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What should we do? An explanatory analysis of the decision-making process in biodiversity conservation

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ABSTRACT

Conservation decisions can have a major impact on species, and landscapes and the people who live in them. For academics who wish to be involved in conservation practice, understanding how these decisions are made is crucial. This mixed-methods study used a descriptive approach to understand decision types, actors, influences and information sources in biodiversity conservation. We conducted semi-structured interviews with eleven conservation professionals to generate information on decision making and then used these data to develop a survey completed by 36 conservation professionals. This approach highlighted numerous important insights for conservation academics wishing to support conservation decision making, and we suggest that identifying the frequency and complexity of decision types in conservation could highlight areas where academics could have the greatest impact.

1. Introduction

Many conservation academics wish to 'make a difference' (Pienkowski et al., 2022), and one way of doing this is to contribute to conservation decision making. To do this, understanding the process of conservation decision making is crucial (Kørnøv and Thissen, 2000; Papworth, 2017). Decisions happen at multiple levels, from the strategic to the routine, and even after high-level decisions have been made about conservation priorities, there will be other choices, such as about funding and logistics, before priorities can be turned into actions (Ausden and Walsh, 2020; Fuller et al., 2020). These complex decision contexts mean that researchers need to identify pathways for informing practical conservation (Evans et al., 2017). Explicitly investigating how conservation professionals make decisions can help academics to understand who to talk to, and how they could best aid the decision-making process.

There are many academic publications identifying critical species, habitats and best available practices to aid on-the-ground conservation decisions and actions (Mace, Possingham and Leader-Williams, 2013; Pullin et al., 2013), and various frameworks and tools for supporting decisions (Schwartz et al., 2018). These conservation frameworks and tools can be guided by three connected decision theories (Hemming et al., 2022). Normative decision theory describes how decisions ought to be made, providing guidance for choosing between alternatives (Bell et al., 2011) and identifying logically consistent decisions that maximise the value or utility of the decisions' consequences (Hemming et al., 2022). However, these approaches and their assumptions can neglect key factors in decision making, such as the impact of emotions (Angie et al., 2011; Meek et al., 2015), time pressure (Meso, Troutt and Rudnicka, 2002) and information seeking behaviour (Mishra, Allen and Pearman, 2015). These factors can be crucial in determining the success or failure of conservation actions (Martin, Nally et al., 2012). Another branch of decision theory, descriptive analysis, focuses on the decisions people make, specifically how and why they make those decisions (Keller, 1989; Bell et al., 2011; Hemming et al., 2022). This approach does not try to influence or modify behaviours (Bell et al., 2011). Finally, prescriptive decision approaches combine the 'ought' and the 'is' of decision making to help decision makers make better choices (Bell et al., 2011). This combination of normative and descriptive approaches can guide decision making to improve decisions, while acknowledging and allowing for commonly observed patterns in decision making (Bell et al., 2011), such as use of heuristics and the effect of cognitive biases (Hammond, Keeney and Raiffa, 1998).

Although there is great value in normative and prescriptive decision analysis and support (Hemming et al., 2022), in conservation to date there has been less focus on descriptive decision making, which also has

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value (Keeney, 2004; Papworth, 2017; Sinclair, 2018). Descriptive approaches can inform those who wish to contribute to, but have little experience with, decision making, and can inform prescriptive approaches to decision making (Keeney, 2004). For example, research in South Africa using descriptive analysis identified the importance of informal negotiations between actors and interested parties within the formal environmental impact assessment process (Sinclair, 2018). Likewise, cognitive mapping of decisions by policy makers and managers in the USA allowed researchers to present their data within decision makers' existing understanding of their context (Biedenweg et al., 2020). These two studies explored decision making within different contexts using different methods, and thus identified different 'emergent themes' and 'mental objects' respectively. Despite the differences between the studies, both found respondents considered the political environment in their decisions, something that is widespread across conservation decision making (Fuller et al., 2020), but not necessarily included in some decision support tools such as systematic conservation planning (McDonald, 2009). Greater expansion of descriptive approaches to decision making in conservation could identify further critical influences on decisions.

We investigated the decision processes of conservation professionals, including both those based inside and outside of academia. Although descriptive decision theory includes research on cognitive biases and heuristics, in this study we do not focus on the psychology of decision makers, but instead on four areas of potential interest for conservation academics interested in supporting conservation decision making: decision types, actors, information sources and influences. Many different actors (decision makers) are involved in conservation decision making and they make a variety of decisions (Ausden and Walsh, 2020) thus we aimed to generate information on as broad a sample of actors and decision types as possible. We also wanted to collect data on the types of information used to support decisions (decision information) as much of the academic literature on conservation decision making thus far has focused on this topic. Finally, we collected data on perceived influences on decisions (decision influences) so that conservation academics could better understand how their input might fit into the broader decision-making process.

2. Methods

We used a three-phase exploratory sequential mixed-methods design (Creswell and Plano Clark, 2018). First, we used semi-structured interviews with conservation professionals to generate themes (phase one). To explore the relative importance of the information generated from these interviews, we then developed (phase two) and administered (phase three) an online survey, which was completed by a different sample of conservation professionals from those interviewed. For phases one and three, we invited participation from conservation professionals both inside and outside of academia to allow for these different perspectives to be represented. The three phases of this study's design are outlined further below.

2.1. Positionality statement

It is important to note that our positions in academia, and other characteristics of our identities, will have influenced the data collection and analysis of all parts of the study, not just the qualitative interviews (Jamieson, Govaart and Pownall, 2023). The first author was an undergraduate student at the time of data collection, the second author was a PhD candidate and the third author was a university lecturer. Some potential participants may, therefore, not have responded to the survey or interview invites because of the research was not seen as important, or because they did not have an existing relationship with the authors, or with academic research in general. For the interviews, our positions relative to the participants and our own preconceptions will have influenced the results, although this should be also considered a strength of qualitative research, which partly relies on the richness of subjective interpretations for its value (Rubin and Rubin, 2011; Olmos-Vega et al., 2023).

