Chapter 6: PRODUCING

The environment in which data were collected during the two field seasons of the spring of 2015 and 2020 is complex and multidimensional. During fieldwork, the biologists and I were immersed in the habitat of the Siberian jays in the boreal forest of Arvidsjaur in Sweden. Here, the birds live among trees, bushes, rivers, bridges, marshlands, paths, mushrooms, lichen, moss, and snow. They witness the different seasons and are exposed to the environment. Occasionally, they fall prey to the surroundings with which they are entangled. The trees serve as spaces to build nests and raise offspring under the protection of the branches, while the berries, seeds, nuts, worms, spiders, and insects serve as nutrition. In winter, the jays become hoarders and store their food in the bark of the trees; one bird remembering several hundred hideaways. In summer, the forest protects them from predators, but in winter, the brown-orange birds stand out against the white snow, making survival more difficult, especially in scarcely vegetated or deforested landscapes.[1] Aspects of this multiplicity and ecological entanglement become visible as material traces in the raw data. In the field notebooks, one can see the marks of raindrops that had fallen onto the pages and the remnants of midges that could not escape before the notebook was shut.

1 Layton-Matthews, Ozgul, and Griesser, 'The Interacting Effects of Forestry and Climate Change on the Demography of a Group-Living Bird Population'.

Therefore, without further transformation, formalisation, and abstraction, certain characteristics of the birds cannot be converted into formal scientific results that contribute to knowledge production – an issue closely tied to the loss of their environment. While on-site in Sweden, the birds' complex entanglements with the forests can be witnessed and explored; for scientific purposes, the birds must be disentangled and extracted from the forest by the biologists and transferred to a different environment. They must be transferred to offices where the actual knowledge production occurs. Only here, as a result of data processing, do *insights* appear to be gained and *facts* produced on the behaviour of the Siberian jays.

The biologists return from the field to their offices with notebooks filled with handwritten charts, notes on separate sheets of paper, and printed maps to organise fieldwork. In addition to their notebooks, they have SD cards containing 15-minute video recordings of the birds' behaviour, and blood samples, tail feathers, and body measurements of the new birds that have become research objects. These are raw data, resulting directly from the field, mostly produced based on formalised empirical observations of the Siberian jays. To produce knowledge, these data must be processed.

This processing creates the gap I mentioned in Chapter 1 of the book. The gap is defined by the invisible steps between bird and published paper. It is marked by a (visual) difference between the representation of data as published results and the raw field data that are not made public. The raw field data are produced in a technically simple manner during fieldwork, often by means of notes on a video recording. The visible results are highly technical images generated at the end of the research process, based on data modelling, coding, and algorithms applied to raw data plots (Figures 50 and 51).

These final technical images are 'not simply compendia of visible information, they document the schematic presentation of carefully distilled and edited observation',[2] hiding the technical and other operations that led to them. The visualisations usually consist of a few lines on a graph with an x- and a y-axis, along with abstract numbers, individual letters, and a few indexical words that provide some details of the situation, such as 'displaced', 'chased', 'male nonbreeder', or 'female nonbreeder'. Colour is used solely to distinguish the data. The life cycles of most data that led to the refined images have become invisible in these datasets. The data have become visually generalised and homogenised and have lost their complexity. They serve as visual proof of the arguments made in the paper.[3]

This chapter focuses on the life cycle of data based on the archival material of my case study, along with the knowledge and experience of data processing gained through fieldwork and conversations. I consider mainly how the datasets are prepared for publication rather than the process of writing a scientific paper. I describe the operations that the biologists apply to the raw visual material from the field to produce a *robust* scientific result, following the threads that lead from bird to paper and from inscription to inscription.[4] By such means, I return to Latour's concept of creating reference in the scientific process. While Latour argues that the individual steps from research objects to results are shaped by a 'long series of manipulations' to 'narrow the gaps',[5] which will later be made invisible, I suggest changing the metaphor.

2 Johanna Drucker, 'Graphesis: Visual Knowledge Production and Representation', *Poetess Archive Journal* 2, no. 1 (2011): 7, https://paj-ojs-tamu.tdl.org/paj/article/view/4.

3 Johanna Drucker, *Graphesis. Visual Forms of Knowledge Production* (Cambridge, MA: Harvard University Press, 2014); Latour, 'The More Manipulations the Better'; Merz, 'Bildkomplexe als Geschichten: Naturwissenschaftler Erzählen'.

4 Latour, 'The More Manipulations the Better'; Latour and Woolgar, *Laboratory Life*.

5 Latour, 'The More Manipulations the Better', 348.

Accordingly, I introduce the concept of filters rather than *manipulation* to describe these practices and provide a different understanding. The concept of filtering emphasises two aspects: First, it poses the question of what acts as a filter and how. Second, it highlights who applies these filters that facilitate the scientific practice (situated mediations) and help to make agencies visible. When examining raw data rather than the final object, this situatedness becomes visible in material traces that the biologists do not consider data. Attending to these emphasises 'a performative understanding of the scientific practice'.[6] Understanding the process of transforming raw data into final results as one of filtering helps illuminate how biologists conceptualise and develop their research object.

While the term 'manipulation' has a negative, slightly moralistic, connotation, and could perhaps imply deceit, the term etymologically means the handling of persons and/or objects by hand, often to one's own advantage. The Latin word *manus* means hand; thus, all other body parts are excluded. However, as I have discussed in previous chapters, the biologists' entire bodies and all their senses are involved in fieldwork. The term *filtering* does not have this negative connotation. I consider it wise to use a metaphor that does not inherently refer to any particular body part and does not privilege specific body parts over others. This allows me to discuss the practices without simultaneously evaluating them.

In the following section, I discuss *filtering* as a metaphor for the practices that help transform the birds into scientific output. Here, I refer to theories on different media modalities, how they constitute themselves in their usage, and how they are made visible and/or invisible. In particular, Offen-

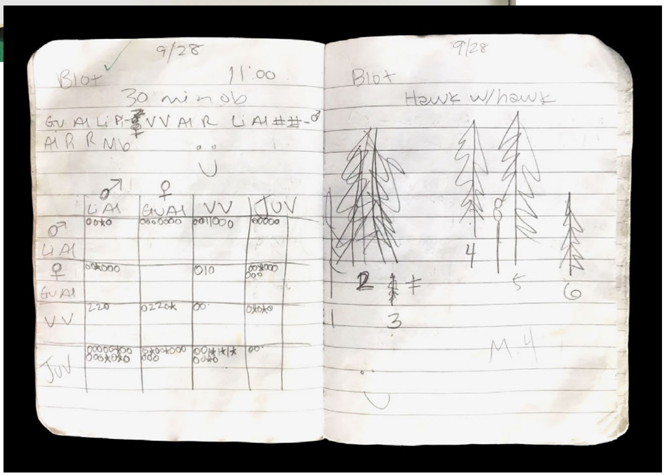
6 Barad, *Meeting the Universe Halfway*, 49.

huber's[7] concept of *autographic data* helps shift attention to the *side*-data that become visible in the raw biological data. Furthermore, Jane Bennett's theory on the *vitality* of things offers an understanding of these data as having agency rather than being biological waste products.

