Capstone

Database interfaces, knowledge infrastructures and conservation policy

A case study of Movebank

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Abstract

Through a rise in GPS tracking data and other tracking methods the need for a extensive data storage system has grown. This need is filled by Movebank, an online animal tracking data storage system. Through a broad data system a range of researchers and agencies is facilitated in their needs. Knowledge infrastructures show the flow and creation of data and information. Movebank is, as a database interface, a clear part of a knowledge infrastructure. Through its management and design of its system it also impacts this very infrastructure. Furthermore, with the recent growth in need for evidence based policy, Movebank also has the potential to serve policy makers and conservation managers. This paper identifies the placement of database interfaces, with Movebank as a case study, within their knowledge infrastructures. The design and management of these interfaces are looked into, assessing their impact on the use of these interfaces. Finally, the potential of systems such as Movebank on conservation policy is assessed. This paper uses a mixed methods of interviews and a walkthrough method.

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Introduction

The past decades have shown a datafication of the animal and in particular the movement of the animal. Through the rise of tracking technology such as GPS, ecologists have been able to follow an ever-increasing number of species. The resulting data is of high value to understand phenomena like biodiversity and the state of natural areas. Due to the growing interest by biologists and ecologists in animal tracking, a whole new subdiscipline, movement ecology, was created (Benson, 2016).

Within movement ecology we can find Movebank, an online platform, formed in 2008, where researchers can store their acquired data and make them available to both a wide public as well as fellow scientists. It is a platform hosted by the Max Planck institute in collaboration with a range of other public institutions. Movebank uses data acquired through GPS tracking, sensors, tag usage and a variety of other measurements to be put into the system. The system is thus flexible to different kinds of data admissions. Movebank archives the data in its system allowing users to share and collaborate around it. Even the public can find this data as it is available on a public website. Although for viewing some data, permission needs to be granted by the data owners. (Kranstauber et al., 2011).

Being a databank and enabling transformation of data in models and knowledge, Movebank can be seen as being part of a knowledge infrastructure. Knowledge infrastructures are, as Edwards (2010) describes; *'robust networks of people, artifacts, and institutions that generate, share, and maintain specific knowledge about the human and natural worlds'.* Infrastructures can thus be understood as the flow and creation of knowledge. This is an all but practical description of these infrastructures which is where Leonelli (2018) comes in.

Leonelli describes the knowledge production cycle in which objects become knowledge through first turning into data and being modeled. After this interactions with the world are had which impacts the objects in question starting the cycle over again (Leonelli, 2018). As Movebank is a database of data in which objects are stored, interactions with this cycle seem natural. Yet, how precisely these interactions occur depends on the users and managers of Movebank. Movebank, being a digital database, can also be described as an interface. An interface that facilitates interaction between users of the database and the functions the database offers. Describing Movebank and databases like this is all about the relationship between the system and its users and potential users. Or as Hookway (2014) puts it; '*a relationship with technology rather than technology itself*'.

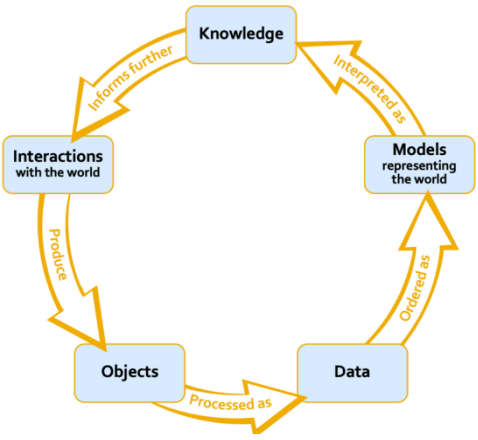

Figure 1: The knowledge production cycle, Leonelli 2018

Describing this relationship requires an understanding of Human-Computer-Interactions(HCI). The fields of knowledge infrastructures, interfaces and HCI have always been closely connected as all three fields are intimately connected to computing and data storage. Yet, this also requires an understanding of the current paradigm within HCI. HCI has seen a history in which three different paradigms have been experienced. Initially, the goal of interfaces was to reduce human errors by making machines a better fit. The second paradigm accepts both the brain and machine as being information processors and attempts to optimize the information between the two. The third paradigm is the one that is most prevalent at this moment and is the one that this paper will work with. It describes how the online environment and embodiment of humans alter the way users interact and experience interfaces. The third paradigm embraces the variety of perspectives and subjectivity that is engrained in the human experience. It thus sees users, may it be researchers, policy makers or the general public as being embedded in locality. The technology should then thus adapt to the local conditions or situation of the user. It is this research paradigm that is used in this paper because it allows for a look at the relationship of the user, through the technology to data and knowledge instead of primarily focussing on the technology discussed (Harrison et al. 2007).

Understanding knowledge infrastructures, such as the Movebank, is essential as systems like this are bridges towards users of knowledge. They give an insight into science for the general public and work as connective tissue between science and policy. Ecology itself poses itself in relation to policy as figure 2 shows. Chapin explains that ecological knowledge allows for predictions on changes and can help create policy in dealing with these changes (Chapin et al, 2002). Policy furthermore has the potential to use ecological knowledge in evidence based policy which has become increasingly important. The increasing importance of evidence based policy is indicated in ‘The public policy primer’ where a distinction is made between political policy and evidence based policy. Political policy is seen as more of a symbolic measure to please the political arena and the public. This is contrasted to the prefered option of researched and thus evidence based policy. This policy needs systems to produce knowledge about and monitor the sectors in which the policy is implemented (Wu et al. 2018).