2.2. Phase one: semi-structured interviews

Participants in the semi-structured interviews were identified through snowball sampling (Noy, 2008), starting with the personal contacts of one of the authors. Additional participants were identified from attendance at UK conservation symposia and meetings during April-May 2016. Any individual responsible for making decisions about what species or areas to conserve, or what methods to use (whether individually or as part of a team) was considered eligible for inclusion. After establishing that participants were eligible for participation, and gaining their informed consent, semi-structured interviews were used to examine their decision-making processes. Semi-structured interviews were chosen to ensure the themes outlined in the interview guide were covered, but that respondents were also able to talk about issues that were important to them (Young et al., 2018; Silverman, 2020).

Interview recordings were transcribed by a transcription service and analysed with the assistance of Nvivo 11 (QSR International Pty Ltd, 2015). Applied Thematic Analysis was used as it allows an inductive approach to build theoretical models through a combination of interpretive and positivist approaches, and is appropriate for mixed-methods research (Guest, MacQueen and Namey, 2012). After data immersion, one author coded the text of each interview and then iteratively classified codes into themes using the interview guide as a structural codebook (Guest, MacQueen and Namey, 2012).

Excerpts from the transcripts are presented in the results section to illustrate the themes identified. Some of the information [indicated with square brackets] has been redacted to protect the anonymity of the participants. Where participants talked about their experiences in previous roles, their role at the time of the decision they talked about is ascribed to the statement, as opposed to their current role.

2.3. Phase two: survey development

The themes identified in the interviews were used to design the online survey. Table 1 shows this process by displaying the themes identified from the interviews alongside the survey questions they informed. Prior to this research, conversations with other conservation professionals suggested that how decision-making processes are described in abstract terms (e.g. what an individual reports they 'usually' do), differs from the way it is described when discussing a specific example. Therefore, the survey asked about past decisions in general, but also asked participants to answer the questions for the last decision they made.

2.4. Phase three: Online survey

The online survey (see supplementary materials) was constructed and completed using Qualtrics (Qualtrics, Provo, UT). The survey presented a list of ten conservation decision types for participants to indicate how often they made each type of decision (daily, weekly, monthly, quarterly, annually, less often than annually or never). We did not specify what types of actions an individual might take within these decisions for example, when a participant indicated they made a 'decision about lobbying' less often than annually, these decisions could be about whether or not to lobby, or who to lobby. A list of 15 items that could influence conservation decisions was presented. Participants were asked which of these items influenced the decisions they made and to rank the items selected from the most to least influential. This process was repeated with a list of 13 potential decision makers, and a list of 15 information sources. The options were identified in the semi-structured interviews, but a free text option was included for each question so participants could identify and rank additional items. A subsequent

Table 1
Findings from the interviews, and the corresponding survey questions which explored these (paraphrased for brevity, see supplementary materials for full survey). Information in brackets shows the relationship between the findings and themes.

Interview finding	Corresponding survey question
Decisions are made about a wide variety of topics (Theme 4)	*How often do you make the following types of decisions?* Participants selected a frequency (seven options ranging from 'daily' to 'I've never made this type of decision') for a list of 10 decision types identified in interviews (see Fig. 1). An 'other' option was included so participants could state other decision types they made.
Decisions are complex and influenced by a wide variety of factors (Theme 4)	*Which factors have influenced conservation decisions you have made?* Participants selected from a list of 15 factors identified in interviews, and were provided with an 'other' option. They ranked the options selected from most influential to least influential.
Decisions are rarely individual, and instead are made by multiple individuals (Theme 1)	*Who has been involved in previous conservation decisions you have made?* Participants selected from a list of 13 actors identified in interviews, and were provided with an 'other' option. They ranked the options selected from most influential to least influential.
Diverse information sources are used (Theme 3)	*What information sources have you used to inform your decisions?* Participants selected from a list of 15 sources identified in interviews, and were provided with an 'other' option. They ranked the options selected from most influential to least influential.
Differences between general descriptions of decision-making and descriptions of specific examples (interviewer observation)	Participants were asked the above questions for 'past decisions' to include all decisions made. They were then asked to state the type of decision they made last, and then select and rank the influences, actors, and information sources.
Academics are involved in decision making, but may experience the process differently (Theme 2)	Academics involved in decision making were invited to participate in the survey. Responses by academics and non-academics participating in the decision-making process are contrasted.

section asked the same questions, but specifically focused on the last conservation decision that participants made.

A sample of 460 individuals within the field of conservation were individually contacted via email in December 2017 and January 2018, and invited to participate in the survey. The invited participants did not include the interview sample. Fifty-six individuals responded to the survey, and of these, 32 completed the study and 11 partially completed the survey. Another 13 individuals clicked on the link in the survey but did not move past the page asking for consent to participate in the study. We were unable to determine before contacting individuals whether they viewed themselves as conservation decision makers, which could have contributed to the low rate of participation in the emailed survey. However, this low rate could also be attributed to other factors, such as lack of time or motivation to engage with the research. For the 43 individuals who consented by clicking 'I consent' and moving to the next page, demographic information was requested, specifically on age, gender, nationality, qualifications, the number of years worked in conservation (and specifically as a decision maker), and the type and size of the organisation they worked in (see Table 2). Six individuals had not previously participated in the decision-making process for biodiversity conservation and were excluded from further analyses, leaving a sample of 36 conservation decision-makers. As not all participants answered all questions, reduced sample sizes are reported where applicable.

Table 2
Demographic information on survey participants. One participant did not respond to the question about the number of years as a decision maker but answered questions about the types and regularity of the conservation decisions they had contributed to.

		Summary information for all participants (n = 43)	Summary information for participants who make decisions in conservation (n = 36)
Age		39.5 ± SD11.1	40.8 ± SD11.3
Gender	**Male**	22	19
	Female	21	17
Education	**Undergraduate degree**	5	5
	MSc/PGDip	19	15
	PhD	19	16
Years working in conservation		13.0 ± SD10.2	13.8 ± SD10.6
Years as a decision maker			8.0 ± SD7.0
Nationality	**UK**	26	23
	USA	6	4
	Australia	3	3
	EU	5	3
	Other countries	3	3
Type of organisation	**NGO**	17	13
	Academia	25	20
	Government	2	2
Organisation size	**< 10**	3	2
	11–50	7	4
	51–250	10	10
	251 +	23	20
Country principally working in	**UK**	24	21
	USA	4	4
	Australia	3	3
	Non-European countries	9	8

2.5. Data processing

To create a measure that combined both the number of individuals who selected an option and how important the option was to those who selected it, we calculated the overall salience. The overall salience can vary between zero (where no participants selected an option) and one (where all participants selected an option and rank the option first). For each participant, the salience of each ranked option in a list was calculated using the following equation (Quinlan, 2005):

$$Salience_{o,i} = \frac{1 + length_i - position_{o,i}}{length_i}$$

Where *length* is the number of options from a list selected by the individual (*i*), and *position* is the ranked location of a specific option (*o*) for the same individual (*i*).

