulted in significant interactions in the choice model. We discuss only those that were.

For the model that integrates individual characteristics to explain preferences, the representative utility function of a respondent n provided by an alternative i according is as follows:

$$V_{ni} = \beta_1 \times species_i + \beta_2 \times perc_i + \beta_3 \times China_i + \beta_4 \times NZ_i + \beta_5 \times NT_i + \beta_6 \times (perc_i \times cert_n) + \beta_7 \times (perc_i \times RT_n) + \beta_8 \times (perc_i \times SLO_n) + \beta_9 \times (China_i \times LC_n) + \beta_{10} \times (WA_i \times RT_n)$$

The representative utility is relative to the utility provided by an offset strategy implemented in Western Australia and aimed at protecting the Ruddy Turnstone with a 75% direct offset to someone who:

- is neither certain nor uncertain of the answers he gave in the choice scenarios;
- thinks it is neither important nor unimportant to protect the Ruddy Turnstone;
- does not agree nor disagree with the items used to measure the "Social legitimacy";
- believes that it is neither important nor unimportant to protect the local communities in Western Australia.

The expression of the representative utility can be rearranged:

$$V_{ni} = \beta_1 \times species_i + (\beta_2 + \beta_6 + \beta_7 + \beta_8) \times perc_i + (\beta_3 + \beta_9) \times China_i + \beta_4 \times NZ_i + \beta_5 \times NT_i + \beta_6 \times cert_n + \beta_7 \times RT_n + \beta_8 \times SLO_n + \beta_9 LC_n + \beta_{10} \times (WA_i \times RT_n)$$

In addition to including individual characteristics as interaction terms with attributes in the choice model, we also considered that the variability in responses across individuals. That is, although background information explaining the concept of biodiversity offsets was included in the survey instrument, it is a complex issue and we can reasonably assume that the large majority of respondents would not have been familiar with the topic of the survey. Since it is often argued in the literature that complexity can bias the results of a choice task (Mazzotta and Opaluch 1995, DeShazo 2002) we studied its effect on our results by allowing variance to change in the model. This is known as a heteroskedastic multinomial logit model, where the scale parameter is allowed to vary according to some characteristic(s) of the respondents in order to study their effect on the variance of the choices (Louviere and Eagle 2006, Hole 2006). In this case, we allowed the variance to change according to the certainty of the answers the respondents gave (i.e. *cert*). The estimated model is described in Table 4.2.

Table 4.2: Heteroskedastic model with individual characteristics included to explain preferences and variance in response.

Explanatory variable		**Notation**	**Coefficient (Standard error)**
Species		$species$	**0.2510***** (0.0526)
Percentage of direct offset		$perc$	**-0.0062**** (0.0025)
Location (compared to an offset strategy that would take place in Western Australia)	China	$China$	**-1.0434***** (0.1579)
	New Zealand	NZ	**-0.9325***** (0.1085)
	Northern Territory	NT	**-0.5458***** (0.0909)
Percentage*Certainty of the answers given in the choice scenarios		$perc \times cert$	**0.0031**** (0.0013)
Percentage*Importance of protecting the Ruddy Turnstone		$perc \times RT$	**0.0025**** (0.0011)
Percentage*Social legitimacy		$perc \times SLO$	**-0.0058**** (0.0023)
China*Importance of the local communities		$China \times LC$	**-0.2322***** (0.0712)
Western Australia*Importance of protecting the Ruddy Turnstone		$WA \times RT$	**0.1028**** (0.0408)
Variable used to model the scale: certainty		$cert$	**0.0855**** (0.0407)

Note: Log likelihood = -2817.80. Observations: 1878. ***, ** indicates significance at 99% and 95% level of confidence, respectively.

In comparison with the simple model, the estimated parameters associated with the species attribute and the location levels New Zealand and Northern Territory remain approximately of the same sign and size. This observation is consistent with the fact that none of these variables are influenced by the respondent's characteristics included in the model.