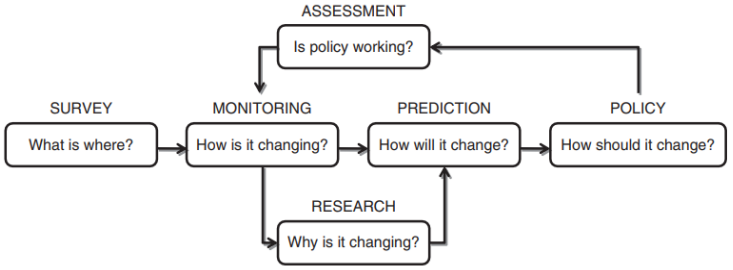

Figure 2: A framework for flow of ecological information through the society and the scientific community. (Chapin et al, 2002).

This paper is interested in the following questions. How do database interfaces such as Movebank contribute to conservation policies and their underlying knowledge infrastructures of monitoring? More specifically, what does the way these database interfaces are designed and maintained, or the types of data they include and exclude, tell us about their (non-)users and added value?

These questions are answered through the usage of two distinct methods that supplement each other. Both the walkthrough method, as described by Light et al. (2018), and a series of interviews with stakeholders as Movebank and policy makers using the platform. The interviews will serve to understand the intentions and experienced implications of Movebank and the relationship between the users of the system and Movebank as a database interface. The walkthrough method will add to this by tracing the embedded vision and ideals still present in the interface. Both of these methods will be built upon a framework that is created through a literature review.

Methods

The added value of Movebank is non-quantifiable and thus requires a qualitative approach. Looking into to what extent the design of Movebank, embedding certain vision and goals, creates added value for policymakers the following needs to be understood;

1) The vision and goals of those people governing Movebank
2) To what extent such vision and goals of these people are reflected in the design of the movebank
3) The experiences of the users (policymakers)

An interview method can capture the lived experiences and values of the human stakeholders. Yet, this qualitative research needs to be supplemented with an additional method to assess how these aims and values are reflected in the design of the platform; that is the walkthrough method.

This paper will enact a walkthrough method as described in Light et al. (2018). In this method, the goal is to surface embedded socio-cultural representations and technical features that have social and cultural origins. This is accomplished through two separate processes that compliment each other and give a complete picture. 'The environment of expected use' will be researched through the Movebank website and websites that describe it. It encapsulates the way the developers of the platform expect the way users interact with the platform and includes the perception of the Movebank on who its users are. This environment is studied in three different ways; its vision, its operating model and its governance. The vision describes the goals and purpose of the application while the operating model describes the way the application finds its resources and can sustain itself. Finally, the governance describes the ways the platform guides its users through the programs and implicitly enforces its vision onto the user. The second process is the technical walkthrough. This is a step by step walkthrough of the application that involves exploring its technical options. This will be done by exploring all options, menus, information centers and interactive elements of the Movebank interface. It explores the ways the application enables and constrains the user and what consequences this has to the users behavior. Although the walkthrough method is designed for mobile applications, Movebank's online platform does not differ significantly from an app and can thus be viewed through the same lense.

These two methods will supplement each other in such a way that both the values of those who maintain the platform and the way these values are transposed onto the interface are captured. The interviews will be built upon a literature that poses a framework and guides the asked questions.

As the research will be qualitative in nature, the reliability and validity of the data will be guarded by a variety of processes. First of all, the interviews will be proofread to protect the integrity of the data. Furthermore, a transcribing and coding process will be conducted and saved so that all potential data is captured. The interviews will be conducted in English. The data collected from the interviews will be collected on audio before transcription. After transcription and finalization of the project, these audio files will be deleted. The written out raw version of the results will be sent to those interviewees who want to check how they are portrayed within the final product. The data collected from the walkthrough method will be stored in fieldnotes which will be saved online and made available on request.

To safeguard the trust and safety of interviewees, this paper will allow for the option of anonymizing the data. Otherwise the interviewees may opt to reduce the personal information to their working titles to make them unidentifiable. Finally, they can choose to not be anonymous in any way so they can receive credit for the insights they provide for this research. After the completion of the research, the interviewees will receive the resulting paper. For this research all interviewees have chosen to be named within the final product and one interviewee has proofread her own additions.

The ethical considerations of this paper are mostly concerned with the walkthrough method. To understand the platform of the Movebank, full interaction is required although no interaction is possible between the users of the platform. The concern here is that an account needs to be created which will convey data to the Movebank. This may cause an unforeseen impact on the datasystem of Movebank as all kinds of interactions are made, impacting the internal understanding of the usage of the platform.

The following interviewees have participated in this research;

Name interviewee	**Relevant background information**
Prof. Roland Kays	Co-founder Movebank
Sarah Davidson, PHD	Data curator at Movebank
Valentina Iesari	Assistant research fellow at Max Planck institute working with Movebank in 2019
Prof. Gil Bohrer	Principal investigator on Room to Roam project by Ohio state university. Project is designed to create conservation management strategies supported by Movebank.
Chad Witko	Outreach biologist on migratory bird initiative, Audubon society. On his projects he works with Movebank

Literature review

This literature review discusses database infrastructures such as Movebank in the way data is acquired and stored. Then their role and place within knowledge infrastructures are discussed and this literature review ends with a discussion of evidence based policy and conservation policy.

Data acquisition and storage

The Movebank is, as established by the introduction, part of a knowledge infrastructure. In a practical sense the Movebank however is more than that. It is a system that stores and maintains animal tracking data, and consequently allows research with or on them. The data is acquired through the uploading of studies into the system. The acquisition of the data itself is done in a variety of ways ranging from GPS, camera traps and to the ringing of birds (Kranstauber, 2011). Animal movement itself is a biological phenomenon that happens for a variety of reasons and that thus shows a variety of natural phenomena. Reasons to move can be migration to food-rich regions to forage or nest. These movements can occur on a daily or yearly basis or even over a longer period of time. It is for these reasons that movement data is informative about climate change, for example by measuring arrival times compared over years and compared to insect hatching seasons (Hansson & Akesson, 2014).

