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On the Role of Perception: Understanding Stakeholders' Collaboration in Natural Resources Management through the Evolutionary Theory of Innovation

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Abstract: Natural resources management deals with highly complex socioecological systems. This complexity raises a conundrum, since wide-ranging knowledge from different sources and types is needed, but at the same time none of these types of knowledge is able by itself to provide the basis for a viable productive system, and mismatches between the two of them are common. Therefore, a growing body of literature has examined the integration of different types of knowledge in fisheries management. In this paper, we aim to contribute to this ongoing debate by integrating the evolutionary theory of innovation—and specifically the concept of proximity—and the theory of perception. We set up a theoretical framework that is able to explain not only why the different types of knowledge differ, but also why they should differ and why this divergence is useful to develop fisheries management. This framework is illustrated through a well-known complex scenario, as was the implementation of the Landing Obligation (LO) in Europe. We conclude that diversity (distance) between types of knowledge is essential for interactive learning, innovation, the incorporation of new ideas or to avoid lock-in, etc. At the same time, cognitive, institutional, geographical, etc. proximity is needed for effective communication, participation and dialogue.

Keywords: perception; evolutionary theory of innovation; proximity; natural resources management; fishers' knowledge

1. Introduction

Like other resource-based activities, fisheries management takes place in complex, contingent and uncertain circumstances. Scientific advice for fisheries is expected to support policymaking processes, and the need to minimise risks in contexts with high uncertainty has led to the establishment of the preference among policymakers for indicators based on quantitative modelling that helps to simplify and to objectify decision-making processes [1].

However, decision making is not a linear process, from lab to bill, but rather shaped by different perspectives, expectations, drivers, obligations and needs, etc. of the stakeholders involved in each process [2,3]. Therefore, qualitative evidence such as perceptions provides the contextual knowledge to complete the picture of the complex socioecological

systems where the resource exploitation takes place [1,4,5]. The conservation literature has discussed which sources of evidence are the most appropriate to provide advice for policy making, concluding that the information delivered to policymakers must be as complete as possible [4]. Said differently, this implies the use of several sources of evidence including both the scientific and fishers' knowledge.

However, when it comes to processes of knowledge creation, diffusion and use, several factors come into play and explain the process and outcome differences, including labour, geographical and even variations in terms of different focuses and subjects. Because knowledge is not a public good produced outside the economic system [6], fishers focus more on the productive characteristics of socioecological systems (SES) and scientists on the biological ones. Therefore, knowledge creation, diffusion and application takes place in a specific area bounded by institutions, values, rules and even expectations. In other words, knowledge is context-specific [7–10]. Consequently, the closer the knowledge base is, the closer the knowledge output and more opportunities for knowledge exchange and dialogue emerge.

Linking science and decision making is considered "boundary work" [11,12], and boundaries help to protect science from potential biases caused by what is at stake in decision making. However, at the same time, they can lead to problems in communication and collaboration [3], and effective communication and collaboration require understanding where these problems come from. Related to this, much work on the expert and lay knowledge gap, together with proposals for bridging it has been carried out: local ecological knowledge, fisheries knowledge research [13], collaborative development of knowledge [14] or fisher perception studies [15] are among the most widely spread approaches. All of them converge in the need to deal with and integrate different types of knowledge in realising fisheries sustainability and increased policy efficiency.

Efforts towards the reduction of discards is a good example of the link between science and decision making in fisheries. Discards are one core management challenge faced by the modern fishing sector, since they represent a negative externality of unpredictable ecological consequences [16,17]. They pose a threat to marine ecosystems' sustainability and their future socioeconomic exploitation [16–23]. Given the dimension of the issue, the European Commission proposed the Landing Obligation as its main institutional solution to mitigate discarding in the European fleet [24]. In its 15th Article, the Common Fisheries Policy (CFP) 2013 establishes the obligation to land all catches of species subject to quota, including those that are undersized. The implementation of the LO in the European Union is a paradigmatic and recent example of the divergence between fishers' perception, scientific advice and political decision making. It provides an excellent *example* for illustrating knowledge boundaries based on proximity, and the added value of incorporating this concept into fisheries management.