The overall salience across all participants for each option within a list was calculated using the following equation:

$$Overall \quad salience_o = \frac{\sum salience_{o,i}}{n}$$

where *n* is the number of individuals who participated in the question by selecting at least one item from the list. These calculations were conducted using the Anthrotools package (Purzycki and Jamieson-Lane, 2017) in R version 4.2.2 using the GUI RStudio 2022.07.1 (R Studio Team, 2016; R Core Team, 2022).

2.6. Ethical approval and consent

Ethical approval for the study was given by the School of Biological Sciences, Royal Holloway University of London (applications 95–2016–02–19–11–33 and 719–2022–09–12–56). Informed consent was gained from all participants before they contributed to either the

interviews or the survey.

3. Results

3.1. Semi-structured Interviews

Interviews with twelve conservation professionals were conducted from April-July 2016. Some individuals had roles that spanned sectors (or had previously worked in other sectors of conservation), but at the time of the interview the primary sectors of those interviewed were non-governmental organisations (n = 4), government (n = 3), academia (n = 3) and the private sector (n = 2).

Important evidence on the nature of decision making in conservation was generated during the interviews. Analysis led to the identification of four themes: 1) Multiple actors in decision making; 2) The relationship between research and practice; 3) Information sources used to guide decisions; 4) Diverse decision types and influences on decision making. The themes are described further below and illustrated using quotations from the study participants.

3.1.1. Theme 1: multiple actors in decision making

Although participants all made decisions about conservation, most decisions involved multiple actors and interested parties:

> "We had a workshop where we invited everyone who is doing anything on [the species] including biologists […] organisations who are doing small projects in the area, […] the forestry department […] identified a lot of actions that were needed. […] the intention was that the nature reserve and the authorities would play the lead." (NGO employee)

When discussing the decision-making process, participants often described the influence of other actors and the limitations of their ability to influence the decisions made. For example, one participant described their role as an advisor:

> "[I've been involved in] lots of […] on-the-ground conservation decisions around […] should this area be turned into a protective area, should that area be managed by communities or local government or central government? But, of course, I can't decide that for the central government or the local government or the communities." (*Academic*)

Because of this, all twelve participants talked about the importance of interpersonal relationships for conservation decision making. These interpersonal relationships sometimes created new opportunities for conservation. For example, one participant worked on the conservation of a critically endangered species, and felt that:

> "The decision making was often in response to an opportunity that was created through the relationship, the deepening relationship with the authorities." (*NGO employee*).

Due to the importance of interpersonal relationships, trust between decision-makers was also considered very important. The importance of trust was found across all types of decisions, including funding decisions:

> "There aren't many cases where we would be mainly guided by someone we don't know. So knowing someone and trusting their judgment is really important for us." (*Conservation funder*)

3.1.2. Theme 2: the relationship between research and practice

During the interviews, participants were asked about (and some spontaneously mentioned) the relationship between conservation research and conservation practice. Both academics and non-academics however expressed a wish to integrate research and practice. For example, one participant talked about how when looking for a PhD topic:

> "I was looking for a species where research would make a difference for conservation." (*PhD student*)

The desire to integrate research and practice was not only expressed by academics, however, as other non-academic participants also expressed a desire for closer working relationships with academics:

> "I would like academics to actually roll their sleeves up and […] come and talk to us, and actually come and see what we're doing, and actually find out what questions we really need answering." (*National Park employee*)

Where participants did talk about successfully combining conservation research and practice, this seemed to be a result of academics working with practitioners to develop and conduct research that will be applied:

> "So, my experience is if you work with practitioners and do stuff that they want doing or that's useful for them it will get used." (*Academic*)

3.1.3. Theme 3: information sources used to guide decisions

Diverse sources of information were identified as supporting decisions. Participants talked about the importance of personal experiences, and the experiences of colleagues, in guiding decisions. For example, one participant talked about how they chose the reintroduction site for a species of conservation concern:

> "[I relied on my] practical experience of working with [the species] and seeing what they can get up to in the wild and then [translating] that into what sort of habitat is available at the time." (*NGO employee*).

Prior experience was particularly valued for its ability to provide site-specific and longitudinal context for decision making, although some felt this experience was undervalued:

> **"**The value and expertise of the […] site-based practitioners that know the site really, really well […] that knowledge of the changes they've seen across the site or the knowledge of the practical challenges of how a site's managed are sometimes really overlooked**."** (*National Park employee*).

As well as the prior experience of individuals, information that informed decisions was found in management plans, population viability analyses and population monitoring. Generation of this information was often conducted by the participants' organisation, for example:

> "We do have a science department and we do have a science strategy, it's recently been reviewed. [The strategy has] top priorities for what [the NGO] sees as the main issues and priorities to address for our research department." (*NGO employee*)

The importance of having evidence to support decisions was highlighted by several participants, particularly its importance for encouraging confidence and the trust in collaborators and other decision-makers. For example, an employee at an NGO focusing on a group of related species:

> "If we are making a point about something and we are firm on it people will […] now know that we will have the evidence to support that if they push us. So if you're in discussions with government about things, you really have to be seen to be strong and [have evidence] and then you can be more effective." (*NGO employee*).

Although multiple participants talked about the importance of academic papers, academic collaborators were also valued outside of the production of peer-reviewed papers. For example, one NGO employee described how a PhD student had made a significant contribution to their work:

"She also wrote up a really important document, the conservation management plan for that species [including] where it was and what its status was […] the habitats it used and how it moved around the landscape. [It includes] everything you need to know and […] what you need to do to save it." (*NGO employee*)

3.1.4. Theme 4: diverse decision types and influences on decision making

As originally developed, this research planned to focus on decisions about what species and areas to conserve, and decisions about what methods to use. However, the participants identified ten different decision types during the interviews, many of which might be made in a single project, and included the decisions they had to make about monitoring, policy, project logistics and funding:

"You have to decide how much it's going to cost and what steps will get you. And then that starts defining what people's work programmes would be." (*National Park employee*).