Movebank's animal tracking is part of the new and upcoming discipline of movement ecology. Within this field the step and stop method of capturing movement data is one of the most prevalent. Within this method, animal tracks are compared to DNA strings in which the traveled between stops can be compared to DNA strands. Further ecological knowledge is captured by comparing the steps to environmental and other forces, this is the so called 'step and stop method'. In this method, animal movement is understood in terms physical of the steps inbetween two measurement points. A short distance can for example mean resting while a long distance can mean that the animal is fleeing. Determining the length of time in between stops is something however that is still under discussion by movement ecologists. The longer the time between measurements, the higher the insecurity about the path taken. The shorter the time in between the less animals are suited for tracking due to increased equipment weight. It is estimated that 70% of bird species can currently not support GPS trackers and numerous other smaller species will remain unfit for tracking. Animal specific databases can still provide extrapolation of their data onto the environment. Movebank however, due to its multitude of species, may struggle with this. Extrapolation from a combination of Movebank sources requires unified theoretical theories and compatible data structures. This may make Movebank an archive of different and separate species repositories (Benson, 2016).

Movebank accepts a variety of old and new techniques to acquire animal movement data. A variety of methods such as GPS and satellite data are accepted but older data that is privately stored in researchers private collections can also be uploaded. The data is put into the system as being a study that remains in the control of those who have uploaded it. Data access is thus decided by the uploaders allowing for different scales of access. Access can be requested but may be denied for a variety of reasons such as the data being unfinished or because it captures the locations of endangered species (Kays et al, 2021).

Movebank has conceptualized the process of capturing data, as seen in figure 3, further into a number of baseline concepts that can be applied in all its situations;

- Animal: an individual specimen with optionally additional status related data.
- Tag: the device used for the tracking.
- Sensor: capacity to provide more specific data based on GPS.
- Tag deployment: Information of a specific tag to a specific animal, one tag can be used on multiple specimens.
- Observation: all other concepts grouped together and stored at the same location.
- Other measurements: due to the variety in nature of data stored in the Movebank, some additional data can be stored too, e.g. the lengths of a bird's wing.

Figure 3, Kranstauber (2011)

These different concepts thus work together to create observations which are the ultimate data stored in the system. Still one can still search for and select based upon the other concepts (Kranstauber, 2011).

Knowledge infrastructures and their design

Observations are thus the cornerstone of Movebank yet they are also the basic building block of knowledge and evidence. The studies that researchers put into the system carry in them pre-made structures while Movebank's system itself also structures the data through its interfaces (Kays et al. 2022). For knowledge to serve as evidence in new publications, researchers can get their data from the published studies and thus use it as secondary data (Argyrous, 2019). Movebank can also provide citizens or other non-academic users with access to scientific data allowing for a level of citizen science. Furthermore, reports or presentations in various contexts can be based upon the available data and/or models. The final way of this data becoming evidence can be through decision making tools (Ausden & Walsh, 2020). These products can eventually serve a role for policy, specifically for evidence based policy.

Databases are human-made leading to subjective choices that are made in the design of databases. Movebank generally has the main task of storing data for later use. To fulfill such tasks a general level of objectivity is expected in the carriers of data Yet, being a database some general challenges exist as no body of knowledge can ever truly be objective. Choices in design are always motivated by pre-existing assumptions of conventions. Specifically in databases, the choice for in-between menus and metadata choices have an impact on the perception and understanding of the total data. Furthermore, the databases by their nature demand a certain form of data to be included, think of it like storing boxes in your storage at home; the shape and weight of the boxes depends on the given space (Turnhout en Boonman-Berson, 2011).

Another task Movebank gives itself is that of being a collaborative platform from which collaborations start. In this collaborative nature it allows for the needs of ecologists, as described by Millerand and Baker (2020), to be fulfilled. These platforms fulfull the need of ecologists to contact each other and store their personal data that is expanding with new technologies. Databases, such as Movebank, can thus potentially enable community building through collective data management within these platforms. These platforms then open up the opportunity to share and reuse previously used data.

Movebank is thus special in that its data is not always specifically made for its database. It combines data from different origins. However in the selection choices following such intwinements no choice can be objective (Bowker, 2000). Hine (2006) also emphasizes that databases mostly enforce existing ideas about the scientific discipline they portray. This is important as Movebank is building upon the current sequencing framework that is dominant in movement ecology. Even more important when moving databases towards policy is that, as Beaulieu (2003) argues, reusing data for different purposes has a strong and possibly negative impact. This is the case because conventions may not exist or are developing, creating unforeseen results. Furthermore, the conventions of current design categorize the field when they are translated within data infrastructures. These categories, on which analyzing and other kinds of tools are built, are not set in stone and often contested within scientific communities (Millerand and Baker, 2020).

Evidence based policy

Policy and evidence-based policy is generally understood through the framework of the policy cycle, although other methods exist. Using this cycle as the basic framework, allows for an understanding of the process in phases which enables the linkage between knowledge infrastructure and policy. This cycle flows both ways and phases can be skipped and returned to. Still a general flow, according to Wu et al. (2018) can be presented as follows;

- Agenda setting: the process starts off with the agenda setting in which attention is gathered for certain perceived problems or solutions. Either from external or internal sources or pressures a public administration can decide to move forward and formulate policies.
- Formulation: in the formulation phase the policy is put onto paper and is given shape. Alterations of public policy are here created and given form.
- Decision-making: in the decision-making phase, authorities choose to follow policy out of a pre-selected number of policies. This is the phase with the highest level of political involvement.
- Implementation: in this phase the policy is actually implemented and executed by the administration and the sub-administrations. It is here where mistakes are serviced and where civilians get in touch with policy makers.
- Evaluation: the evaluation phase is where the quality of the policy is assessed and its output and impact are considered.