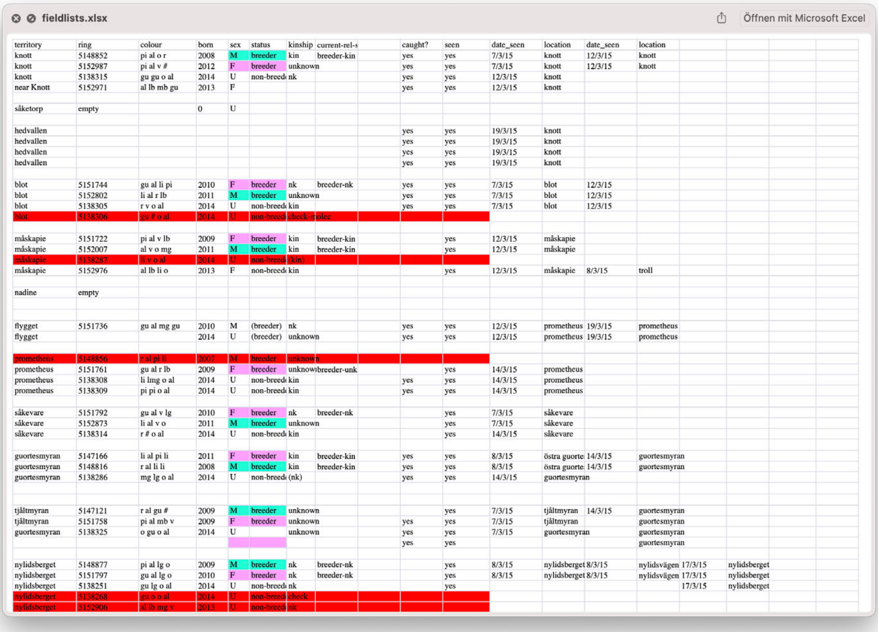
Having outlined the steps of filtering (6.1), I describe how the working environment shifts from field to office, and how this is closely related to *Relocating Birds and Biologists* (6.2). I conclude the chapter with a *Thick Description by means of Visualisation* (6.3), referring to the ethnographic method of thick description and the concept of *infrastices,* in which Tim Ingold and Mike Anusas state that interfaces should be transparent.

7 Dietmar Offenhuber, 'Data by Proxy – Material Traces as Autographic Visualizations', *IEEE Transactions on Visualization and Computer Graphics* 26, no. 1 (2020): 98–108, https://doi.org/10.1109/TVCG.2019.2934788; Dietmar Offenhuber, 'Dis/Entangling Perspectives in Material Research', in *Data Autographies – A Material Perspective on Data Visualization and Evidence Construction* (online: Matter of Activity: Humboldt University Berlin, 2022), https://www.matters-of-activity.de/en/activities/6386/dis-entangling-perspectives-in-material-research.

52



53



territory	ring	colour	born	sex	status	kinship	current-rel-s		caught?	seen	date_seen	location	date_seen	location		
knott	5148852	pi al o r	2008	M	breeder	kin	breeder-kin		yes	yes	7/3/15	knott	12/3/15	knott		
knott	5152987	pi al v #	2012	F	breeder	unknown			yes	yes	7/3/15	knott	12/3/15	knott		
knott	5138315	gu gu o al	2014	U	non-breed	nk			yes	yes	12/3/15	knott				
near Knott	5152971	al lb mb gu	2013	F					yes	yes	12/3/15	knott				
såketorp	empty		0	U												
hedvallen									yes	yes	19/3/15	knott				
hedvallen									yes	yes	19/3/15	knott				
hedvallen									yes	yes	19/3/15	knott				
hedvallen									yes	yes	19/3/15	knott				
blot	5151744	gu al li pi	2010	F	breeder	nk	breeder-nk		yes	yes	7/3/15	blot	12/3/15			
blot	5152802	li al r lb	2011	M	breeder	unknown			yes	yes	7/3/15	blot	12/3/15			
blot	5138305	r v o al	2014	U	non-breed	kin			yes	yes	7/3/15	blot	12/3/15			
blot	5138306	gu # o al	2014	U	non-breed	check-molec										
måskapie	5151722	pi al v lb	2009	F	breeder	kin	breeder-kin			yes	12/3/15	måskapie				
måskapie	5152007	al v o mg	2011	M	breeder	kin	breeder-kin			yes	12/3/15	måskapie				
måskapie	5138287	li v o al	2014	U	non-breed	(kin)										
måskapie	5152976	al lb li o	2013	F	non-breed	kin				yes	12/3/15	måskapie	8/3/15	troll		
nadine	empty															
flygget	5151736	gu al mg gu	2010	M	(breeder)	nk			yes	yes	12/3/15	prometheus	19/3/15	prometheus		
flygget			2014	U	(breeder)	unknown			yes	yes	12/3/15	prometheus	19/3/15	prometheus		
prometheus	5148856	r al pi li	2007	M	breeder	unknown										
prometheus	5151761	gu al r lb	2009	F	breeder	unknow	breeder-unk			yes	14/3/15	prometheus				
prometheus	5138308	li lmg o al	2014	U	non-breed	kin			yes	yes	14/3/15	prometheus				
prometheus	5138309	pi pi o al	2014	U	non-breed	kin			yes	yes	14/3/15	prometheus				
såkevare	5151792	gu al v lg	2010	F	breeder	nk	breeder-nk			yes	7/3/15	såkevare				
såkevare	5152873	li al v o	2011	M	breeder	unknown				yes	7/3/15	såkevare				
såkevare	5138314	r # o al	2014	U	non-breed	kin				yes	14/3/15	såkevare				
guortesmyran	5147166	li al pi li	2011	F	breeder	kin	breeder-kin		yes	yes	8/3/15	östra guorte	14/3/15	guortesmyran		
guortesmyran	5148816	r al li li	2008	M	breeder	kin	breeder-kin		yes	yes	8/3/15	östra guorte	14/3/15	guortesmyran		
guortesmyran	5138286	mg lg o al	2014	U	non-breed	(nk)			yes	yes	14/3/15	guortesmyran				
tjåltmyran	5147121	r al gu #	2009	M	breeder	unknown				yes	7/3/15	tjåltmyran	14/3/15	guortesmyran		
tjåltmyran	5151758	pi al mb v	2009	F	breeder	unknown			yes	yes	7/3/15	tjåltmyran		guortesmyran		
guortesmyran	5138325	o gu o al	2014	U		unknown			yes	yes	7/3/15	guortesmyran		guortesmyran		
									yes	yes				guortesmyran		
nylidsberget	5148877	pi al lg o	2009	M	breeder	nk	breeder-nk			yes	8/3/15	nylidsberget	8/3/15	nylidsvägen	17/3/15	nylidsberget
nylidsberget	5151797	gu al lg o	2010	F	breeder	nk	breeder-nk			yes	8/3/15	nylidsberget	8/3/15	nylidsvägen	17/3/15	nylidsberget
nylidsberget	5138251	gu lg o al	2014	U	non-breed	nk				yes					17/3/15	nylidsberget
nylidsberget	5138268	gu o o al	2014	U	non-breed	check										
nylidsberget	5152906	al lb mg v	2013	U	non-breed	nk										