These decisions might be made by the decision maker themselves, but in some cases, these types of decisions were seen more as external influences on the decision-making process, and part of a broader context which informed decision making.

"So, a lot of the decision making is based on time and money; that's the main restraints [on] what I'd like to do" (*NGO employee*)

The availability of funding was mentioned by all participants, and considered by more than one to be the single most important influence on decision making:

"Probably what drives everything is the availability of funding." (*Public company employee*).

All participants, however, cited multiple factors that influenced the decisions they made, and this included the role of other decision makers:

"You can't make conservation decisions without having the right team of people, and you can't make conservation decisions without the right policy being in place, and you can't make conservation decisions if your client is not interested in it." (*Ecological consultant*).

3.2. Survey development

Table 1 (below) is an instrument development display (McCrudden, Marchand and Schutz, 2021) showing how the themes identified through the interviews were used to develop elements of the survey. The questions and options are shown in the supplementary materials.

3.3. Online survey

Although invitations to participate were sent to conservation professionals worldwide, the individuals who participated in the survey were mostly from the UK (Table 2). They were employed by NGOs, governments, and academic institutions, and almost half had a PhD (Table 2).

3.3.1. Types of decisions

Prioritisation of methods, areas and species had all been completed at least once by most (76%, 68% and 65% respectively) participants, but relatively infrequently, with modal frequencies of quarterly or less often (Fig. 1). In contrast, decisions about logistics were the most frequently made decision type—at least weekly by 30% of participants, and at least quarterly by 70% (Fig. 1). Other commonly made decisions were monitoring of research needs (e.g. deciding whether additional research was needed to support the project), deciding when and whether to start or stop projects, and funding considerations. Six participants identified decision types which were not identified in the interviews, which were decisions about media communications (n = 2), capacity/planning (n = 2), habitats (n = 1) and field site selection (n = 1).

Thirty participants provided information about the last decision they made. Of these, most were about what conservation methods to use (7 participants, Fig. 2). Monitoring research needs, logistics and funding were the next most common last decisions (4 participants each), followed by species prioritisation and policy (3 participants each), then starting or stopping projects and area prioritisation (2 participants each). One participant selected the 'other' category and reported they were making a decision about where to direct capacity. Almost equal numbers of academic and non-academic participants selected all decision types; the greatest difference was three academics reporting their last decision was about monitoring research needs, compared to only one non-academic.

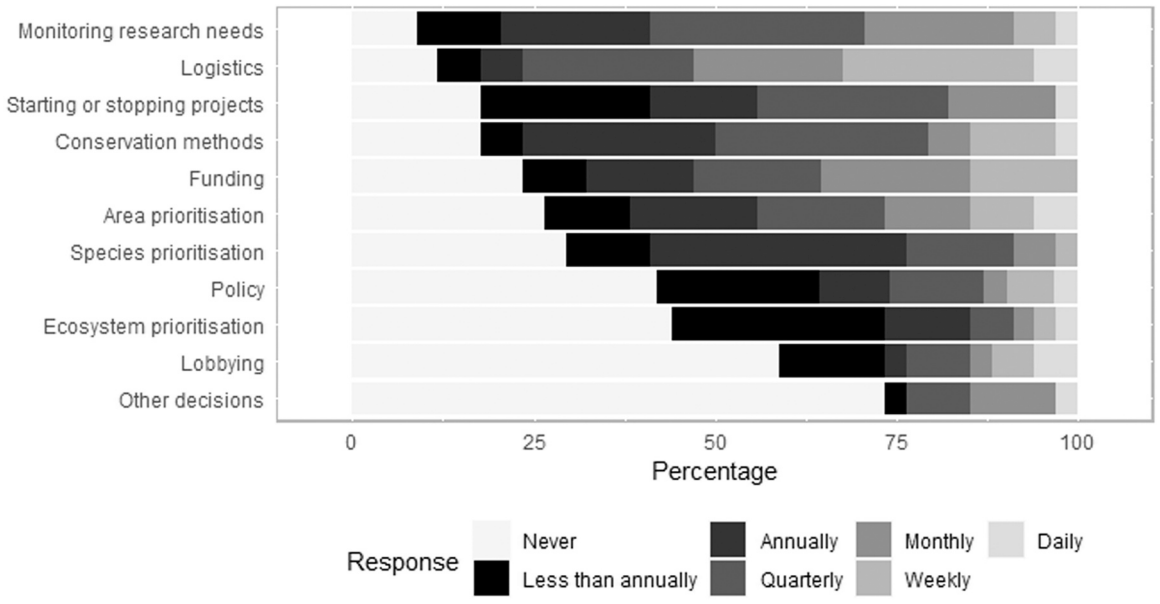

Fig. 1. Frequency that 34 conservation professionals made different types of conservation decisions, ordered by the percentage of participants who had ever made each type of decision.