In this study, we integrate the evolutionary theory of innovation, particularly the concept of proximity, and the perception approach to settle a theoretical framework capable of explaining not only why different types of knowledge differ, but also why they should differ and why this divergence is useful to develop fisheries management but also why they should differ and why this divergence is useful to develop fisheries management.

2. Perception and Types of Knowledge

While perception belongs to the classical study scope of disciplines such as psychology and sociology, it has been growingly adopted by other areas of inquiry across natural, medical, social and agricultural sciences, including fisheries management [25–27]. Perception is a basic psychological process by which "individuals receive and process information" [28] using sensory input but also available knowledge, experience and thoughts.

Perceptions stem from the different available sources of knowledge and learning. At a general level, the literature has tended to draw from the differentiation between tacit and codified knowledge [29,30]. The first has been described as the knowledge that people in a given community develop over time as a collection of facts, concepts, beliefs and

perceptions held about their context. It does not only include the way people observe and measure their surroundings but also how they solve problems, validate new information and transmit it to others [31]. According to Nonaka and Takeuchi [30], tacit knowledge can also be divided into two dimensions: a first technical component (know-how) and a second cognitive component that stems from mental models, culture, reality observation, intuitions, etc. Such a definition fits well with the usual mechanisms through which fishers create and incorporate new knowledge [32]. Particularly, Stephenson et al. [13] pointed out that fishers hold relevant contextual and experiential knowledge about the fisheries they belong to. This encompasses species and relations beyond those targeted, ecosystem functioning, human behavioural dimensions taking place on it and other economic, social and governance aspects of the fishery.

On the other hand, Brusco [33] has described codified knowledge as knowledge that is transferred through technical and scientific language in scientific journals, technical notes, formulas, books, etc. When it comes to production systems, codified knowledge is mainly encompassed by technical knowledge [34].

These forms of knowledge are ideal types that in practice adopt hybrid forms, giving rise to an amalgam of categories and classifications. For instance, Asheim [35] refers to synthetic knowledge as knowledge that can be found in activities where new developments rely mainly upon existing knowledge and often responds to the need to solve specific problems. Tacit knowledge, or the know-how of how to implement a solution, is intricately connected to synthetic knowledge.

All in all, none of these ideal types of knowledge, tacit and codified, is by itself a sufficient condition for a viable production system to develop [33], since all have their limitations. In this vein, the evidence of the limitations of expert assessments of environmental risks has been accumulating during recent decades [36,37], showing different biases resulting from particular academic backgrounds and their lack of exposure and feedback to environmental local threats, which in turn serve as the basis for lay perceptions of environmental risks [38].

3. The Concept of Proximity within the Evolutionary Theory of Innovation

The evolutionary theory of innovation has established that proximity is key to information exchange, interactive learning and innovation. We build on Boschma's work [6] depicting the five main dimensions of proximity: geographical, cognitive, organisational, social and institutional, and developing how they affect knowledge creation and exchange.

Geographical proximity refers to the spatial or physical distance between economic actors, both in their absolute and relative meaning, being positive for knowledge sharing and communication. However, since proximity limits the diversity of knowledge sources, it may lead to a lock-in situation [6]. Furthermore, in geographical terms, different types of knowledge usually emerge in different places [39]. Hence, the effective transfer of tacit knowledge across large distances requires other forms of proximity.

Cognitive proximity implies overall similarity in the way people perceive, interpret, understand and evaluate the world [40]. It also points to relatively close knowledge bases [6], which in turn encourages information exchange and helps avoiding misunderstandings [41]. Here is where the conundrum lies: whilst cognitive distance is needed for novelty and innovation, cognitive proximity is needed for absorption and communication [42].