The framework of the policy cycle can be used in a variety of contexts. On the one side there is evidence-based policy; policy that requires evidence to proceed through the cycle. One may now question why one would not want their policy to be based on evidence. Yet, some policy is issued as being political policy. This is a policy that has a symbolic value and is implemented when wicked problems may be unsolvable. Public agencies may then want to show their disapproval of certain phenomena through symbolic or political policy (Wu et al. 2018). Increasingly however, it is evidence based policy that is requested by the public and by societal stakeholders. Especially, the last 30 years have seen a big increase in demand for policies that show from the start that whatever is done -even if it does not reach its objectives- is still done in the best possible way. The definition of evidence based policy is contested within the scientific community with both a narrow and a broad view of the term. The narrow approach centers around translating systemic reviewed research into guidelines for centrally imposed programs. This thus implies that policy is to be based upon the work of researchers who receive a question from public agencies, study this and then give a recommendation. The broad view on the other hand goes beyond reviewing what works and considers a much broader range of potential sources. It goes beyond what works to what are potential problem sources and why phenomena occur. The broader view, which is what this paper endorses, thus seeks evidence as fitting the problem at hand. This view also allows for evidence to stand in either a positive or negative relation to policy either as an influence on practices or as critique (Argyrous, 2019).

The narrow approach excludes marts of Movebank as being direct evidence for policy as Movebank itself cannot directly provide research papers. It is the researchers that use Movebank as a storage that publish their work. The broad view seems to allow more for the inclusion of databases as an evidence source and is thus needed to pull Movebank into evidence based-policy making processes. This is because the database contains secondary data; data collected for studies with a different purpose. In using this data both advantages and disadvantages can be found. On the one hand, this data and is time- and cost-friendly, may contain data that is difficult to attain and can be of high quality due to the scientific involvement in capturing it. Secondary data is also useful as it may contain historical data and can thus extend the moment of measuring into the past. On the other hand, validity of data may become questionable as the data may have been captured with different definitions and goals in mind. Additionally, data gaps, limited quality control and limited familiarity with the data may prove challenging to the new goal (Argyrous, 2019).

Conservation policy

Movebank itself is a database that is specific to animal movement tracking. This type of data is not useful for all kinds of policies. This paper will therefore primarily focus on conservation and biodiversity management and policies. The difficulty here is that policy for conservation and biodiversity are at the crossroads of multiple sciences; social, physical, urban, and more. Furthermore, strategic decisions concerning conservation often have long term implications with potentially high financial costs (Sutherland et al., 2020).

Practitioners in conservation generally have three different decision areas; ‘strategic-level’, ‘site-level planning’ and ‘day to day’ decisions. On a strategic level ecological values are one of many as this is about planning long term. Strategic and political objectives are often more important here. The day to day decisions are often made on personal experience and education and thus too require a lesser degree of evidence albeit that general policies for day to day experiences may be built on evidence. It is however site-level planning that seems the most open for direct evidence build-ins (Ausden & Walsh, 2020). These are policies for spatial areas based on local evidence. Movebank would then also seem the most promising for site-level planning as local data and spatial information can be relatively easily located.

Forming evidence out of database data also requires a certain degree of knowledge on ecology and conservation. Evidence itself should be as concise as possible and contain the smallest possible amount of jargon. This is needed in order to be as small of a burden on busy policy makers as possible, who themselves often need specialists like ecologists to actually and correctly process the new data (Altringham, Berthinussen and Wordley, 2020). It is for this reason that generally governments, at least in the West, create special commissions to investigate the path that is to be taken. Yet, these commissions are expensive and require time. More importantly however, the time pressures may create problems in accuracy and in getting the right information. To shorten this process, decision support systems have been developed to help illustrate possible pathways. These systems however often impact the quality of evidence negatively and show a certain pre-existing model (Dicks et al, 2020).

Concluding the literature review

In summary, it seems that the way databases such as Movebank are designed impact the usage of the platform. Furthermore, it seems that reusing data is not without its challenges and that the relationship between Movebank and policy makers is not straight forward. The kinds of accepted data and the model that is worked with have an impact on the scientific discipline. Yet, it is unclear what this impact may be in the case of systems like Movebank. This very likely lies in the hands of the programmers of Movebank and which they direct the system to be for. Finally, what is the impact of the way Movebank is designed on the underlying knowledge infrastructure system underlying conservation policies. Consequently, it is unclear how new databases such as Movebank can be used for policy. What specific needs does it have and what connections may be lacking and if connected what does Movebank actually add?

Results

After coding the interviews and conducting the interviews, the results are categorized starting with Movebank's vision and governance. Following this, the two major goals of Movebank -enabling collaboration and archiving- are presented. Finally Movebank's handling of the data is presented ending with the relations between Movebank and conservation policy. Where courses are provided, the information is retrieved from the walkthrough method. While the data provided under specific names originates from the interviews.

Movebank's vision and it's envisioned users

Movebank's core vision, as seen on its website, is to be a platform that helps researchers and wildlife managers, manage, share, analyze and archive their animal movement data (Movebank, n.d.-a). The target audience of Movebank is research and researchers. Kays (co-founder of Movebank) explains that he and a fellow researcher created Movebank out of the need to store and manage his in size increasing set of data. After this worked well they decided to open it up to other researchers to make data more accessible and help fellow researchers. He explains that the rise in GPS technology was an especially strong driver for this process. Currently Kays still considers researchers to be Movebank's main audience. For this reason, he explains, one of the main goals is to maintain expansion and data space for the increasing flow of data.

'And so we were sort of creating something to manage our own data. And we realized it could also be useful for other people. And so we had the idea of opening this up and also with the idea that it could help people share data and make data more accessible as well. (Kays, 2022)'

Alongside this main goal, Movebank also strives to enable collaboration, help address new questions through combination of their datasets, and to promote open access to data. Finally, Movebank also has an eye for a second type of users; the general public. In its goals, Movebank also wants to enable the public to explore Movement data (Movebank, n.d.-a). Yet, because this user is not Movebank's main concern, making the interface more user friendly remains on the to do list as both Kays and Davidson (Movebank's lead data curator) explain. Still the animal tracker app allows the public to engage in a different way; the general public can follow animals and engage with movement data (Movebank, n.d.-b). Policy makers and conservation are generally not considered within Movebank's online interface. Only when it comes to external partnerships, conservation management and policy is named as a potential goal (Movebank, n.d.-a). Bohrer adds that conservation partnerships do have a higher potential through the use of Moveapps. Because Moveapps -a platform where analysis tools and workflows about Movebank can be shared- allows for easier access to analysis. This tool however cannot be found on Movebanks main website.