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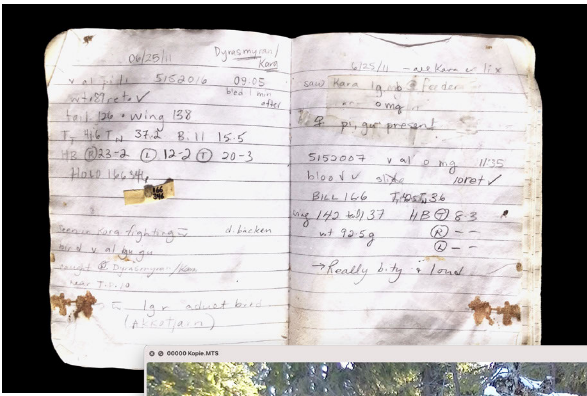
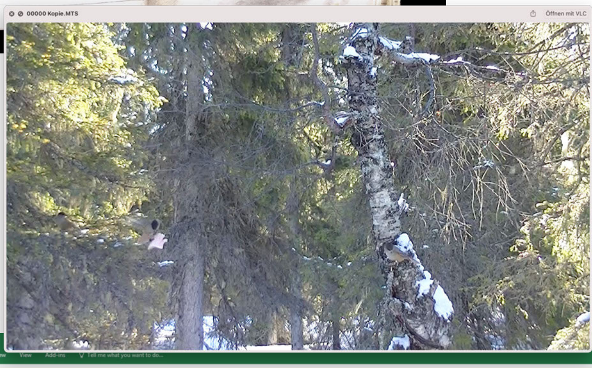
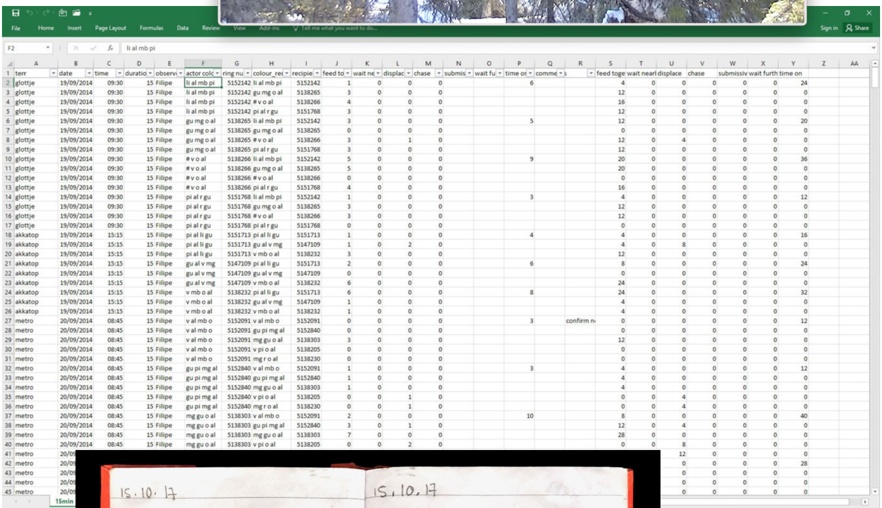

06/25/11
Dyrasmyran / Kora
6/25/11

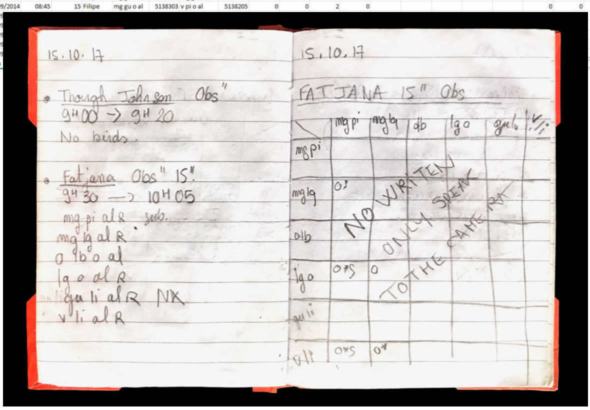
55


00000 Kopie.MTS
Öffnen mit VLC

56



57


15.10.17
Through Johnson Obs"
9H00 → 9H20
No birds.
Fatjana Obs" 15"
9H30 → 10H05
15.10.17
FATJANA 15" Obs
NO WRITTEN
ONLY SPEAK
TO THE CAMERA

58

Figure 52:
Field notebooks stored in a cabinet in Michael's office at the University of Zurich. Zurich, 2018.

Figure 53:
Screenshot that I took after scrolling through a PDF file with scans of the biologists' field notebooks. The screenshot shows a double page of Sinja's field notebook with a behavioural observation protocol in territory *Blot* to the left and side-notes to complement the video recording on the right.

Figure 54:
Excerpt from field list for the study in 2015 (Excel chart) representing the territories and the Siberian jays living in them. The breeding couple and Siberian jays that are missing are highlighted. Zurich, 2021.

Figure 55:
Screenshot of a double page of a field notebook from 2011 with bodily measurements of Siberian jays taken by biologist Lena in *Kara* and *Dyrasmyran.* A radio tag is taped onto the page on the left. Several brown marks indicate blood or dirt. Zurich, 2018.

Figure 56:
Screenshot from video recording by Kate in territory *Knott.* Arvidsjaur, 2015.

Figure 57:
Screenshot of Excel data plot with behavioural observation after transfer from video in the office. Zurich, 2018.

Figure 58:
Double page of Jasmin's field notebook from 2017. On the left showing that she had been to the territory *Tough Johnson* where she waited for 20 minutes without Siberian jays appearing. Below is an indication of the time she spent in *Fat Jana* (9:30–10:05 a.m.) and the six Siberian jays she identified. Behavioural protocol of the Siberian jays in territory *Fat Jana,* which Jasmin started but then omitted: 'No written, only speak to camera.' Zurich, 2018.

6.1. Filters

Filtering is a mechanical process that separates or *purifies* substances. During the process, the *input* is separated into at least two components, namely *residue* and *filtrate,* determined by the permeability of the filter. For my case study, I suggest conceptualising the field as the input and the raw data as the filtrate. The residue is what remains in the field: all formal and informal observations that did not become data. In the next step, the data that have been transported to the researchers' offices become the input, while a *refined* version thereof is the filtrate. Consequently, the aspects that are unimportant to the biologists, such as side-notes in their field notebooks, become the *residue.* In each of the steps, the permeability of the filter is the interest with which the biologists study the input (data). Based on this, they decide what should be kept and what should be discarded. The permeability determines which information passes through the filter and becomes the *filtrate,* and which information becomes *stuck* in the filter as the *residue*. The tools, such as the behavioural observation protocol, video camera, and computer interface, support and determine the individual steps of filtering. Thus, together, the biologists and their tools form a filtering apparatus.

The filters have different levels of permeability. In some cases, the filtrate does not carry any remaining sediments that might provide insight into the conditions of its production, such as the refined Excel sheets on computer screens (these differ from those on which the biologists manually captured information during the fieldwork season). In other cases, such as the video recordings or behavioural observation protocols, additional information becomes visible as autographic data. The filters, with their varying permeability, can thus be separated into densities, ranging from thick to thin, or obscure to transparent.