Social proximity is defined as a quality where socially embedded relations between agents at the micro-level feed identification processes, like the creation of a sense of belonging [43]. Relations between actors are socially embedded when they involve trust based on friendship, kinship and experience [6]. It has been pointed out that social proximity encourages a social and open attitude of '*communicative rationality*' rather than a pure, calculative and narrow market orientation towards minimising costs [44].

As for organisational proximity, it can be defined as the set of interdependencies within and between organisations connected by a relationship of either an economic or

financial nature [45]. This would be the case of interdependencies between companies of the same group or within a network. Finally, institutional proximity includes both the idea of economic actors sharing the same institutional rules of the game, as well as a set of cultural habits and values [46,47].

In short, the greater the proximity (geographical, cognitive, institutional, social and organisational), the deeper the communication. The more distance, the more sources of learning and innovation. Put another way, dissemination needs proximity while innovation needs diversity.

4. Perceptions of the EU Landing Obligation

Perceptions are modelled by the social structures and motivations through which reality is instituted. Membership in different social groups, power relationships, education levels, identities, socioeconomic conditions, gender, the place where we live or our culture all build and constrain how we assess reality and the way we act accordingly [48]. Thus, they play an important role in conservation attitudes because natural resource users tend to be coherent with their perceptions [5]. Despite this, and due to the dialogic and multilevel nature of the processes by which our attitudes and perceptions are shaped, attitude-behavioural inconsistencies are common [49–51]. This issue is one of the main focuses of sustainability science, policymaking and civic movements, among others [52]. Becoming aware of this inconsistency creates an internal struggle both at the individual and group level, and many times can cause an adjustment in behaviour [53].

In this sense, considering users' perceptions can prevent policies from being socially or economically unfair, culturally inappropriate or perceived as illegitimate by stakeholders, which gives clues not only to improve the definition of conservation policies but their implementation as well [4,5,54]. On the other hand, user perceptions can also be influenced by a subject and personal interest in the matter [5]. A management measure can be perceived as negative or unfair from an individual or community point of view even when that rule is consistently tested as necessary, either socioeconomically or environmentally [8]. Here, we should also consider how users or a group of users are affected by specific management actions.

First of all, it should be noted that the adoption of the LO was preceded by a strong social debate spurred by the Hugh's Fish Fight campaign [55,56]. Thus, the whole picture was a four-party debate (policymakers, fishermen, scientists and NGOs and civil society), with NGOs advocating for the reduction of waste associated with discards. Secondly, the new CFP defined the LO in general terms and the regulation was developed only at a later stage [55]; it was only from that moment on that fishers were included in the decision-making process [57] such that little room was given for fishers' involvement in the definition of the objectives of the LO. When discussing proximity later on, we are referring to only a particular stage of the development and implementation of the new regulation.

Policymakers' views are usually stated in public documentation. The same applies to the L.O. Regulation (EU) No 2015/812 (the so-called Omnibus Regulation), which established an obligation for the Commission to report annually on its implementation based on information transmitted by the member states, the Advisory Councils and other relevant sources. The reports indicate that member states have been making significant efforts to disseminate information to fishers through industry meetings, information notes and government websites. Member states have also increased their level of engagement with the relevant Advisory Councils and in the case of the Mediterranean area, have largely followed the advice provided by the Mediterranean Advisory Council MEDAC in developing the discard plan for the sea basin. Some member states have investigated specific studies and pilot projects to test selective gears or avoidance strategies, assessing the impacts of the landing obligation on specific fisheries or to provide data to support de minimis and high survivability exemptions under discard plans [58].

On the other hand, and similar to any discard legislation, the enforcement of the LO is highly sensitive to fishers' perceptions. This is because it affects the core of every fishery

operation (i.e., the rejection or retention of a catch) in the sense that it affects the possibility of selling that catch. The discarding behaviour follows a pattern for every boat and is part of the fishing strategy that is rather stable; it also serves as a strategy to gain and occupy commercial niches in competition with other fishers [59]. Any regulatory change affecting this discarding pattern may have a cascading effect on that consolidated fishing strategy, which is polished day by day. This is one of the reasons that fishers usually perceive this kind of regulatory change as a threat that could force them to change their business-as-usual [21].