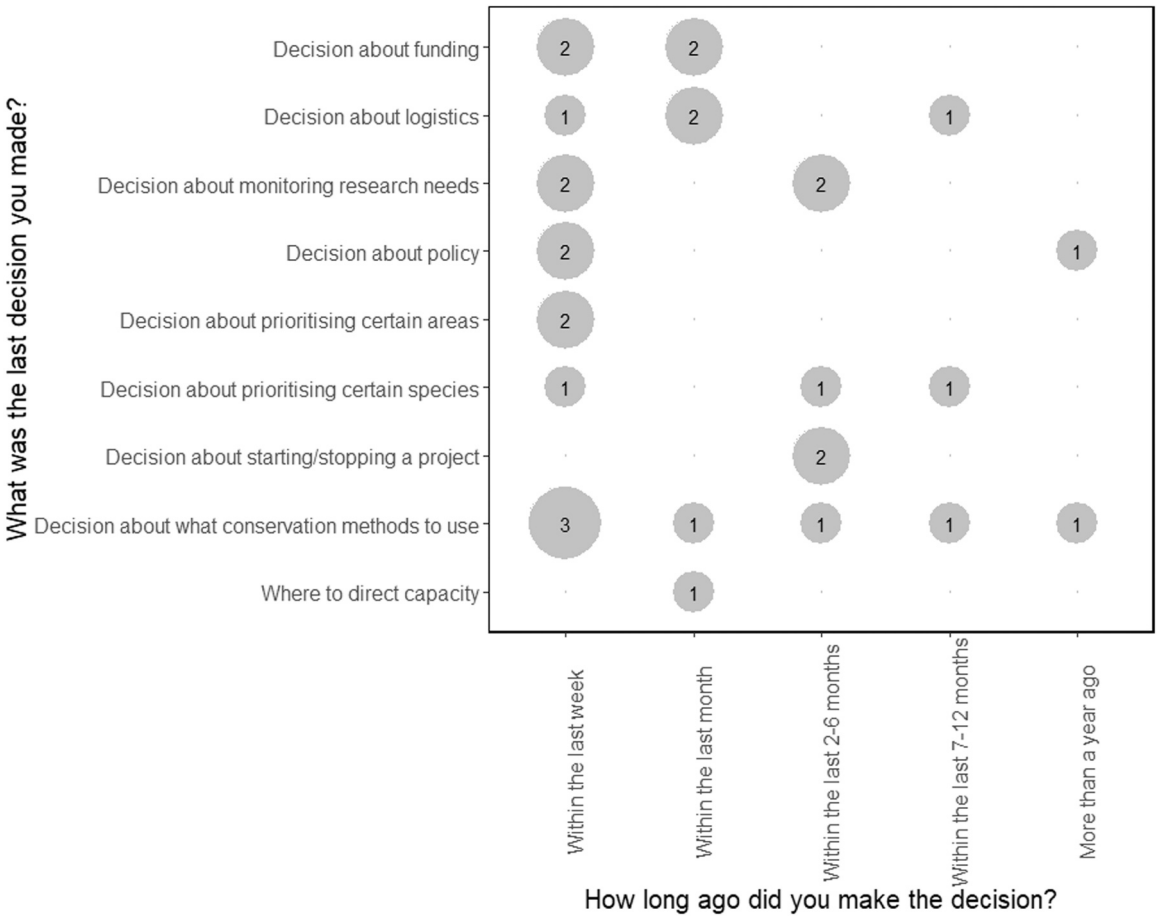

Fig. 2. Last decision made by 30 conservation professionals and how long ago they made that decision. Circle size and text shows the number of participants in each combination of these two variables.

3.3.2. Influences on decision making

For academic participants, research was also the most salient influence on both past and last decisions (Fig. 3). In contrast, institutional priorities and lack of funding were more salient than research for past decisions by non-academics (Fig. 3a). Non-academics also identified multiple additional influences which were not included in the 15 factors identified in interviews, such as 'time constraints' and 'urgency of need'. Participants reported between one and seven influences on their last decision (median = 3).

For non-academic participants, line managers (the person that directly manages that individual) were the most salient actors who influenced both past decision making and the last decision made (Fig. 4). Colleagues were salient actors for both academics and non-academics. A single participant reported their past decisions were influenced only by themselves. Three participants reported they were the only decision maker in their last decision, but most participants identified multiple actors (median 2, range 0–6).

Information sources used were broadly similar between academic and non-academic participants (Fig. 5). Other people (e.g., conservation practitioners and colleagues) were highly salient information sources for past decisions by both academics and non-academics (Fig. 5a). Participants identified diverse information sources for their last decision (median = 3.5, range 1–11), though previous experience of the participant was the most salient information source for both academics and non-academics (Fig. 5b).

4. Discussion

This study used a three-phase exploratory sequential mixed-methods design (Creswell and Plano Clark, 2018) to provide insights into how decisions are made in conservation. The results from the interviews showed that most decisions involved multiple actors and that, therefore, interpersonal relationships were very important for decision making. The qualitative interviews suggested there are likely to be benefits from closer working between academics and non-academics, but the interviews and surveys suggested key differences in how academics and non-academics approach decisions. For example, academics tended to rely more on research to make decisions, whereas non-academics were guided and/or constrained by institutional priorities and funding, and made decisions partly based on past actions. The results also showed that decisions are made about a wide variety of topics. In this study, 10 different decision types were identified through the interviews (see Fig. 1), and an additional four decision types were identified in the survey. These decisions were made with varying frequencies and participants reported diverse actors, influences and information sources. Through these results, we demonstrate how descriptive approaches to decision making in conservation can provide new insights for individuals involved in, and wanting to support, decision making in conservation. This discussion highlights the findings that we think can generate practical recommendations for those based in academia who are interested in contributing towards conservation decision making.

As noted in the results section, the research was intended to focus on what species and areas to conserve and the methods that might be used to achieve this. We found, however, that the two most common decisions made were those referred to as "Monitoring research needs" and "Logistics". A third of participants had made their last decision in the last week, although the type of last decisions made was diverse. Both these findings point to decision-making processes that are more diffuse than