Movebank's governance

Governing the database, Movebank is dependent on the Max Planck institute which hosts the platform. Movebank's funding however, extends grants by other agencies such as local governments and UN related agencies (Movebank, n.d.-a). Furthermore, a larger number of partnerships are undertaken with other animal tracking agencies and tech-companies who provide the necessary technology for the tracking (Movebank, n.d.-c) . Movebank can also be beneficial to these agencies to achieve their data sharing requirements (Movebank, n.d.-d). Overall, the walkthrough showed that Movebank guides towards the archiving of data, showing an assumption on Movebank's side, that the user is a researcher.

Davidson and Kays, both indicate that the funding of Movebank is not straightforward. Davidson explains that because no fees are required, the platform is dependent on funds and grants. This funding is often research driven and prioritizes bigger data sets over for example a more (general) user-friendly website. Kays explains that this also accounts for general upgrading of the platform instead of maintaining the current system as it is. Davidson also indicates an importance of Movebank for potential funding of other agencies that put their data into Movebank. Their funding may require a certain amount of sharing of the data which can be accomplished through Movebank.

Movebank as enabling collaboration

One of Movebank's main goals is to enable collaboration between researchers and between researchers and other societal stakeholders (Movebank, n.d.-a). This is done through both partnerships with external organizations, of which most are research based and general enabling features within Movebank (Movebank, n.d.-c) The goal to enable collaborations is present when Movebank explains its benefits. The platform creates a level of uniformity within the data which allows for an increased shareability (Movebank, n.d.-e). Furthermore, through its contacting portal Movebank actively facilitates contact between researchers and allows users to reach out to data owners (Movebank, n.d.-f). By extension, Movebank also encourages the sharing of analyzing tools through the Moveapps service. This service allows analysts to share their data analysis tools to be shared with other users to enable easier analysis as users can stitch together the tools to create non-coding analysis(Movebank, n.d.-g). The collaboration thought is also reflected on Movebank's archival page in which public access is propagated in order to enable as much collaboration as possible (Movebank, n.d.-h).

The enabling collaboration function is also felt and shared by the interviewees. Iesari (former research intern at Movebank) experienced the uniformity of data as useful in international collaboration as data infrastructures may differ between states and institutes. Bohrer (lead researcher on a Movebank based policy project) also emphasizes Movebank's power to bring stakeholders -who find each other through Movebank- together for bigger and shared projects. He also emphasizes that especially for stakeholders without their own biologists can benefit from these collaborations. In particular with the analysis tools in Moveapps as these require relatively less skills. Meanwhile, Movebank and MoveApps do allow for larger scale projects that connect multiple states and government bodies to collaborate through the same program.

Witko (outreach biologist at Audubon, one of Movebank partners) sees the enabling of collaboration in Movebank. He specifically uses it to contact researchers within Movebank but also invites other collaborators to put their data in Movebank. He does add that Movebank's contacting intervenes with his institute's normal contact rules. Instead he acquires data managers' contact details through the internet and uses email for archiving reasons. Davidson also experiences that the uniformity of data and the findability that Movebank offers allows for quick action and contact. Especially, starting projects who inject their early data into Movebank can find collaborators. This is illustrated with the Covid-19 Biologging project in which she and Movebank were quickly able to identify projects so that project leaders could initiate contact with data owners to see the impact of decreased human activity on nature.

'so we were able to act much more quickly in terms of actually getting projects off the ground on a time sensitive basis. (Davidson, 2022)'

Movebank's archiving function

To create an archive for future use is one of Movebank's main goals (Movebank, n.d.-a). This counts for data and studies but also for analysis tools. Movebank actively encourages the storage of older data for possible future studies and evaluation. Movebank also encourages that both the data context and a general description of the study are published. This bolsters findability and attempts to retain the context of the observations as much as possible. Interesting here is that private data can be stored for a longer period of time but that no guarantee can be given for permanent privacy because data owners must remain in their positions (Movebank, n.d.-h). Alongside its general database, Movebank also offers the Movebank data repository. This is a formal data repository in which data managers cannot alter their data anymore. It allows for the archival of published studies giving the data reviewed status. Storing your data in the repository also allows others to officially cite the data. It must be noted that this repository is significantly smaller than the general database (Movebank, n.d.-i).
Why archiving is a goal to Movebank is explained by Davidson who explains that Movebank prevents the creation of smaller local archives and thus makes the life of researchers easier.

'We are reducing their need for a local infrastructure or to even collect the data. (Davidson, 2022)'

Bohrer adds that earlier all researchers had their own excel files while Movebank reduces this need. Witko adds that Movebank is also a way of storing older data stored on CDs and other devices. He also explains that the goal of some of the partnerships between Movebank and other organizations is to get new data owners into the archive to expand the range of data available. Finally, Davidson also explains that the archive allows for faster collaboration because the studies do not need to be completely finished before archival can take place.

Movebank's data management and control

Throughout Movebank's online platform, Movebank makes clear that the control over data remains in the hands of those who put it onto Movebank. It is these data managers that can decide who has access to the data or who can alter it (Movebank, n.d.-e). This is further encouraged through the push for data control contracts within collaborations and by stating that Movebank has no right on the data (Movebank, n.d.-f). To access any data, one must create an account -thus showing their name to the data manager-. The tools within Movebank available to those with access to the data are all only usable for managing. They only allow for outlier identification and alteration or for managing tag-object relationships. Analysis is done on external services such as Moveapps and Env DATA system, which are still connected to Movebank but not findable within the main platform (Movebank, n.d.-g). Movebank itself can only report on aggregated data such as the number of total data points on the platform (Movebank, n.d.-j). Movebank does require the citation of Movebank when data from the database is used (Movebank, n.d.-k).