The research carried out within the EU iSEAS Lifeplus project help us to illustrate this point. During the iSEAS project's [60] lifetime, two surveys aimed at studying fishers' perceptions of the LO implementation were conducted. Table A1 (Appendix A) shows the different questions addressed to interviewees, organised in three blocks: (i) fisher participation and knowledge exchange, (ii) fishers' perception on expected outcomes of the LO, both in terms of potential economic and conservation outcomes, and (iii) expected compliance with the LO. The fishers' general perception about the LO was gauged through an open question.

The data on fishers' perceptions gathered in this study come from 24 in-depth semi-structured interviews conducted with ship-owners and skippers of a Galician coastal trawlers fleet. These commercial vessels fish in two otter bottom trawl métiers, both in Northern Iberian Waters (Spain, ICES division 8c and 9a). The first one is focused on a very limited array of demersal species (OTB_DEF), whereas the second targets mixed pelagic and demersal fish (OTB_MPD). The interviews were carried out face-to-face, in the offices of the fishing companies or on the ships, on the Galician ports of Marin, Bueu and Ribeira. The study comprised two different research stages: the first one took place in 2015 and the second in 2017. This two-stage design was aimed at identifying eventual changes over time in the perception of the fishers regarding the LO implementation. The interviewees were the same individuals in the two stages, despite two of the informants refusing to participate in 2017.

The general perception of the LO among the fishers was rather negative. Broadly speaking, the LO was referred to as an ambiguous, complex, wrongly transmitted and a measure unilaterally imposed on the industry [60]. A similar perception was reported by other recent developments on the LO in different European fishing areas and fleets [25,27,57,61]. Different forms of distance can be identified among the fishers' arguments for rejecting the discard ban policy.

Cognitive distance can be identified in what Interviewee No. 10 [60] pointed out:

> *The big problem is that they make the law without regard to the sector. They mark certain dates from which on it must be put into effect, and when you ask them how you should act, they do not know. Those who made the law don't know what a ship is*

Thus, the gap between the fishers' knowledge and the knowledge of policymakers is implicitly suggested. Or, in the same vein: A law like that can't be done from an armchair in Brussels (Interviewee No. 5) [60]. The distance between the knowledge of those who think and the knowledge of those who produce is stressed. Moreover, this reflects the small room left for fishers' participation, which, as mentioned before, took place only during the regulation implementation and developing stages. History and context are key to understanding not only the conditions for participation but also the outputs of the participation process.

Similarly, the different rules of the game that apply to fishers and policymakers and that are associated with institutional distance are expressed in what Interviewee No.4, [60] declares.

> *My impression is that Brussels plays music and we dance*

Fishers used to understand the LO as a threat to their activity, prompting too many obstacles to run their business profitably, as the following quote reflects:

> *The LO was made from an office by people that didn't take into account the real effects of a law like that* (Interviewee No.1) [60].

That is to say, the language of the regulations and administrative information on the one hand and the different rules of the game that each stakeholder uses to interpret reality on the other may be creating a communication gap regardless of the dissemination efforts coming from the EC. Apart from that, this divergence suggests the existence of more room for technical cooperation. As a matter of fact, the Dutch case [55] illustrates how technical cooperation based on proposals from the fishing sector can provide a bridge between fishers and governments.

Communication (despite the notable effort the Commission claims on this topic) appears to be a big issue. As some informants state: "The law is extremely ambiguous, we don't know what to expect" (Interviewee Nº1) [60]. Or, in the same vein: "We are waiting, nothing is clear" (Interviewee No. 10) [60].