On the other hand, the marginal utility of direct offsets would increase with the importance people give to the protection of the Ruddy Turnstone and the certainty they have regarding the answers they gave in the choice scenarios. Indeed, the importance to protect a species often implies a certain urgency of action because of the irreversibility of biodiversity loss. In this context, it seems coherent that people who care the most about the Ruddy Turnstone support offset strategies which comprise a high proportion of direct actions. Moreover, if someone is unsure of what alternative would achieve the best outcome in a choice scenario, they might prefer to foster research, and thus indirect offsets, in order to reduce this uncertainty by gaining knowledge in the species and its management. Although it was explained in the survey that all options would lead to the same environmental outcome in terms of number of birds protected, it is worth noting that the respondents could still doubt that every option implied the same results regarding the state of the ecosystems, for example.

The more people trust the oil and gas sector and believe that it contributes to the well being of the State, the more they prefer options with a low proportion of direct offsets. This result could indicate that people who trust petroleum companies also tend to believe that they are unlikely to cause irreversible damages to a species and, thus, it would be preferable to take time to improve conservation techniques rather than implementing direct offsets.

The respondents who believe that it is important to support the local communities in Australia are even more reluctant than other respondents to the idea of offsetting in China. Indeed, as a powerful and growing country, China is often seen as a threat to the livelihood of the local communities in other countries, such as Australia. People who care the most about the local communities could be more likely than others to mistrust China in general, including for biodiversity conservation issues. However, the Pearson chi square test conducted to compare the distribution of the respondents who do not trust and trust the Chinese government among those who find it important to support the local communities and the other respondents showed no significant difference. Therefore, the previous hypothesis is not confirmed. Another explanation could be that people who want to foster local communities in Western Australia tend to be more willing to support communities that are culturally similar to them. As a result, they might prefer to improve the well being of populations in Western Australia, the Northern Territory and New Zealand rather than in China.

The respondents who find it important to protect the Ruddy Turnstone are also more likely than the others to support offset strategies in Western Australia. Thus, these people could in fact be more concerned about maintaining the environment as it is than about protecting the Ruddy Turnstone for its own sake. Indeed, this species is not well known so that people who care about its protection may be more worried about the consequences of its loss as part of an ecosystem rather than as a charismatic species.

In the heteroskedastic specification, the parameter $cert$ is significantly different from zero. Thus, the scale of the errors significantly varies depending on the level of certainty that the respondent had in their answers to the choice scenarios. The variance is inversely proportional to the scale, indicating

that the more certain of their answer the respondent is, the lower the variance of the error term is. This confirms the hypothesis that the perceived complexity of the choice task increases the dispersion of answers. This could mean that, when faced with complexity, and in contradiction with the neo-classical assumption, people do not have a clear and stable preference pattern. As a result, taking the answers of an uninformed public into account without caution to design offset strategies could not only lead to environmentally inefficient outcomes because of their unfamiliarity with the subject, but also to social discontentment because of the instability of their preferences.

However, in this case, on a scale from 1 ("Not at all certain") to 7 ("Very certain"), 60.31% of the respondents chose a value higher than 4 when indicating certainty of their responses, and the average value is 4.73 (Figure 4.3). Thus, we can assume that a majority of them still have a rather stable opinion regarding the kind of offsets they would be willing to support. The preferences of the average person in the sample studied can be considered reliable.

As for the seagrass case study, we considered what combinations of the offset attributes would provide an acceptable offset strategy, according to public preferences. Recalling that the design of this case study also addressed the question of whether marine biodiversity offsets were generally acceptable as a practice, we note that very few respondents *always* chose the opt-out option in the unforced and dual versions of the survey (Table 4.6). Therefore, it is likely that the approving a development on the proviso that any necessary offset package was defined appropriately would provide most people with a positive utility. Thus, we hypothesized that offset packages that provide at least the same level of utility as the reference (or baseline) offset defined in the choice models, which consists of protecting the Ruddy Turnstone in Western Australia with 75% of direct offset, were socially acceptable. Consequently, we compared 23 strategies with this baseline policy. Each of them takes place in one of the proposed locations, targets either the Eastern Curlew or the Ruddy Turnstone with 50%, 75% or 100% of direct offset. Table 4.3 reports the percentage of the respondents in the combined sample (i.e. Combined3) whose utility associated with the considered offset package is greater than the baseline policy.