Again, during these practices, the biologists do not act as neutral bodies. The filtering is based on their intra-action with the technical operations, discourse, and apparatus of knowledge production that define their decisions. In short, the filtering practices are another form of situated mediations, which are a combination of situated enskillment, formalised training, discourse literacy, skilled visions, and the employment of technologies, with which the biologists filter aspects of the birds. Thus, through the steps of filtering, three kinds of situated mediations become visible.

The process of filtering occurs in three main steps: from bird to raw data (in the field), from raw data to analytical data (in the office), and from analytical data to a graphical representation as the result of the scientific process. The raw data collection is based on a first filtering process of skilled mediations as filters. The second is from raw field data to analytical data by capturing the raw data on an Excel sheet where they are combined with all the data from the previous seasons and homogenised. The third filter is applied to the Excel sheet, based on algorithms, where specific aspects of the dataset selected by the biologists are quantitatively combined and modelled into a final visual representation of the results for publication along with a written account. In most cases, this is a graph or schematic diagram, as described at the beginning of this chapter. Each of these steps is shaped by the tension between the visible and invisible. To make one aspect visible, something else must often be removed from the biologist's sight, as it prevents them from *seeing* the facts.

It is important that nothing is discarded, even if all data points are not transferred. Waste data can be stored in the archives, along with the notebooks, individual sheets of paper, and hard drives containing the video recordings. From a biological perspective, this is a process of refining data by separating it. However, to guarantee objectivity and ensure that the data are not arbitrary, certain organising principles must remain constant. Accordingly, in these filtrations, the bird colour codes (IDs), territory names, and study sites, among other things, circulate as 'immutable mobiles', which are '[...] objects which have the properties of being mobile but also immutable, presentable, readable and combinable with one another'.[8] From an STS perspective, the data transform from a thick description that is rich, multi-layered, and complex to a *flattened* result where the data have lost their complexity. Therefore, I suggest focusing on the *residue* to reintroduce the practices that produced the scientific results into the discourse. As outlined in the introduction, I filter them back *in*to the knowledge of the scientific process. I do this by mixing the *poor*ified[9] filtrate with the residue, thereby complexifying the data again.

To conceptualise the residue, I refer to 'autographic data'. Offenhuber introduced this term in *Data by Proxy,*[10] and it will help describe the 'surplus data' of scientific knowledge production. Offenhuber understands autographic visualisation as a graphical practice of data visualisation that specifically attends to the material entities of data and the self-inscription of data on these entities. He refers, for instance, to tree rings as data visualisation, where material and data have become inseparable.[11]

8
Latour and Woolgar, *Laboratory Life,* 7.

9
*Poor*ified as in 'purified': I allow myself this play on words to emphasise the duality of the data. From a design-informed STS perspective such as mine, the data that remain after processing become poor in the sense that they lose complexity. They become 'flat' – as I call it – for the sake of reductionism. However, from the biological perspective, they become *pure*ified, which is an essential step for the biologist to *see* their proof by presenting their data visually with graphs.

10
Offenhuber, 'Data by Proxy – Material Traces as Autographic Visualizations'.

11
Cf. ibid., 99.

Autographic visualisations are defined as a process in which 'phenomena [...] reveal themselves as visible traces'.[12] These 'epistemologies of traces'[13] decentre the human, as they can inscribe themselves on the humans and other carriers of data traces. As these traces are usually filtered out during subsequent steps, they are disregarded by scientists. In this sense, autographic data materialise and inscribe themselves on the data carriers, for instance in the biologists' notebooks. They provide insight beyond the data collected, for instance, the processes, practices, and environmental aspects that accompany the research process. Other than the tree-ring example, they can be separated by filtering, as I shall illustrate.

6.1.1. First Filter: Transforming Observations into Raw Data

When studying the behaviour of the Siberian jays, bare visual observation is insufficient, as discussed in the previous chapter. Therefore, the biologists' observations in the field are captured by behavioural observation protocols and video recordings. These practices function as filters that sift the relevant information from all the information the biologists receive. The behavioural observation protocol works as a filter by predetermining what should be documented and turned into data (Chapter 5).

Observations are considered valid data only when they are visualised and stored on data carriers as raw data – the filtrate produced by the behavioural observation protocol. Without documentation, there would be no scientifically valid data to be systematically analysed and interpreted. Regardless of whether a study is in ethnography or biology, data are inevitable to produce scientific output. Therefore,

12 Ibid.

13 Cf. Offenhuber, 'Dis/Entangling Perspectives in Material Research'.

the life cycle of data starts with this initial *filtrate,* the documentations made in the field based on situated mediations, which, as illustrated earlier (cf. Chapter 5: 5.2), work as filters during fieldwork. They isolate the birds from the field, thus reducing their complexity. The birds are slowly turned into abstract scientific representations through this process.

Along with organising principles (such as naming the study areas, bird families, and individual birds, which circulate as 'immutable mobiles' (Latour) through the datasets and allow consistency and connection between the specific birds and the collected data), and formalised methods (that enable a steady collection of data), the biologists formalise quantitative theories and produce scientific evidence. The territory names function as references to the groups and bird territories, and in terms of data analysis, they allow the biologists to disregard the physical and geographical relations of these territories with the others in the study area, as they are replaced by cells on an Excel sheet. The field data contain much more than these organising principles and the information collected through formalised methods. Besides the relevant biological data, the notebooks and raw field data also carry material traces and autographic data.

In this sense, information has both been extracted from the birds during data collection and been added to. The 'adding', from the biologists' perspective, occurred as a side effect, as in the case of their handwriting. For the filtering process, this additional autographic data is *noise* that must be separated from the data. For now, I focus on this noise before it is filtered out in the next steps of the research process.

To follow the material traces of what becomes visible in raw data, I make use of my archival material. I open the folder named 'Material' on my MacBook, followed by the subfolder 'GSA_FS18_Labday_04052018', where I find the PDF called 'Fieldnotes_Notebooks_students_2011-17'. It contains a collection of several field notebooks from master's, PhD, and postdoctoral students who conducted fieldwork in Arvidsjaur between 2011 and 2017. I scanned these notebooks one day in the researchers' office.

Michael had granted me access to his filing cabinet (Figure 52), which usually remains locked. He prefers that the material remains in the office, but I can go through everything and make notes and scans, which I eventually did with my smartphone because there was only one (very slow) scanner in the office. Therefore, I did not scan each notebook entirely, but instead focused only on excerpts that struck me. I focus on differences in the noting practices: aspects that did not appear to be part of the process of biological data collection, such as small drawings or traces of the research conditions inscribed on the pages of the notebooks, such as dead midges or pages wrinkled from the rain.

Scrolling through these excerpts now, I stop on page 64 of 73: an excerpt of biologist Sinja's notebook from 2014 (Figure 53). I have never met Sinja, but I can identify with her by examining this page of her notebook. I imagine how she may have worked with the birds. To follow her thoughts, based on this archival material, I study not only the pages in the notebook but also the material relating to her notes, such as the Excel sheet of all the registered birds. I attempt to understand how many birds she managed to attract, determine in which territory and study area she worked, and learn the characteristics of her environment. Based on her notebook entry, I trace Sinja's observational process – her situated mediations – to understand how she employed the behavioural observation protocol in the field.