The importance of data control is also emphasized within the interviews. Here 4 out of 5 interviewees indicated the importance of having the data control in the hands of the data owners. Kays even called the strong data control Movebank's biggest strength and a benefit over alternative databases. Davidson further explains that Movebank facilitates this control by only providing guidelines which explains why this focussed on, on Movebank's platform. Bohrer explains that this data control is important to convince researchers and agencies to put their data on Movebank. It must be made explicitly clear that they remain in control of the data. Witko expands and explains that one of his tasks is to convince data holders to put their data onto Movebank and that this is a task that may take up some effort. Not only on his side, but Movebank also needs to actively help data owners in putting their data online. Finally, Davidson explains that it often is the sensitivity of data that creates this need for control and which may block innovations in the findability of studies with e.g. endangered species.

'For agencies, using Movebank is a scary step. They need to be convinced that Movebank is not some google of data, in that they take away that data. It is more like they are the Amazon Cloud Service of animal movement so it is their space. (Bohrer, 2022)'

Movebank's data structure, data types and, user interface

Movebank supports one specific type of data; animal tracking data which is captured through a variety of methods (Movebank, n.d.-l).

'The Movebank database supports the import of animal tracking data based on almost any method—GPS, Argos Doppler locations, radio and acoustic telemetry, solar geolocators, bird rings and natural markers'(Movebank, n.d.-e)

This data is captured in specific geo-located data points which can be accompanied by, depending on the species, specific animal data. The accompanying species are based on the ITIS system which contains a standardized global version of all taxa. The data is harmonized within the existing data structure Movebank adopts. All data on Movebank is built in tabular format and may need processing before it is ready to be input into the database -as is the case with radio and acoustic data- and thus requiring a bigger effort (Movebank, n.d.-l).

Kays explains that data captured by photography are excluded from the platform to keep it focussed. Furthermore, it is not possible to input personal variables to, as Davidson puts it, avoid a growth in undocumented variables in place of effort to map to existing variables as much as possible. A large range of information can be accommodated using nearly 300 variables in the database, including several generic variables for those that do not have an ideal fit, and the possibility for users to advise on the addition of more variables when they can be well defined and used by others. Davidson further explains that Movebank's data model is indeed general in comparison to other databases. Yet, this is both a strength and a challenge at the same time. On the one hand it allows for a big variety of species that can be put into Movebank. On the other hand it makes the data model less specialized than alternative platforms, which may be designed around specific species. Kays agrees with Davidson that the generality can be a strength of Movebank because it makes working with it easier.

Analyzing the data is not possible within Movebank's general website and platform but the Env DATA system, which can be accessed through Movebanks website, does allow for environmental data layering. This program however does require a level of understanding and training of those using it (Movebank, n.d.-m). Data can furthermore be put in as a live data stream allowing for live following of specimens. Yet, this does prevent Movebank from being used offline although individual data studies can be downloaded (Movebank, n.d.-d).

When it comes to understanding the data, Iesari, Bohrer and Witko agree that additional knowledge or data layers are needed. This can for example be an environmental force such as wind or local road networks. Witko even goes further and explains that specialists are needed to interpret the raw data Movebank provides. Bohrer also sees this need but also explains that analysis tools such as MoveApps have the potential to (partly) fill this function.

But it does require folks who know how to analyze it or work with the data.
It's not simply just plug and play (witko, 2022).

On the user interface level, the studies are visible through the study finder which is both a search engine and map projection. Here it can be experienced that can be found based on data owner and dataset description. They can be viewed through a variety of underlying maps suggesting that a layering of the movement data and different maps brings information. Region specific searches are hard and dependent on manual map knowledge creating difficulty for migrating species who may be missed. The studies available are spread out around the world with a higher amount of data available for the US and Europe (Movebank, n.d.-n).
Finally, most all interviewees agree that Movebank's biggest strength is its ability to store big datasets and the general amount of data it hosts. According to Bohrer this especially helps when working with bigger projects may even cross borders. But Bohrer also states that making changes may become more difficult the bigger Movebank gets.

Movebank and policy

Conservation managers and policy makers do not seem to be considered as a main user of Movebank. Where the other users of Movebank are named, policy is almost always missing. It is only when it comes to collaborations and partnerships that conservation projects are named. Moving into the future Movebank is thus moving towards policy (Movebank, n.d.-f). Davidson here explains that Movebank does support government agencies and projects led by conservation and policy leaders such as the Audubon Society's Migratory Bird Initiative. Movebank does however, develop and supply analysis tools such as Moveapps and Earth ranger. Moveapps allows for the sharing of analyzing tools, one can make a data flow which is then usable for all types of data. The Earth Ranger app helps local rangers track the local animals allowing them to alter their personal behavior and conservation strategies (Earthranger, n.d.). When it comes to Movebank's research interface -where one can explore the available studies-, a skill gap can be seen and experienced. This is further shown through the dictionary and the teaching programmes that indicate that the interface needs additional explanation before proper usage can commence (Movebank, n.d.-o).
Movebank does have a potential for policy is what all interviewees agree on. Iesari explains that Movement data is important in those areas where animals interact with humans and human activities. Yet, to make the data useful, additional layers of environmental or spatial data are needed. This layering does require a level of skill and expertise to be done well, especially since both environmental and movement data are often of big sizes. Davidson expands on Iesari by explaining that movement can be used in court cases, when examining wind energy projects and for hunting regulations. She also mentions Earth Ranger as being a tool, based on Movebank's database, with direct impact on the ground. Yet, she also considers Movebank more of an archive and would not necessarily say that it leverages the knowledge within.