Approximately half of the sample would prefer an offset package to be also implemented in Western Australia and aimed at protecting the Ruddy Turnstone but with only 50% of direct offset, while the other respondents would have a greater utility if the same offset included 100% of direct measures. Moreover, almost all respondents prefer packages which target the Eastern Curlew in Western Australia, for all three levels of direct offset. In addition, 14.15% would prefer to protect the Eastern Curlew with 50% of direct offset in the Northern Territory.

As a result, acceptable offset strategies could be aimed at protecting either the Ruddy Turnstone or the Eastern Curlew in Western Australia and with any of the three levels of direct offset proposed. However, the location determines if an offset package is acceptable or not. Indeed, no matter the level of the other attributes, almost no one in the sample would prefer an offset to take place in China or in New Zealand, whereas only a few would prefer to see it implemented in the Northern Territory.

Table 4.3: Percentage of the respondents who would prefer the stated offset to the baseline policy.

Offset packages aimed at protecting the Ruddy Turnstone				
		Percentage of direct offset		
		50% direct	75% direct	100% direct
Location	China	0.63%	0.00%	0.00%
	NZ	0.00%	0.00%	0.00%
	NT	3.77%	0.00%	0.00%
	WA	55.03%	**Baseline**	44.97%
Offset packages aimed at protecting the Eastern Curlew				
		Percentage of direct offset		
		50% direct	75% direct	100% direct
Location	China	1.57%	0.94%	0.63%
	NZ	0.31%	0.00%	0.00%
	NT	14.15%	2.52%	0.31%
	WA	93.71%	100%	85.22%

In summary, people would rather protect the more endangered species in Western Australia. They are not flexible regarding the country where an offset is implemented, whereas a proportion of them would be willing to relocate it in the Northern Territory or to protect the less endangered (impacted) species if the percentage of direct offset changes. Finally, people who trust the oil and gas sector a lot have a preference for less direct offset, whereas those who do not grant it with a SLO prefer offset strategies with more direct offset. However, for most of the respondents, the choice of an offset policy does not depend on this attribute.

4.3 Discussion of migratory shorebird results

Both the Australian government and the State government of Western Australia consider biodiversity offsets as eligible candidates to play such a role in meeting economic and environmental objectives. While there is still no certainty on their environmental outcomes[10], the focus of this thesis was to study their social acceptability, which is a necessary condition for them to lead to economic efficiency.

Marine biodiversity offsets can be implemented using very different features. In particular, they can be characterized by the place where they are implemented, the percentage of direct action they comprise and the environmental feature they are designed to conserve. Oil and gas companies

[10] Pickett et al (2013) recently demonstrated that to achieve no net loss in the population size of a vulnerable Australian frog species, it was necessary to restore a surface habitat 19 times larger than the impacted site. In general, most of the developers propose to offset their remaining damages on an area only two times larger than the impacted one.

should thus try to understand how people picture what a good offset strategy is in order to suit the population's preferences and improve their SLO.

The choice experiment confirmed that people prefer offsets to be implemented in Western Australia, rather than in the other proposed locations, and that they least like offsets that take place in China. This could be explained by the fact that it is the most culturally and politically different country proposed in the choice scenarios.

However, respondents would give more support to offsets which protect a more endangered species than the Ruddy Turnstone, which is the impacted species in the hypothetical scenarios. This finding could indicate that biodiversity offsets, in the public's opinion, should rather serve as a means to improve biodiversity conservation in general rather than to compensate for a specific loss.

We did not expect that, on average, the proportion of direct offset would not impact people's preferences for an offset strategy. This can be explained by moderator variables: respondents who are more concerned about the protecting the Ruddy Turnstone tend to prefer offset strategies which include more than 75% of direct measures, whereas people who have a lot of trust in the oil and gas sector are more inclined to support strategies with more indirect offsets. This result reflects the effect of an individual's point of view regarding the urgency of the situation. A high proportion of direct offset is required when people believe that the environment is in immediate danger (i.e. when they think that it is extremely important to protect the Ruddy Turnstone: high score on RT) whereas those who think that the petroleum companies are rather trustworthy prefer to allocate more effort to finding more efficient conservation strategies through research.