The scan reveals that the notebook itself is somewhat weathered on the edges, likely from its frequent use during fieldwork, and as far as I can see on my scan, the right side of the notebook became wet at some point, as the edges have a weathered appearance and some of the lines have rubbed off. Before I study the notes more specifically, I am struck by Sinja's handwriting, which is quite large compared with that of others. There is more space between her capital letters, which makes it easier to identify her notes and helpful for me as an outsider wanting to study and understand the relationship between the biologists, how the birds are studied, and the role of the notes. I can also study the density of her lines by the varying shades of grey of the graphite pencil on the paper.

At the top of the left-hand page of the behavioural observation protocol, she wrote 'September 28th', the name of the bird territory, *'Blot',* the time, '11 o'clock', and the task she fulfilled, a 30-minute observation,[14] which she noted as '30 min obs'. There are other elements to her notes as well. I can see moments of hesitation where she crossed out the male symbol and replaced it with the female symbol at the top of the left-hand page. I feel as though I can also see how she hesitated for a moment when drawing the trees on the right-hand side page. The fact that she drew a '2' over a '1' leads me to believe that she changed her mind as she was numbering the trees (to guide the biologists who will eventually analyse the video recording).

Looking at the handwritten protocols allows me to examine the boundaries of the visual filtering practices. First, for the biologists, the behavioural observation protocol is a highly efficient and effective tool to monitor and document the complex aspects of social behaviour among several birds. It combines time, three-dimensional movement, and different kinds of interactions into one simple two-dimensional visualisation that usually fits on half a page of an A6 notebook. With this technique, the biologists can translate a 15-minute (or longer) excerpt of an event they triggered in the field among several individual birds into an immutable mobile. The result is a document indicating the location, bird territory, date, time, and IDs of the birds present during the behavioural observation protocol, as well as the interactions between individual birds, which are quantified.

14
During my study, the video recordings were extended from 15 to 30 minutes to ensure that all relevant behaviour could be observed.

The birds' IDs are in the vertical and horizontal columns with boxes containing the relevant codes for the individual interactions observed. This immediately allows an (en-)skilled eye to gather information on the individual birds. It functions as a condensing tool and a filter that captures only the relevant interactions and events that occurred during this period. It also helps to turn qualitative observations into quantitative outcomes that provide the biologists with clear information on their research object.

The field data do not provide any direct information on anything else, such as the environment, weather, temperature, other animals, or predators. Nor do they indicate any human conditions and interventions; the disposition of the biologists; infrastructure, such as houses, cars, railways, paths, forestry works; or other people, such as the Sámi reindeer herders, who occasionally drive through the forests on their snowmobiles. However, this information is not entirely filtered out. In some cases, the biologists note that heavy forestry work has occurred, that they spotted predators, or events occurred that may influence the birds' behaviour. According to Sinja's observation, this was not the case.

On further examination of the double page, I notice four other marks that I can only interpret as two 'u' shapes with two dots on top; in German they could be read as the umlaut (ü). To me, it seems more likely that these shapes represent smiley faces. Considering the location at the bottom of the double page, I do not know whether I should interpret this as Sinja's satisfaction with a successful observation, or a secret code she is communicating to the biologists who will process the data. It could also function as a mnemonic technique to help her recall the field situation when she uses the notebook again later, for instance, when choosing a suitable group of birds with which to conduct further observations.

There is also a combination of the letter M and the number 4. I do not know what it represents and I disregard it for now. Lastly, I notice a small hook in green ink on the top-left corner of the page. I assume that the biologists who transferred the notes (along with the relevant video recording) to a digital datasheet had written this. To recall specifically where *Blot,* the territory in which Sinja worked, is located, I refer to a document called 'Maps_2020.pdf'.[15] It contains maps of the three study areas. When Sinja made her observations in 2017, the study site was different. Some of the birds have since died, perhaps from the cold winter, predators, or age, and some have emigrated. Some territories did not yet exist, while others have since disappeared. As I have access only to the maps of 2020, I can see some of these changes on the maps, while I must assume others based on the material. I find *Blot* on the map for *Managed* in the top-right-hand corner and disregard the maps for *Fat Road* and *Reivo* for now.

I subsequently move on to a different file called 'fieldlists.xlsx' (Figure 54), an Excel datasheet from the final data plot, which I received from Michael for my fieldwork in 2015, where I also look for *Blot.*[16] On the left page, I read 'GU AL PI', followed by the male symbol, which has been crossed out and replaced by the female symbol, followed by a combination of letters and signs ('VV AI R Li AI ##'), and then the male symbol. The letters represent abbreviations for the Swedish words for colours, an additional translation step the researchers must perform. This has now changed and since 2023 they employ the English translation to make it easier for the international community of researchers involved in the project. I find another combination in the next line ('AI RR Mb'). Comparing this with the Excel field list from 2015, I can confirm that there are four birds in this territory; the code 'VV AI R Li AI ##' indicates the individual colour IDs of two birds, which can be separated into 'VV AI R' and 'Li AI ##'. The latter bird has lost two

15
Michael asked me not to publish detailed representations of the territory maps to avoid revealing the exact locations of the birds. Figure 19 provides a general idea of what the maps look like.

16
Both a copy of the map and the field list were likely glued into Sinja's notebook in the front and back, as was done by all the biologists to have these essential details close to hand at all times. I did not scan the list and the map, as they are in every notebook I studied.

rings since 2015 as indicated by the '#'. I can derive from the Excel sheet that the missing IDs were red and light blue. The other two birds are no longer the same in the Excel sheet and notebook. Presumably, they have changed territories between 2015 and 2017, which is likely given they were both non-breeders, who usually find a new territory in which to start their own group. The birds that remained the same are the breeding couple (male and female).

As can be seen with Sinja's corrections, media have their obstinacies, which become particularly visible in moments of interference. The reason Sinja needed to make corrections is unknown to me, but, as media scholar Judith Willkomm points out, this moment of interference makes the modality of the notebook visible.[17] While most media are usually hidden and naturalised, through this correction, the notebook itself becomes visible.[18] This 'constitutive moment'[19] illustrates how a notebook is different to, for instance, digital applications as actants (to echo Latour) in a research setting. From my perspective, the use of a handwritten notebook allows me to trace the moment of data collection in richer detail than would be the case for a digital recording.

With the notebook, corrections cannot simply be made if Sinja does not have an eraser to hand, which the biologists usually do not. Thus, her error becomes a visual trace that tells its own story. This kind of *storytelling* is a result of the modality of the notebook. In another case, if the notebook had been replaced by an application for conducting the behavioural observation protocol – which exists but has not been used by Michael and his team thus far – the error would have been invisible and remained a brief, untold moment that Sinja experienced in the field.

17
Translated by Judith Willkomm, 'Mediatisierte Sinne und die Eigensinnigkeit der Medien. Für eine Medientheoretische Sensibilisierung der Sinnlichen Ethnographie', in *Ethnographien der Sinne,* ed. Lydia Maria Arantes and Elisa Rieger (Bielefeld: Transcript Verlag, 2014), 51.

18
Ibid.

19
Latour and Woolgar, *Laboratory Life,* 88.

While the chart on the left-hand side of the field notebook (once it has been completed) delivers initial insights into the behaviour of this group of birds, the drawings on the right represent the setting and complement the video that Sinja has been recording during the 30-minute observation, as is usually the case. The numbers of the trees help systematise the verbal descriptions, making them more precise by giving the trees designations to which Sinja can refer. In addition, the small vertical line with the two horizontal lines across indicate where the feeder has been located, while the line at the top right with the two circles on top between trees 4 and 5 indicates where an artificial hawk was positioned as part of the experimental setting.