Bohrer explains the need of a data translation system for policy makers. Because movement data is only valuable in combination with other data this previously explained layering is needed. Bohrer sees a role for Moveapps in this need. As a developer on Moveapps, he explains that the tools on Moveapps should be general in nature but with a high level of personalization. This is necessary in order to accommodate the local data that policy agencies provide. Furthermore, it should be directly directed towards policy makers because many agencies involved do not have (enough) researchers. Still Bohrer sees the importance of incorporating this type of data into policy, especially since it generally does not happen but would make policy more holistic. The biggest barrier he experiences in this department is that policy makers and agencies need to trust Movebank as described in 'data management and control'. Getting policy makers and agencies to actually use the tool and convince them of the ease and safety of it is the most important task. Witko also stresses Movebank's power as being a connective tissue between partners and agencies on a local and international level. Because of its easy and uniform data sharing capabilities. He also explains that working with Movebank does require a team of experienced professionals to help agencies put their data in Movebank and to contact them.

Discussion

This discussion aims to put the results into perspective by combining them with the theories explained in the literature review. So far this paper has identified possible strengths and pitfalls of interfaces like Movebank. Furthermore, the research questions asked have been provided with answers through both interviews and a conducted walkthrough method. The result is knowledge on a range of features, systems like Movebank possess. These range from the vision and goals, through added value and used data model to applications for policy.

Movebank through a narrow and broad lense

Understanding Movebank requires an understanding on how to view the platform; in a narrow or a broad lense. In a narrow sense, Movebank is the website in which data can be stored, shared and managed. Yet, in order to understand Movebank's full functionality, a broad lens is to be applied. Through this lense the Env-DATA system, Moveapps and Movebank's other partnerships such as Eathranger become visible. This discussion discusses Movebank through the narrow lense due to it being the central platform within the Movebank system.

Expanding the vision and goals

Movebank has mostly specified itself to a secluded target audience; researchers. It seems to aim to be a facilitating interface in the production of knowledge as it aims to assist researchers in storing and managing their data. Movebank thus assists in the creation of models by researchers to allow for further creation of knowledge. More specifically, interfaces such as Movebank allow for objects, or observations as they are called within Movebank, to become datapoints. This positions these interfaces in between objects and data in the knowledge production cycle (Figure 1) used by Leonelli (2018). Furthermore, Movebank projects itself in between data and models in this cycle. It does this by providing a basic data structure that for some is already enough to facilitate analysis. Finally, a broad view of Movebank allows for analysis to help process the data allowing Movebank to be a facilitator between models and knowledge.

To move into the process of policy would demand further steps from Movebank, straying away from the main goal. It would require the expansion of Movebank's vision into the translation of knowledge into interactions with the world. This would require further and more intense expansion of the broad vision. Within the narrow sense, Movebank would still not be able to go further than storing data. When Movebank does decide to expand further into a policy direction. A change in funding may be needed as current funds may only be useful for research ends. Overall this shows that when databases like Movebank want to expand into policy territory this needs to be reflected in their vision and may require heavy changes or a broader scope.

Movebanks added value

Movebank adds value to the process of knowledge production by being a facilitating factor and platform. Standing out in the results is that Movebank puts itself forward but is also perceived as a key element in enabling collaboration between researchers themselves and with agencies. This confirms Millerand and Baker (2020) as they describe this need within ecology. Yet, this enabling does come with challenges. Databases such as Movebank need to actively engage with potential collaborators to create and sustain a level of trust between them. This comes in the form of active communication and constant passive reassuring on their platform. Collaborators must be convinced that their data is safe and remains theirs while on Movebank. Database interfaces are thus heavily prevented from exceeding the borders of being an interface. Where control remains with researchers, becoming more than a facilitating in-between is difficult and turning knowledge into an impacting factor. For this, the interface is reliant on its users as they have control over the data.

The second aimed for and perceived added value Movebank offers is as an archive. Movebank actively attempts to get older data onto their platform and is a huge proponent of serving as an archive for researchers. It claims that it can lessen the need of local researchers and agencies to create their own databases. It thus indirectly aims at becoming a central archive for movement data. Big databases such as Movebank thus have the potential to lighten local responsibilities, duties and financial issues. Furthermore, Movebank's official repository can give credibility to data and research. Agencies with a narrow approach to evidence, as described by Argyrous (2019), can thus also profit from Movebank's archive. Databases with the size of Movebank thus have the added value as reliever of local duties. As centralized and credible agencies they also have the ability to give credibility to research.

Implications of the data model

Movebank's data structure is based on step and stop data points (Benson, 2016) and has a level of generalization compared to alternative databases. The generality of the model however does allow for a high level of collaboration and accessibility. It is even named one of the biggest strengths Movebank has and may be crucial in involving external parties into the system. Yet, for more specialized groups of movement ecologists for which databases are already in place, these alternative systems may be more favorable. Still, the challenges to enter personal variables -however broad the existing range of variables may be- does have an effect. The existing variables and data structure reflect the existing conventions of movement ecology and thus impact the understanding of future users (Turnhout and Boonman, 2011 -Benson, 2016).
Movebank's data model may be broad but is still based on tabular data points and thus excludes data such as photography and film. Furthermore, radio and audio based data need processing before being allowed into the system. Although understandable and practical, these choices do impact future usage and may exclude or disadvantage the users of these methods. This may impact the interest in these methods when Movebank becomes an important force within the movement ecology field.

Databases of the size of Movebank have a considerable influence on their respective research fields. This calls for responsibility and an awareness of the role fulfilled. Especially since it was indicated that changes are already difficult due to Movebank's size. Databases like Movebank are based on archiving material for other (future) generations who can use this data for secondary usage. The usage of data as secondary data can be a risk to the quality of research. Reasons for this are the distance between researcher and original data, possible changes in conventions and understanding of data within its respective scientific field (Argyrous, 2019; Beaulieu, 2003). Within movement ecology this risk is especially potent since the step and stop method of understanding movement is not unanimously supported (Benson, 2016). Databases such as Movebank must be aware of this and allow for alterations in their model. Meanwhile it must also make sure that as much context on studies is given to allow for proper future understanding of its background by secondary users, something Movebank is actively pushing.