Additionally, the interviewees noted they had no specific channels for transmitting doubts, complaints or suggestions, although some of them also recognised the fishers and shipowners organisations as their main source of information and advice. This role played by fishers' organisations or associations as the main source of information illustrates an issue of cognitive and institutional distance and also highlights their work as bonding actors or gatekeepers [62] since they are responsible for creating proximity and facilitating communication, which in turn shows how the transfer of complex knowledge requires strong ties because of the need for feedback [63] and common backgrounds.

> *The shipowners' organisation is who informs us. They have skilled staff that explain it to us. If I have a doubt, I don´t call the Secretariat, I call the association. If they don´t know the answer they call to Madrid and solve the doubt* (Interviewee No. 6) [60].

The above also suggests that diffusion efforts do not directly mean that information has been easily internalised [64], nor that proximity was created.

Contrary to the purposes of the new regulation, fishers doubted the usefulness of the L.O., which they framed as a measure that would neither be positive for their businesses nor serve to encourage selectivity in the trawl fleet or improve the sustainability of fisheries.

Additionally, informants emphasised their concerns about potential increases in operational and logistics costs associated with the LO, such as handling, conservation, transport and landing costs. Besides, they showed their worries about the likely increase in fuel consumption, use of materials or working time to ensure compliance with the LO, and the need to hire additional services for handling and conserving catches at port.

5. Towards an Effective Coupling of Different Knowledge for Better Management and Mitigation of Fishery Discards

The European LO seeks to promote more selective fishing, reducing the mortality of species and fish sizes of low commercial value [56]. The idea underlying the LO is that the fishing industry internalises the social and environmental costs of discarding, with a view to achieving a balance between environmental and economic sustainability [65].

Related to the latter, one of the trickiest points in the process of transitioning to a new framework to govern the fishing sector is the risk that it involves fishers facing a decrease in income while their costs rise [66]. For this reason, the CFP has allowed a progressive reduction of discards, including adaptation elements such as the de minimis exemptions that help fishers to solve the challenges caused by the high costs of catching management, or by the need to adapt to a scenario of increased selectivity [67]. The conditions of implementation of the LO are complex, affecting a fleet, which involves different types of vessels, gear, métiers, fishing grounds and target species [68,69]. Therefore, the European fleet represents such a complex web of institutional, economic and social relations that enforcing the LO cannot happen homogeneously. Fishers' attitudes towards the new scenario, rules and packages of obligations to be complied with can be revealed from perception studies.

The disparity between the characteristics of the knowledge of producers, fishers in our case, and that of other stakeholders, as policymakers and scientists, has given rise to an intense debate about the role that the knowledge of the first should play in fisheries management. With this in mind, perception studies are the first step to formalise tacit knowledge and start the dialogue while boosting the learning processes between fishers, scientists and policymakers.

Perception studies can also lead the way to reduce the cognitive distance between these three types of actors and enable the collaborative development of knowledge [14], as well as improve the LO implementation by highlighting potential weaknesses and providing practical solutions based on user experiences [21].

However, the fishers interviewed unanimously perceived the LO as an imposed law in which stakeholders were excluded from decision making. Even though these answers came from a specific geographic and sectoral context, they are in line with data from other fleets and areas in Europe, where results also provided evidence for fishers claiming having felt ignored in the formulation of the LO regulation [25,27,57].

Furthermore, fisheries laws, particularly at the international level (as is the case of the EU) are not always an adequate response to the problems faced by fishers in the varying local contexts they operate in [70]. Therefore, geographical distance could also be contributing to shaping this communication problem. Actually, evidence shows that knowledge tends to be "sticky" to the context in which it was developed [71].