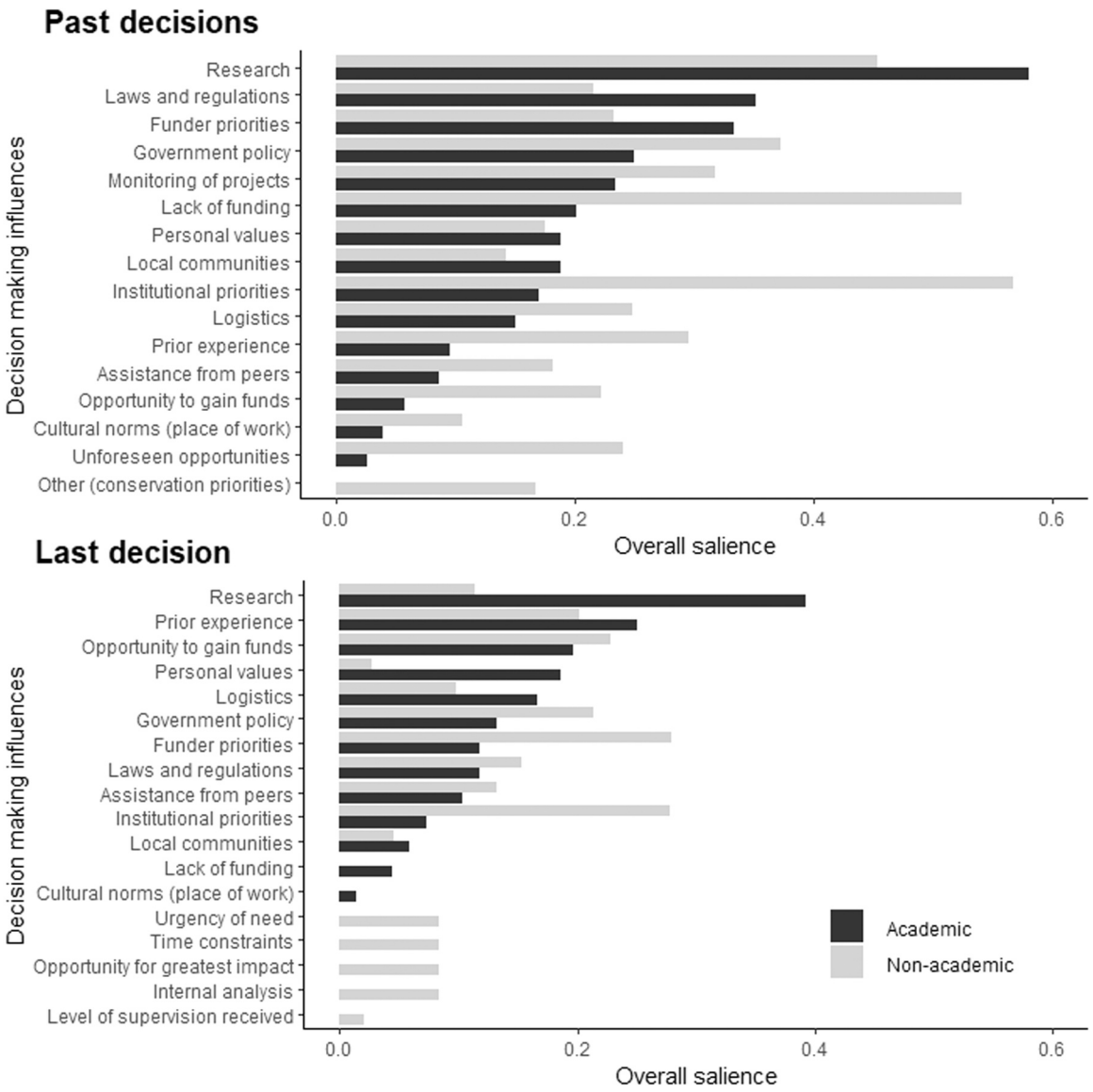

Fig. 3. A) Salience of 16 factors that have influenced past decision making by 31 conservation professionals, calculated separately for 19 academics and 12 non-academics. B) Salience of 18 factors that have influenced the last decision made by 29 conservation professionals, calculated separately for 17 academics and 12 non-academics. Both graphs are ordered by salience for academic participants.

discrete, with previous decisions revisited and affirmed or challenged, as suggested by Laurans, Leflaive and Rankovic (2020). These multiple decisions may not be of equal complexity: based on more general work by Keeney (2004), Hemming et al. (2022) suggested that nine out of 10 decisions in conservation may have smaller consequences or obvious solutions, but these figures are theoretical and have not been quantified for conservation.

Fuller et al. (2020) suggest that decisions in wildlife management are complex due to contentious issues and multiple objectives – if this is true more broadly across diverse decision-making contexts in conservation, then this may mean that compared to other decision-making contexts, fewer conservation decisions have smaller consequences or obvious solutions. It may therefore be valuable to use a broader and more representative sample to identify which types of conservation decisions are more challenging, and how often these decisions are made. This could then identify areas where academic input to support complex decisions would be most valuable. However, even if such areas were identified, academics who aim to support conservation through their research and prior experience should recognise the multiple influences on conservation decision making. Projects are impacted by the political environment, funding availability and funder priorities, and many other influences, all of which can fundamentally determine which actions can be taken (Bottrill et al., 2008; Waldron et al., 2013).

The third most common decision type was those about starting or stopping projects. These can be psychologically challenging due to status quo bias – a preference for current conditions (Schwartz, 2021). One way in which such decisions could be supported is through decision triggers, a conservation tool where specific points in an ecological attribute are identified and when these points are crossed, they trigger management decisions (de Bie, Addison and Cook, 2018). The expertise of ecological researchers on specific species or ecosystems could be used to inform the definition of appropriate trigger points, or design monitoring programmes to determine whether a trigger point is reached. One example where this could have been useful is for the scientists monitoring the Christmas Island pipistrelle bat (*Pipistrellus murrayi*). Scientists knew the bats were disappearing, and even predicted extinction by 2009 (Lunney et al., 2011), but the Australian government did not act until just months before the last ever Christmas Island pipistrelle was heard on the 26th of August 2009 (Lunney et al., 2011). Identifying appropriate decision triggers with organisations that can implement