The resulting behavioural observation protocols no longer show the actual birds, but indexically refer to them based on their colour IDs, which consist of codes that relate the (existing) data points to the individual birds. The birds have thus been completely replaced by their IDs. This code remains the same across the field notebook, maps, and Excel sheet. Thus, it provides an overview, enables the biologists to monitor the bird population (which is only possible through this reference system they have developed), and helps them organise their research and maintain consistency. In the protocols, the birds themselves are filtered out, along with the landscape and the experimental setting with the feeder. They have been removed from their context during their transformation from bird to paper. What remains is a cryptic chart that, to the expert, provides insights into the birds' interaction around the feeder. No other information remains in these documents. Certain interactions between individual birds become visible, which would hardly be possible without this documentation. They would have remained an inseparable meshwork of interactions between birds in the forest that would not have been identifiable to the biologists as the birds of a specific territory or group, as it is incredibly difficult to tell them apart without their IDs.

These data will later partially be turned into digital datasheets and in this way prepared for further processing and analysis. It partly supports the video processing that comes next in the biologists' analysis. However, Sinja's side-notes and the drawing will not be transferred; they only help organise the fieldwork and its analysis for the peer biologists who will analyse the raw data. Her 'errors' will not find their way into the next dataset. Subsequently, the biologists who transfer the data check the side-notes to see if their colleagues in the field documented any irregularities that may have influenced the data collection, which they may need to consider when processing the data.

Three Categories of Data

I suggest that there are three categories of filtered data based on the information appearing on the double page. First, the biologically relevant data are collected based on situated mediations, as they become visible in the behavioural observation protocol in the video recordings or side-notes in the field notebooks. The raw biological data contain two levels of autographic data as material traces, thus forming a second category that inscribes itself on the data carriers as part of the data-collection process. These traces include, for instance, how the behavioural observation protocol is developed, the biologists' handwriting, and their errors (as in the case of Sinja), or the personal methods employed as mnemonic techniques to support the observational tasks. For instance, Marine and Camille first translated the colour codes from Swedish to English or French before they made their observations, while other biologists copied the colours directly to identify them more easily. As a third category, there are material traces that are not part of the actual documentation itself but result from the conditions and the environment of data collection, such as the weathered notebooks, marks from raindrops, or dead midges. In other words, they offer insight into the conditions in the field.

In biologist Lena's field notebook from the summer of 2011 (Figure 55), I can see traces of all three categories. The pages have many folds and the edges are weathered. The notebook looks as though it became wet, which suggests it was raining during fieldwork. There are also brown traces of dirt or blood on the pages, which likely stem from Lena measuring the birds.

While these are autographic data, there is a (category 1) sidenote indicating 'Really bity + loud' on the right-hand page, probably characterising the juvenile bird that Lena ringed and measured in this territory. In examining these pages, I wonder whether some of the blood that Lena sampled from the bird was accidentally transferred to the notebook, or if it is her own blood from a bite by the aggressive bird. However, I can only speculate; perhaps the brown marks are simply dirt.

Out of curiosity, I quickly check the field list from my previous trip in 2020, which is glued into my notebook, to see whether the bird is still alive. And, indeed, I find the bird; however, it is mentioned under a different territory – it now lives in *Måskapie*. According to the field list, it lives there as the male breeder along with a female breeder and a third bird, which may have changed territories again by now.

Studying the PDF with the territory maps also allows me to geographically locate the study, and I can start looking up certain locations to see where exactly the biologists worked and what their surroundings were. These geographical references, territory names, and bird codes usually disappear in the final papers, as the maps are not published. Instead, the birds are referred to as an 'individually colour-ringed population of Siberian jays that has been studied from 1989 onwards near Arvidsjaur'.[20]

20
Griesser, 'Do Warning Calls Boost Survival of Signal Recipients?', 4.

Combining the different field data allows me to create my own stories and images and relate to them from a sensorial perspective. By studying them with my design-informed ethnographic knowledge of the biological fieldwork, I can create my own path to follow the complexity of data collection and its tasks and challenges. The autographic data allow me to identify with the biologists, as in the case of Sinja and Lena, and notice differences in how they take notes, as different people collect data using differing practices, and with varying levels of experience and skill. At the same time, the material traces allow one to imagine the field environment and the conditions to which the biologists were exposed.

This second and third category of autographic data are usually disregarded during the process of digitalisation. In fact, these aspects will be filtered out entirely during the next step. Their existence ends in the field notebooks. Once the data are digitalised and homogenised, these differences become invisible, as does the opportunity to observe certain aspects of data collection. From my perspective, the datasets become *flat* with the elimination of the autographic data. However, for the biologists, only through this step – the literal flattening from three-dimensional notebooks to two-dimensional screens – do their data become manageable. They will be turned into formalised numbers and figures on an Excel sheet that represent the data plot.

I suggest a fourth, immaterial data category, which becomes visible only in the raw data, but is obvious in my ethnographic observations described in the previous chapters. The biologists' sensory, embodied, and implicit knowledge shapes and accompanies the research practices discussed in the previous chapter (Chapter 5: 5.3). This may be the embodiment of certain gestures, movements, or experiences that remain in the memories of the biologists, which means that certain field situations can remain in the biologists' memories more clearly than others. This knowledge is important during fieldwork because it accompanies *Situated Enskillment* (Chapter 4: 4.3), *Sensory Alignment* (Chapter 5: 5.3), *Situated Mediations* (Chapter 5: 5.4), and *Participant Behaviour Observation* (Chapter 5: 5.5). These practices are highly specific and require prior training in situ, familiarisation with the tools and methods, and alignment with the environment and birds. This knowledge is inevitable for data collection; however, when it comes to data analysis, it is filtered out. In short, from a biological perspective, this knowledge is lost, or it remains invisibly inscribed in the individual biologists' bodies.

6.1.2. Second Filter: Processing Raw Data into Analytical Data

A few weeks after data collection in Sweden, I return to the biologists' offices in Switzerland to discuss the next steps. After I make my way to the Anthropological Institute of the University of Zurich, where Michael and his project are based at that point, I enter the room at the end of the corridor, where I observe the field notebooks and hard drives lying on a desk. Seeing them immediately transfers me back to the field, where the very same books accompanied us every day to capture the biological and autographic data. Here, in the offices, they create a strange connection between the two working environments of the field and the office. For now, like the field, the biologists have to treat the data as they did the birds in the field, and, with the help of further filtering, separate the relevant and irrelevant information. They do this by transferring the raw data to digital files that replace the videos and notebook entries as containers for the filtrate. The resulting data and datasheets with the bodily measurements of the new birds will be transferred to a separate Excel sheet.

Here, in the offices, the field material is refined through the filtering process, as though it must first be made suitable for its new, clean environment. In the same way I cleaned the snow and soil from my boots before I entered the house in Sweden after a day in the field, the field data must be cleaned to rid it of all traces of the forest and the individual biologists before they enter the digital space of the university offices. In this moment, the operational space migrates from an analogue to a digital one. Now a biologist who may have never been to Arvidsjaur, nor seen a Siberian jay flying between the pines and birches in the boreal forests, sits in front of a computer with the field notebook, staring at a video recording of three birds around a feeder (Figure 56).