Our results predict that although people would accept, to some extent, to protect a less endangered species if the proportion of direct offset is modified, almost none of them would prefer an offset strategy to be implemented in another country than Australia, no matter the level of the other attributes. This suggests that oil and gas companies would have more chance to improve their SLO if they propose to compensate for their environmental damages locally.

5. Summary

This report presents results from two pilot studies on the community acceptance of marine biodiversity offsets in Australia. The case studies focus on matters of national environmental significance (or on habitats that are important for such matters), which makes the results relevant to inform future revisions of offset policies at both the State and Commonwealth Government levels. Specifically, the case studies report community acceptance of offset policy characteristics in the context of hypothetical developments that will result in residual impacts on marine turtles (due to destruction of seagrass habitat) and migratory shorebirds.

The pilot studies highlight some interesting initial findings, including:

- The majority of respondents do not object to the practice of offsetting environmental impacts in general.
- Preferences for the composition of direct and indirect offsets are varied.
    - In the seagrass case study, respondents tended to prefer that an offset package comprised a majority of direct offset action, with a small amount of indirect offsetting.
    - In the migratory shorebird case study, the ratio of direct to indirect offset was not, on average, an important factor in determining an individual's preferred offset policy.
- In both the seagrass and migratory shorebird case studies, individuals exhibited a preference for the offset to be located near the site of impact, and the offset became more unacceptable the further away that it was located.
- The type of direct offset action matters. In the seagrass case study, respondents generally preferred that the on-ground action dealt exactly with the impact; that is, that the damaged seagrass beds were replanted.
- Respondents tended to prefer that the offset is used to protect a more endangered species than the one impacted by the development. Specifically, in the migratory shorebird case study, individuals preferred to aim conservation efforts at the vulnerable Eastern Curlew rather than the impacted Ruddy Turnstone.

The subsequent choice experiments will build upon these pilot studies to confirm the initial findings with larger samples of the Australian population. It is anticipated that the larger sample size will reveal more consistent trends with respect to preferences for the ratio of direct to indirect offsets. In addition, other policy attributes will be considered.

This might include the party responsible for implementing the offset. In the pilot studies the local government's environment department was specified as the implementer. Alternatively, the proponent or a third party could be responsible for implementation. We note that trust played a role in explaining preferences in the pilot studies, in terms of confidence in the West Australian Government (for seagrass) and social license to operate (for shorebirds), which will need to be considered with respect to any variation in implementer.

Another potential attribute for consideration is the likelihood of co-benefits that might results from an offset. Co-benefits might result, for example, by improving a habitat to protect one species which also happens to protect another species. The pilot study on migratory shorebirds suggests that this

policy attribute could be of relevance: if the community prefers to aim offsets towards more endangered species, suggesting they view offsets as a conservation strategy, it would make sense that they also prefer that an offset protects multiple species.

The next phase of this research will involve revising the choice experiment surveys in light of the pilot study findings. The revised surveys will then be administered to a larger sample of the Australian community. It is anticipated that samples will be collected broadly across Western Australia, allowing comparison of preferences between individuals residing in and out of the Perth metropolitan area. Samples will also be collected nationally to establish whether preferences differ when the development and impact is positioned interstate. In particular, preferences in terms of offset location may vary depending on the location of the respondent.

Finally, it should be noted that the findings of the pilot studies must be interpreted with caution due to the small sample sizes, which are specific to the Perth population, and the exploratory design of the surveys. Subsequent choice experiments will be used to further explore and confirm these findings. Further, it is worth highlighting that broad community preferences generally have limited scientific understanding. Designing offset policies that only consider community expectation could result in inefficient, or even negative, environmental outcomes. Therefore, the findings of this study (once completed) should be used as an input into choosing the more socially acceptable offset strategy amongst an equivalently efficient set of offsets, or to adapt the communication and education strategies about an offset when the best options in terms of environmental outcomes do not match the population's preferences.

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