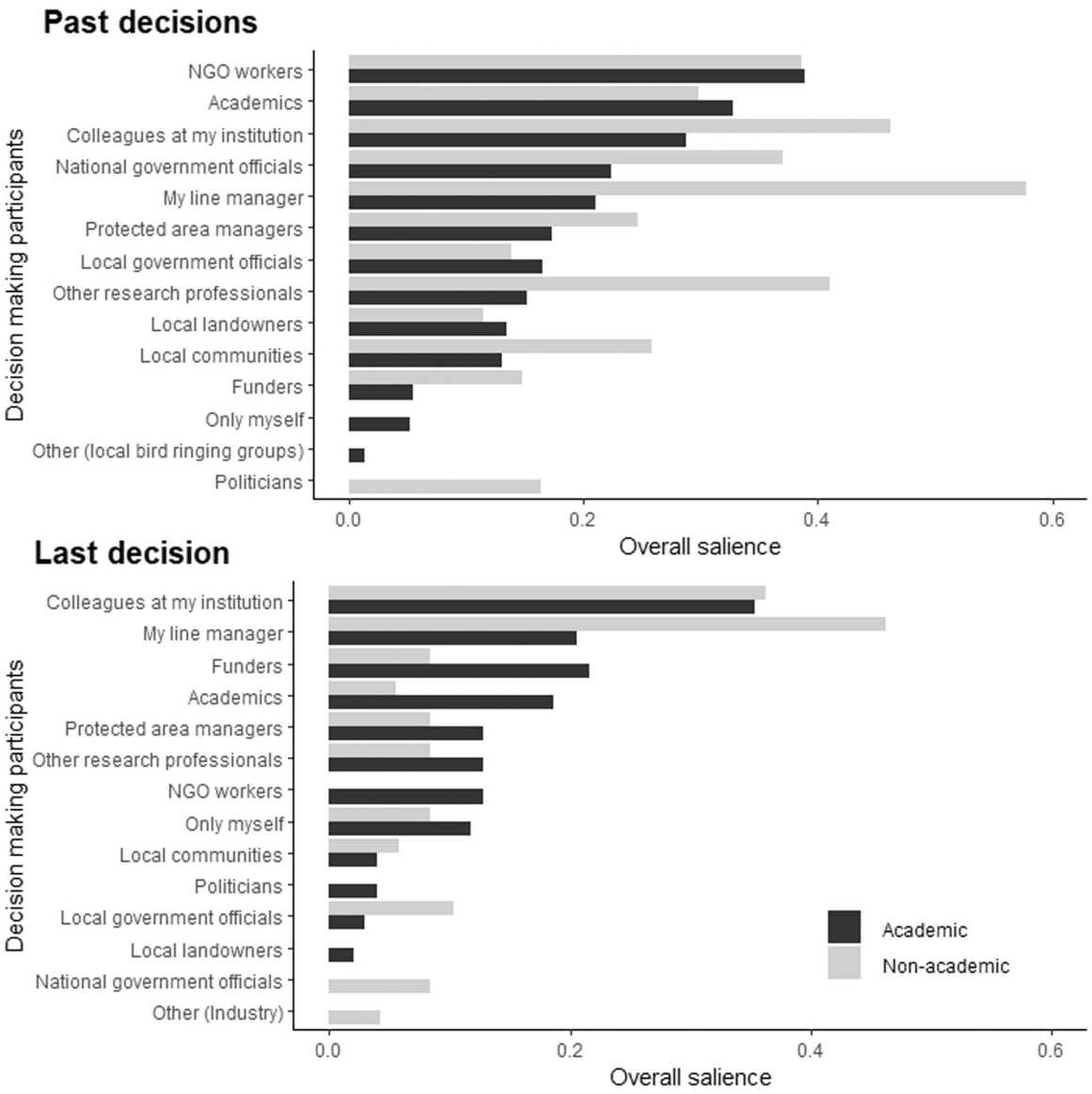

Fig. 4. A) Salience of 14 actors that have influenced past decisions for 32 conservation professionals, calculated separately for 19 academics and 13 non-academics. B) Salience of 15 actors that influenced the last decision made by 29 conservation professionals, calculated separately for 17 academics and 12 non-academics. Both graphs are ordered by salience for academic participants.

management decisions could prevent projects starting too late for effective species rescue.

Previous research has shown that many conservation professionals rely more on personal observations and other experience-based forms of knowledge than scientific and evidence-based knowledge (Pullin et al., 2004; Home et al., 2009; Cook, Hockings and Carter, 2010; Young and Van Aarde, 2011). However, these studies have focused on conservation practitioners, rather than academics involved in the decision-making process. Our study found that the information used by academic decision makers may be similar to those used by non-academic decision makers. For the last decision made, for example, the decision maker's own previous experience was the most salient source of information for both groups. However, when focusing on the most salient sources of *information*, both groups reported other individuals as highly salient.

Information gained from another individual is typically considered to be a less desirable than peer-reviewed information sources because the value of information from individuals can vary due to numerous factors, such as cognitive biases and problem complexity (Wintle et al., 2022). However, a reliance on personal knowledge and/or personal or professional networks is perhaps less of a problem than implied by the research-implementation gap literature (Fazey et al., 2006), because information from personal experience has been found to be comparable to information derived from quantitative measurements (Cook et al., 2014). Moreover, there are various established methods (such as Delphi reviews) which represent best practice for eliciting information from experts (e.g. Martin, Burgman et al., 2012). Consulting experts that can provide pertinent and timely information on specific decisions is a very effective way to gain information, as it allows information providers to tailor information to particular needs and contexts (Fazey et al., 2006; Salafsky et al., 2019). For example, (Barrett and Rodriguez, 2021) report that more than half of all management plan contributors always or frequently use expert opinion. (Pullin, Knight, Stone et al., 2004) also found frequent use of expert opinion, and their follow-up interviews suggested these experts were used to interpret information from peer-reviewed literature, and so perhaps acted as mediators between the literature and decision makers.

Our study suggests there is likely to be value in bringing together academics and non-academics to make conservation decisions. For example, we highlighted that a document produced by an academic was very important for the receiving organisation, and academics