During fieldwork, the video camera worked as a filter, eliminating everything outside its frame. It transformed all auditory and visual information into digital data. The outcome is a high-resolution representation of the events that have been transformed into its two-dimensional equivalent; thus, the third dimension has been lost. The video camera works as a thick filter that omits everything visual outside the frame. At the same time, the value of this tool lies in its permeability. Thus, the video material has been only slightly filtered, and most of the visual information of the scene in which the biologists are interested is kept, whereas all other sensory experiences, except the auditory, are excluded. In fact, it is kept long-term and allows the biologists to transport the event from the field to the office, where they can replay the scenario while sitting on a chair behind a computer in a more comfortable environment than the field in Sweden. However, as raw data directly from the field, the videos do not tell the biologists much – yet. The files must first undergo an additional transformation process through further filtering.

A voice on the video comments:

> *OK, we are in Knott territory. The time is 09.54 and this is Kate, and the date is the 11th of March. There are three birds here, pink aluminium orange and red, pink aluminium, white, #, and yellow, yellow, orange, aluminium. [pause] Orange and red was just on the feeder [pause] that was yellow on the feeder, [pause] orange and red, [longer pause] double yellow again, [pause] and orange and red joins.*[21]

Kate's voice is interrupted by the rustling of her winter jacket as she moves her arms. Thus, the jacket also found its way into the field material as a testimony to the cold conditions, revealing the movement of her arms whenever she lifts the binoculars to study the colour IDs of the birds. This goes on for 15:02 minutes; however, I stop after 01:25 minutes and fast-forward through the video to obtain an overview. I have seen many other similar recordings, and it seems as though I will find nothing unusual in this one. For me, this is sufficient information, and I return to my text and continue writing.

However, the biologists transcribing the data need more patience. They must also study Kate's notebook entries to contextualise the data and note any unusual events that may have occurred that she may have written down, such as the presence of a raven, a predator of the jays. As Michael told me one day, 'The observational chart will in most cases not be transferred at all, it mainly serves for orientation and to get a feel for the territory'. The behavioural observation protocols in the field appear to work mostly as a method for (sensory) enskillment, as the behavioural observation protocols will be repeated in the offices based on the video recordings, thus discrediting those from the field as imperfect or incomplete.

21
Kate: Behavioural observation recording in *Knott* territory, 11/03/2015. File name: 00001 Kopie.MTS

While the relationship between the referent and its reference is symbolic in the behavioural observation protocol, the video recording still shows the birds as they appear in nature. Thus, it produces a translation of an event that occurred in the field. The videos are recorded while the behavioural observation protocols are conducted. Accordingly, when replaying them on computers in the offices, with the notebooks open to check for side-notes, a digital repetition of the event occurs – an on-screen re-enactment of what happened a few weeks earlier in the field. While many aspects are lost in the video, as it is a two-dimensional recording of one frame of a much denser event in nature, this replication of an otherwise ephemeral event also has its advantages. The biologists can pause, rewind, and fast-forward the videos to carefully analyse specific interactions. While the behavioural observation protocol took only 15 minutes in the field, its repetition in the office takes much longer. During this process, the biologists apply the same codes and attempt to identify the same behavioural patterns as they did during fieldwork (Figure 57).

This digital version of the events allows them to scrutinise the interactions between individual birds and then quantify them. The biologists can now further filter their observations from the video to the Excel sheet, thus repeating the entire fieldwork process one more time. However, the environment, tools, and methods, and necessary visual skills, shift considerably. The biologists are no longer exposed to the environment but sit in front of a computer on an ergonomic office chair. They can pause the video whenever necessary, whereas if they miss anything in the field, they lose data. Last, their operations are reduced to a digital environment; they no longer need binoculars, video cameras, or field notebooks. Through this process, the birds are geographically relocated. They are arranged on the data plot in a linear way, as opposed to their geographical location on the maps used for fieldwork.

During this process from video to Excel sheet, the biologists again extract only the relevant information. To filter the interactions of the birds, and to make them unambiguous and enable digitalisation, Kate must disappear from the video. Her voice will become silent and she will be replaced by numbers and figures. In addition to Kate, the trees, snow, landscape, feeder, branch, light, and birds themselves will be filtered out, and with them, the birds as living animals. In fact, the video recording as a file must disappear and be transformed into a new data environment that facilitates further operations. It becomes residue. Only a small percentage of *filtrate* of what can be seen in the video is kept and presented in the Excel data plots. Here, the biologists again combine digital operations, a framing interface, and their interest and skilled visions as situated mediations to fulfil this step. This step is closely related to the objectivisation of the individual biologists who are represented as neutral actors in the construction of scientific facts.

However, the territory names, dates and times, and the birds' IDs remain the same, allowing the biologists to merge the new data with their existing datasheets. With each step that brings the biologists closer to their output, they distance themselves more from the field and the birds, which are replaced with numerical representations. They apply filters to limit their focus even further to finally confirm their hypothesis and ensure that as few autographic data as possible make their way into the research results.

The video recordings and notebooks do not claim objectivity and are therefore much closer references to the field situation than the abstract Excel sheets. Their visual and haptic nature means they are directly bound to their origin in the field. They still carry aspects from the field, such as rainy weather that may have resulted in wrinkled pages or dead mosquitoes caught between pages. To echo Latour, the translation step is much smaller between the bird and the field notebook, where its behaviours are documented, than between the bird and a digital chart.[22] The field notebook offers a much richer representation of the field situation and, ultimately, the natural world. From a new materialism perspective, these field notes can even offer 'a glimpse into a parallel world of vibrant, powerful things'[23] as they have their own lives and make unexpected and unplanned aspects visible; they tell their own stories, as I have attempted to illustrate.

Last, these 'powerful things', 'vitality', and modalities that 'distribute agency'[24] become much more evident in the field notebooks than in the digital charts, where the various media are hidden. The supporting media thus do not play the role of neutral assistants, but the forms of knowledge and thought styles are greatly influenced by the employment of the mediators and skilled visions.[25]

When studying the correct page in Figure 58, biologist Jasmine did not even produce a written behavioural observation in *Fat Jana*. Instead, she wrote in capital letters, *'NO WRITTEN ONLY SPEAK TO THE CAMERA',* either as a note to herself or to her colleague who will analyse the recording. Michael recently confirmed that fieldwork has been increasingly shifting towards digital recordings alone, with handwritten protocols being entirely omitted. These written protocols are mostly used during the first days of fieldwork when the biologists are getting used to observing the birds and practising aligning with them.

As Marine told me, this follows the thought style of technically-inclined biologists or those who base their research more on empirical observation than their virtuosity in the field. The technical approach requires different skills to

22
Latour, 'The More Manipulations the Better'.

23
Jane Bennett, 'Powers of the Hoard: Further Notes on Material Agency', in *Animal, Vegetable, Mineral: Ethics and Objects,* ed. Jeffrey Jerome Cohen (Washington: Oliphaunt Books, 2012), 239.