Understanding the properties of different types of knowledge and its drivers and barriers will be key for a proper contextualisation and incorporation of diversity to collaboratively improve fisheries management. In this regard, it should be noted that the interviewees demonstrate a rationality based on their *rules of the game*, their culture, rather than a highly formalised knowledge. And when those fundamentals are questioned, networks based on strong ties are likely to react adversely [72]. This also indicates that a strong interaction between different types of knowledge (from tacit to formalised) is needed, as it is difficult to innovate without incorporating formal knowledge and without understanding the specific practices, ways of doing, rationale, etc. of the producers [73]. Proximity facilitates effective communication [6] but at the same time, a certain distance is necessary for interactive learning and innovation, as well as to avoid lock-in [74], especially in a context of growing complexity and uncertainty. Furthermore, bringing in external knowledge will require different stakeholders to engage in significant integration, reframing and translation activities to align external knowledge with internal categories [71] from both fishers and policymakers. Coaching and facilitation activities may be useful tools to facilitate such a paradigm shift in fisheries management.

Numerous researchers [35,75,76] have pointed out that successful economic systems are those where these two spheres of knowledge are in continuous interaction, providing new hypotheses and ideas for the other, mixing in innovative ways and cross-fertilising each other. Its relation is circular: the local/tacit provides knowledge for general use and the global/formal furnishes local circuits with knowledge coming from all around the world [39].

All in all, the use of different stakeholders' knowledge is not only a valuable resource for economic management but for interactive governance, and therefore is both an expression of democracy, and a desirable state of affairs [77]. Moreover, transparency, democracy and the engagement of stakeholders are key conditions for improving the performance of resource dependent economies [78–80].

6. Conclusions

This paper examines the suitability of the concept of proximity to enrich the perception approach framework, particularly explaining why stakeholders' views diverge and why they must, and what are the implications for the policy.

The diversity (distance) between types of knowledge is a precondition for interactive learning, innovation and to avoid lock-in situations, especially in a context of growing com-

plexity and uncertainty. At the same time, proximity is needed for effective communication, participation and dialogue. There are no perfect equilibria or predetermined answers that solve this conundrum, so that key content should be "approximated" and specific bridges and/or functions should be developed. In each case, a different commitment, depending on the objectives, participants and strategy, will be needed. Understanding the properties of the different types of knowledge and its drivers and barriers will be key for the proper contextualisation and incorporation of participatory and co-production of knowledge approaches that rely on diversity to reveal new avenues for improving fisheries management.

Perception studies can not only contribute by gathering tacit knowledge (this is a way of creating new knowledge) but formalising it, boosting cognitive proximity between producers, scientists and policymakers; the proximity concept and, more broadly, the evolutive theory of innovation, can help to give meaning to the results.

In the case of the LO, the perception approach has been useful for identifying how distance (cognitive, institutional, geographic, etc.) affects the efficient diffusion, communication and dialogue regarding discard regulation. Also, it has demonstrated its value for identifying the areas where scientific knowledge needs the experience of fishers and their knowledge to be applied and, last, to estimate what the eventual impacts on legitimacy are. Once the problem is delineated leveraging the theory to find mechanisms that help shorten distances and enhance co-construction and exchange of knowledge becomes easier.

Hence, although mismatches between fisher and scientific knowledge are usual, a common learning ground between both groups should be set. Undoubtedly, this will result in better policymaking advice, improved enforcement and increased efficiency and sustainability in fisheries regulation.

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Appendix A

Table A1. Questions on fishers' perception about the landing obligation (LO) (From iSEAS project; iSEAS, 2018.)

1. Perception about processes and fisher's participation in it
(A) Participation in the decision-making process. Q.1.1 Has the industry been integrated into the decision-making processes?
(B) Participation in effective communication arenas, and transmission of the L.O.
Q.1.2 Is the LO clear?
Q.1.3 Do you know how to behave?

Table A1. *Cont.*

Q.1.4 Has communication of the LO terms been improved?
Q.1.5 Are there communicative ways to transmit doubts, complaints and suggestions?
2. Perception about the expected results of the LO
Q.2.1 Will the LO be positive for the industry?
Q.2.2 Will the LO be profitable for you?
Q.2.3 Will the LO improve fisheries sustainability?
Q.2.4 Will the LO incentive the selectivity?
3. Expected compliance with the LO
Q.3.1 Will the fishers comply with the LO?
Q.3.2 Will the compliance be for coercive reasons?

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