Need for interfaces between database and policymakers

What already became clear in Altringham, Berthinussen and Wordley (2020) was confirmed in the results; ecological data needs translation by specialists to become valuable. This seems especially true for movement data which needs layering with other data types to turn into knowledge about environments. It is for this reason that for databases such as Movebank to become valuable to policy an interface is required that is able to translate its data.

The first of these types of interfaces is Movebank as assisting the traditional way, as described by Dicks (2020). In this manner, research is conducted by specialists and working groups. Databases such as Movebank can however, also have an impact here. Movebank offers these specialists, especially when policy is created by a multitude of agencies, a way of collaborating while also providing a shared archive. Its general data model allows for easy step in and easy sharing of data in-between parties. Movebank itself here, is thus a powerful tool and additional interface towards the data. As positioned in between data and research Movebank allows for better findability of data, although some improvements such as area searching may be needed. Database interfaces such as Movebank thus really have the potential to strongly assist researchers and ease workloads. Such interfaces can then save agencies large sums of money which is not spent on long running investigations.

An alternative way of interfacing ecological data also exists. Because database infrastructures such as Movebank in a narrow view do not offer analyzing capacity within themselves, tools can be built to do this analysis. Tools such as MoveApps, Env-DATA system and Earth Ranger can be classified as additional decision support systems (Dicks, 2020). They are tools and systems designed to have technology in place that assists policy makers and conservation managers in making decisions. They have the potential, when they allow for enough personalization, to shorten, ease up and cheapen the process of decision making. Database interfaces are crucial for these systems as they provide the base data input and enable the platforms and collaborative networks in which workflows can be spread.

Policy makers as users of Movebank

Considering policy and conservation managers as users of Movebank results in three levels of understanding. This follows the distinction between site-level decision making, strategic level planning and day to day planning by (Ausden & Walsh, 2020). On the one hand there is day to day decision making by local authorities and individual managers. For them a tool like Earth ranger is highly beneficial and may save time and improve management overall due to the increase in evidence-based decisions. For site-level decision making, MoveApp workflows can help bring evidence into short term planning. Finally, strategic planning can be improved through both data analysis in house or by specialists using Movebank's archival and collaborative functions. These specialists may now also use data from the repository, which is certified, resulting in long term evidence-based strategies even in the narrow sense. Still for all these improvements, training, specialists, contact and financial investments are needed as Movebank, seen through both lenses, requires a certain skill level to use. Database interfaces such as Movebank that facilitate a broad spectrum of services have the potential to assist policy and management on all levels.

Impact on conservation policy cycle

The different functions and added value infrastructures such as Movebank offer benefit the policy cycle, as described in Wu et al. (2018), in different places. As a start, the collaboration allows as a potential source from which agenda setting and policy formulation can arrive. Furthermore, the research and analyzed data that is provided through infrastructures as Movebank can serve as evidence for supporting new policy ideas. Serving as evidence, analyzed movement data can allow for more holistic choices for decision makers. The decision making tools and shortened processes, as described before, can also make the decision making more effective and efficient. Finally, the archiving function databases like Movebank offer allow for evaluation over time, especially when pushing for the allowance of both broad and old data into the system. Still, policy makers as users do need to have a broad paradigm on what makes evidence based policy to allow for databases like Movebank to truly be of help.

Conclusion

To answer the questions asked by this paper, a short look over the shoulder needs to be done to see what this paper has accomplished. This paper used a mixed method approach with both interviews and a walkthrough method. In combination with a theoretical underpinning established in the literature review the research questions are ripe for answering.

So what does the way these database interfaces are designed and maintained, or the types of data they include and exclude, tell us about their (non-)users and added value?

Movebank specifically aims for researchers as their primary users and is able to provide added value to them through enabling collaboration and by acting as an archive. This is reflected in the general nature of the data structure which allows for a wide range of data inputs and thus facilitates a broad range of researchers. Meanwhile the design and maintenance of the platform are also guided by researchers and their needs. By providing a high level of data control to the user, by allowing for in-platform management of data, creating collaborative options and, by coupling the platform to analysis tools, it is the researcher's life that is being made easier. Although policy makers are named, it is only the extended tools that actively assist policy makers and agencies.

Having said that, we can move on to the other research question; how do database interfaces such as Movebank contribute to conservation policies and their underlying knowledge infrastructures of monitoring?

The database structure is not designed for policy makers and where policy is involved it is mainly through additional tools such as MoveApps. Expanding interfaces like Movebank thus requires expanding it in a broad sense. Especially since it is clear that database interfaces like Movebank in a narrow sense are likely to remain just that; interfaces. Without the data control, which remains in the hands of researchers themselves as a prerequisite for them to store the data at all, Movebank has difficulty to move on its own. Nevertheless, interfaces like Movebank have the potential to be valuable to policy and the developments are promising. By assisting researchers for policy and providing analysis tools, interfaces like Movebank have a lot to offer to policy makers and conservation managers. Furthermore, database interfaces can serve as a connective tissue between research oriented knowledge infrastructures and policy making organizations. In the design of these infrastructures it will remain important however, to be flexible and react to changes in the scientific field they are aiding and in a way representing.

This research is limited by a short temporal scale and may have therefore only scratched the surface of Movebank. Furthermore, at the core of walkthrough methods is the subjectivity of the researcher. When it comes to policy related interviewees, the search was made difficult due to Movebank only recently starting towards this direction.

Moving forward, similar research may be conducted at different database infrastructures to see whether the claims made here can be confirmed. Especially for different scientific fields that are reliant on a different data type, a comparison to this paper may be interesting. Furthermore, an expansion towards the perception of researchers using Movebank may be of high interest.

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