24
Ibid., 241.

25
Cf. Frederik S. Pötzsch and Bernt Schnettler, 'Visuelles Wissen', *Handbuch Wissenssoziologie und Wissensforschung,* 2007, 480.

those I have described thus far. When working with big datasets, the biologists require a broader skillset of informatics and programming to analyse and model their datasets. Both create different modes of knowledge production and work in different knowledge spaces and possibilities of thought: they create different knowledge. Accordingly, biologists must critically reflect on their tools and how they influence their perception and knowledge production process so that they can uncover blind spots and unconscious filtering processes, thereby taking responsibility for their knowledge production.

When the biologists filter data in their offices, they capture singular aspects that occurred in the forest of Arvidsjaur on digital datasheets, thereby extracting them from their location and obscuring the conditions of data collection. At some point, the time and date become mostly irrelevant and are condensed as timespans of several years: 'The study was conducted between 1990 and 2004…'.[26] These timestamps shift slightly depending on which data the biologists are working with and publishing.

Along with this, the birds are removed from their environment and reterritorialised into digital data plots. In the field, coloured IDs are attached to the birds' legs. But in the datasets, they become detached from their physical context, existing only as combinations of numbers and letters aligned with territory names in the columns of Excel sheets. For as long as the research continues in the offices, the birds have become refined entries in these sheets, independent of the context and origin of the data. With this, the birds move as detached data points across the digital surfaces of the biologists' computers, ready to be processed further. Henceforth, their environment is no longer relevant. Their three-dimensional space has been replaced by a linear list. However, this list does not follow an alphabetical or chronological order but is organised

26 Magdalena Nystrand et al., 'Habitat-Specific Demography and Source-Sink Dynamics in a Population of Siberian Jays', *Journal of Animal Ecology* 79, no. 1 (2010): 267.

according to the actual locations of the territories in the field. In this way, the biologists have sought to translate the spatial logic of the map into a linear format, arranging the forest territories in the list so that those located near each other in the field also appear close together in the data.

Once the biologists and their assistants have spent several weeks transferring data to digital datasheets, an additional step of filtering has been fulfilled. In this way, the biologists transfer their visual material into a new graphical form through visual reduction and clarification. During data processing, the biologists filter out most of the research conditions, obscuring any aspects besides those that are relevant to their research. In this step, all ambiguity (from a natural scientific perspective) caused by the visual representations is eliminated, and what remains is clear, visual evidence. Only after this transformation can quantitative data analysis be undertaken. The more the data have been transformed by different filters, the more homogeneous they become. In the resulting chart, I cannot identify which data have been collected by whom or make any other assumptions about individual biologists and what they may have experienced in the field. Tracing their practices, as I did earlier (by means of the raw field material from Lena, Jasmin, and Sinja) is no longer possible.

6.1.3. Third Filter: Modelling Data into Results

Observation is a perfectly respectable concept in the natural sciences, but to make it part of scholarship, it ordinarily must be pulled into systems thinking in which ahistorical natural laws can be seen in action. Anna Tsing, an ecologist, explained to me that she loves fieldwork for its natural history observations, but when it comes time to publish an article, she must turn to theory, which, for her, refers to systems modelling, in which observations can be removed from their moments of contingent connection to speak to general, mechanical principles that sustain the world.[27]

Henceforth, the biologists also lock the notebooks and hard drives containing the video recordings away in archives, and their scientific project turns entirely into digital work, disregarding almost all visual operations of filtering that have led to this point. Now, they can start their actual data analysis and modelling to produce visualisations to confirm the hypothesis they developed prior to data collection. Only in very rare cases, if their results appear to be inconsistent, will they consult the field notebooks to check whether they missed anything or made a mistake, such as a typographical error, when transferring the data. This final step is shaped by a third layer of filtering that determines which data from the Excel sheet are evaluated and which data are disregarded.

Now the biologists follow the visual structuring principles that meet the codes of scientific representation. They follow the authority of schematic, *unambiguous* visual representation in the sciences, thereby naturalising the tools and practices employed by making them invisible. They use R[28] software to develop algorithms and write scripts of the raw data plots, which helps them confirm or reject their hypothesis by extracting and selecting data from the Excel sheet, coding it, and generating a visual result – a graph – as *proof*. In this step, the input data in their different stages become invisible, as do the algorithms that create the modelling. The resulting graphs appear to be a direct result of what the biologists encountered in the field, thus obscuring the many operational steps that led to the first data plots and served as input for their modelling.

27
Tsing, 'When the Things We Study Respond to Each Other', 239.
28
R is a statistical environment used by the biologists to analyse, model, and visualise statistical data. See https://www.r-project.org/.

The graphs obscure the fact that their outcomes are the result of a long operational process of bodily and sensory engagement of filtering practices. The final data charts or graphs published in papers are contextualised only by further information provided by the authors; reconstruction of the steps from the original source is impossible. All other traces – the fat, birds, biologists' handwriting, snow, and weather – have disappeared, as they are not relevant to understanding the results.

In summary, turning the birds into flat surfaces is a prerequisite for producing scientifically valid data. The available information must be filtered through several practices to achieve this transformation, which can be separated into three main steps of situated mediations: (6.1) filtering of raw data on the birds and capturing them on data carriers during fieldwork; (6.2) transformation of this raw field data into raw data plots based on digital operations that work as filters; and (6.3) modelling of the raw data plots with computer software until a *poor*ified version of data on the birds is available as the output. In all three steps, the biologists operate the filters. They are entangled with their practices and conduct the filtering. Thus, they have become inseparable from the apparatus of knowledge production. They are inscribed and situated within it rather than outside or even *above* it.

The process described in the previous section is almost like one of purification in a laboratory, or when applying filters with low permeability. What was initially a first-hand account of a single event observed in nature has now been transformed into a schematic representation that enables further data modelling. Through this step, the field and office have been separated in the sense that the field is hardly relevant anymore and the operational space reduced to data evaluation. New images will be developed based on these data plots, all of which are stored on hard drives and clouds, to *confirm* what, until now, has existed only as a hypothesis.

What was developed during several small steps that were not solely performed in a linear, consecutive order, but rather in a messy, multi-layered, entangled environment, cannot be retraced from the resulting graphs. In hindsight, the final images representing the outcome of the research in the coming papers appear to be one large step, produced directly from bird to paper; the life cycle of the data construction has been replaced by a brief explanation in the methodology section.

6.2. Relocating Birds and Biologists

Not only are the birds relocated from field to office during the filtering processes, but the biologists' working environment also changes. While the fieldwork is highly specific and dependent on a specific location – the boreal forests of Arvidsjaur – and cannot easily be replaced by a different location, the offices are less dependent on a particular geographical location. Instead, they depend on the biologists who analyse the data and thus have authority over them. During our collaboration, Michael and his team changed offices several times, depending on Michael's position and the relevant funding bodies.

When my fieldwork started, Michael's team had their offices in the Anthropological Institute of the University of Zurich. After the project's funding period had expired, Michael's office, along with his archives, was moved into his private basement. With the imposition of several COVID-19 lockdowns, the team's working environment moved into the digital space, with the biologists working remotely from their homes, which is where I would meet them. Since then, Michael has assumed a new position at the University of Konstanz. He, his research project, and, most importantly, the digital data (on hard drives and in archives) have thus,