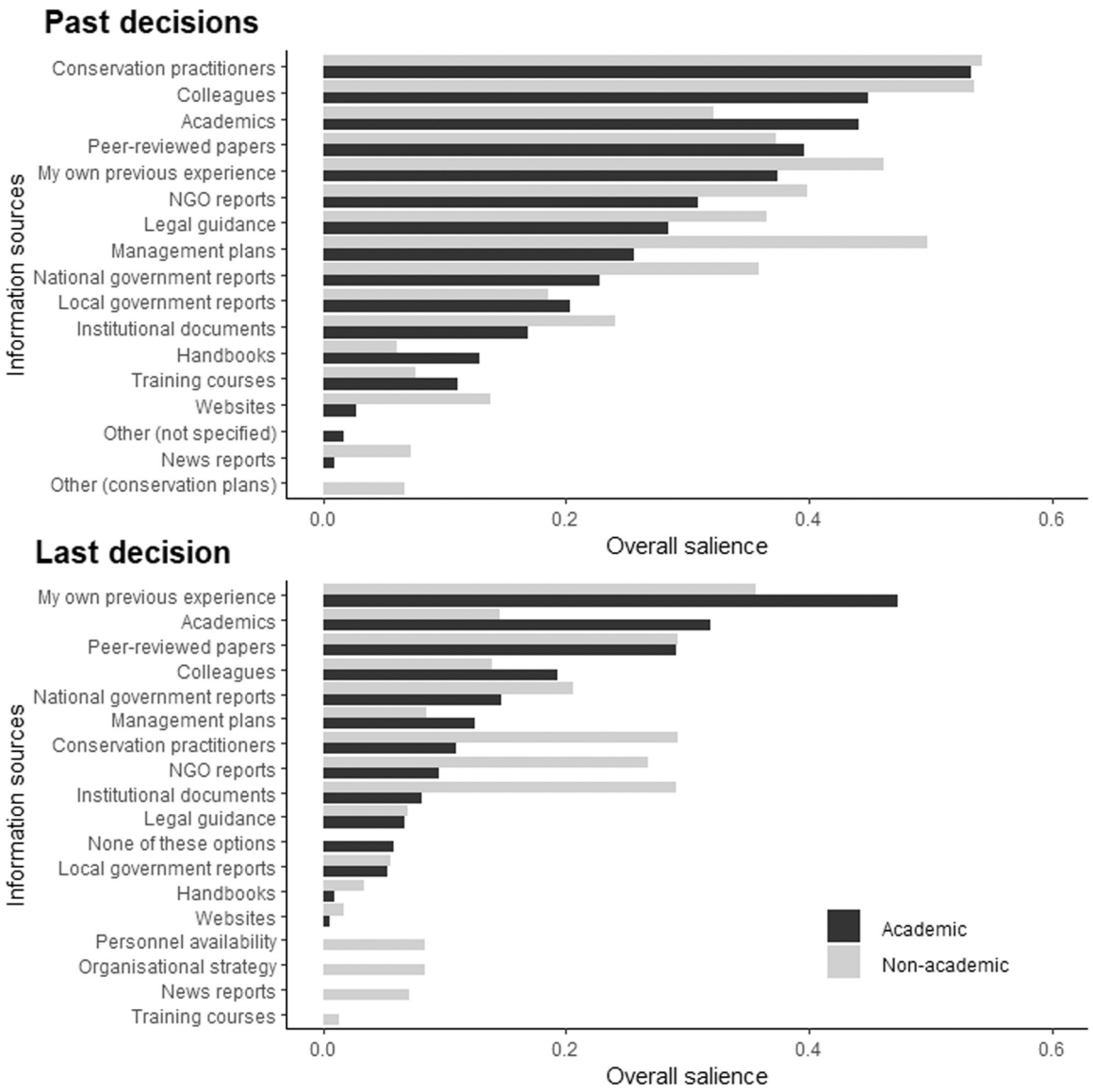

Fig. 5. Salience of 17 information sources which have influenced the decision- making process for 28 conservation professionals in the past, calculated separately for 15 academics and 13 non-academics. B) Overall salience of 18 information sources which have influenced the last decision made by 29 conservation professionals, calculated separately for 17 academics and 12 non-academics. Both graphs are ordered by salience for academic participants.

appreciated the opportunity to work on projects leading to practical outcomes. Nurturing relationships between conservation academics and practitioners in specific contexts is one way to increase knowledge exchange (Jarvis et al., 2020). In recent years there has been an increased interest in co-production approaches (Woodall et al., 2021), which can be defined as interested parties from different knowledge systems coming together to achieve a common aim (Nel et al., 2016; Cooke et al., 2021). For example, Nel et al. (2016) described a process where employees of different government agencies, NGOs, universities and private consultants worked together for four years to share conservation knowledge of river and wetland settings in South Africa, and that this resulted in the production of maps that have since been used widely for relevant conservation decisions. Based on our findings, where some differences between academics and non-academics have been highlighted, but the benefits of working together have been described and the importance of inter-personal relationships highlighted, co-production initiatives could provide a useful paradigm to help improve decision making. These co-production approaches can also allow academics to appreciate the broader contexts that influence conservation decisions and projects, and establish how they can support decision making in biodiversity conservation.

Our study has highlighted similarities and differences in how academic and non-academic decision makers perceive and contribute to the conservation decision-making process. Although both academic and non-academic conservation decision makers worldwide were invited to participate in the survey, the majority of those who participated were UK based, and therefore represents a limited and non-representative sample of those who participate in conservation decision-making. For example, very few of those who responded to the survey were government employees, yet, as highlighted by this research, local and national government employees can have an effect on conservation decisions. This limits our capacity to generalise these results, though we believe the approach taken has highlighted the complexity of decision making in conservation and identified multiple influences, actors and information sources. Due to the range of decision contexts for the last decision made by our participants, we did not disaggregate these factors into decision types, but instead presented aggregated data to demonstrate this diversity. Research by (Ordóñez et al., 2020) Found that even when looking at a more homogenous group of decision-makers – municipal urban forest managers – there were differences in the decision-making

challenges faced by managers in more and less urban areas. Therefore, for academics wishing to contribute to conservation decision making, a good place to start may be to make connections with those who are already making decisions, to find out what they do, how they do it, and what challenges they experience. This would help academics to appreciate specific contexts and establish how they can support decision making in biodiversity conservation.

5. Conclusion

Although originally aiming to understand decision making about species, ecosystems and methods, the interviews described in this paper identified a broad range of decision types, decision makers, decision influences and information sources that were corroborated by a subsequent survey. We suggest that a broader and more representative sample could identify the frequency and complexity of decision types in conservation and highlight areas where academics could have the greatest impact. We also showed the importance of personal experience and interpersonal relationships as sources of information. Investigations into specific decision types, rather than the more general approach used in this study, may generate even greater insight into conservation decision making. Closer working between academics and non-academics, perhaps through co-production approaches, are likely to improve conservation decisions.

CRediT authorship contribution statement

SV: data curation, investigation, project administration, writing – review and editing. AP: methodology, validation, writing – original draft, writing – reviewing and editing. SP: conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, supervision, validation, visualisation, writing – original draft, writing – reviewing and editing.

Declaration of Competing Interest

The authors declare they have no competing interests. This research was supported by a NERC Valuing Nature Placement.

Data Availability

Data will be made available on request.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.envsci.2023.103562.

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