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Feeding Fish Efficiently

Mobilising knowledge in Tasmanian salmon farming. *

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Abstract:

How do certain forms of knowledge become globally mobile? Focusing on Tasmanian salmon farming, this article addresses the negotiation of locally situated knowledge against the persuasive power of universalising expertise. It is argued that intensive salmon farming relies upon techno-scientific regimes of production in which the universality of salmon as biogenetic artefact is already inscribed. Intensive salmon farming thus lends itself well to the need for legibility and abstract calculations of large-scale capitalism. The alliance between scientific and economic interests pushes towards greater technological sophistication, and, in turn, towards a standardisation of salmon as a global universal artefact.

The tension between local and universalising forms of knowledge is a recurrent theme in anthropology. Partly, this results from the recognition of the significance of processes of standardisation and abstraction for the configuration of local realities and embodied knowledge (Pálsson 1998, Lien 2003, Nustad 2003) James Scott (1998) has explored this tension through a focus on states' need for rendering its social and environmental territories legible, Carrier and Miller (1998) have looked at the processes of abstraction in relation to economic models and practices, while Lave (1990), Ingold (2000) and Grasseni (2005), have explored similar issues from the perspective of embodied learning and craftsmanship in situated action, drawing on the theory of practice. In this paper, I draw on these insights as I explore the tension between universalism and particularity as it emerges in techno-scientific production regimes of commercial salmon farming. Focusing on the practices by which knowledge is differently scaled and mobilised, the article addresses the persuasive power of universal expertise, and its implications for the materiality of Tasmanian Atlantic salmon as a universal biogenetic artefact.

Following Annemarie Mol, I approach the ontology of farmed salmon, not as given in the order of things, but '*brought into being, sustained or allowed to wither away in common, day-to-day socio-material practices'* (Mol 2002:6). This calls for a focus on the everyday practice of growing and knowing salmon. Firmly entrenched in what Gudeman (Gudeman 1992) calls a 'modernist production regime', salmon farming is indeed based on the idea that the human and natural world can be organized and subjected to rational, totalizing control. As such, commercial salmon farming is both a man-made 'aquarium' (cf. Pálsson 1998), and yet amazingly mobile. It is from this tension between situated practices and transnational mobility that my argument takes form. I start by situating salmon farming in the broader context of animal domestication.

The 'King of Fish' goes global

Within the last couple of decades, Atlantic salmon (*Salmo salar*) has gone from being an exclusive delicacy, the 'King of Fish', to a mass-produced global commodity available in supermarkets in most parts of the world. The change reflects the development of a global industry of intensive and market-driven production systems that has made the aquaculture one of the fastest growing food production sectors in the world (FAO 2003). Through this process, Atlantic salmon has become a thoroughly domesticated species, enrolled in techno-scientific regimes of production which resemble those of chicken, sheep, pork and beef. The term 'blue revolution' captures the rapid transformation which is due, for a large part, to the expansion of intensive aquaculture.[1]

Intensive aquaculture may be analysed as the most recent turn in the human history of domestication (Lien 2007 *forthcoming*). Its specific characteristics reflect historical circumstances that involve transnational relations of production facilitating rapid dissemination of techno-scientific innovations. Thus, intensive aquaculture both forges, and is shaped by transnational structures related to technology and expertise that contribute in shaping what a farmed fish is and will become.

Atlantic salmon was among the first species to be successfully enrolled in intensive commercial aquaculture three decades ago. Since then, the global production of farmed Atlantic salmon has grown exponentially from nearly zero to more than one million tons. Processes of domestication which previously spanned several hundred years are now compressed into a few decades. By the late 1990's it was estimated that more than 94% of all the worlds' Atlantic salmon had been domesticated and raised on a fish farm (Gross 1998). This is partly due to a spatial expansion through which farmed Atlantic salmon has been transferred beyond its North Atlantic native range, to Chile, Western Canada and Australia. Such expansion involves transnational movements of people, knowledge and technology as well as biogenetic substance, and makes Atlantic salmon farming a unique case for exploring the interface between locally situated husbandry knowledge and the standardising forms of mobile expertise.

Salmon farming has an inevitable local component, as it unfolds at a particular coastal site characterised by distinctive features such as water temperature, currents, day-length, micro-organisms etc. Marine sites allocated to salmon farming are also invariably parts of culturally defined places, landscapes or seascapes which are made meaningful through naming, narration, commemoration or collective experience (Tilley 1994, Lien 2005). At the same time, intensive salmon farming relies upon standardising frameworks for interpretation provided through applied biological research and the uses of standardised techno-scientific equipment. The mediation between these two levels is achieved, in part, by transnational networks of expertise, through which knowledge and technology are actively transferred by parties with a commercial interest in its dissemination. A key question is thus: Wherein lies the persuasive power of transnational expertise, and how can we account for the mobility of certain types of technology and knowledge? I shall explore the standardisation of situated knowledge as it emerges and is negotiated through the technology of feeding, which is the most frequent and economically significant form of human-animal interaction in the salmon industry.

Farmed salmon is usually not destined for local consumption by its producers, but is produced in order to be sold for profit, and often destined for export. The value of salmon at the production site thus rests upon its potential conversion to a global commodity at a later stage, and cost-effectiveness is the key ordering principle of the operation. As the exchange value of salmon is generally interpreted as 'given' by the fluctuation of a global market beyond each individual farmers control, cost-effectiveness is primarily achieved by minimising production costs. This has created a large market for suppliers of cost-saving techno-scientific engineering, positioned at the interface between research and development in marine husbandry.

The most important running cost of a marine farm operation is the cost of feed, estimated in 2002 at around 50% of total costs on an average salmon farm. Thus, controlling feed is the most important strategy to control overall running costs. The 'one million dollar question' for a salmon farmer (or one of them) is therefore *how many kilos of feed do I need to throw into* *the water, and how do I know when I have fed them enough*? This question brings us right into the fuzzy area where salmon metabolism and salmon behaviour meet economy and techno-science. Following the farm-hands and experts in their attempts to find the correct answer, we are able to explore the tensions between scientists and practitioners, humans and animals and between universalising and situated knowledge.

Knowing and growing Tasmanian Atlantic Salmon

Tasmania is an Australian island state at 40-42 degrees south, where commercial salmon farming has taken place since the mid-1980 as a result of, and in cooperation with Norwegian capital investors and know-how (Lien 2005). With a total production of slightly less than 15,000 tons of salmonids[2] in 2002, Tasmania's role in global salmon production is negligible. In Australia, however, Tasmania is the salmon producing state par excellence, providing fresh and frozen salmon for the Australian market, and to a lesser degree for markets in Japan and South-East Asia. My fieldwork in Tasmania spans the period 2001-2004, including six-months of participant observation in and around a medium sized Tasmanian salmon growing enterprise.

In 2002, the industry was largely Australian owned, but relied upon transnational networks of research and technological knowhow[3]. Atlantic salmon is not native to the South Pacific, and the broodstock for Tasmanian salmon production is based on a genetic strain brought from Canada to New South Wales in 1964, and then to Tasmania in 1984. Hatched in freshwater, salmon are transferred to marine farms as 'smolts' (juveniles) where they are kept in circular pens or square cages with a diameter of approximately 30 metres and at a stocking density of up to 15 kg fish per square meter. The materiality of a hatchery and a marine farm is itself a testimony of transnational connections, as most equipment is imported, mostly from Europe and North America[4]. But this is not sufficient for a salmon farmer to succeed. Growing salmon implies *knowing salmon*. Unlike fishermen, whose success depends upon their ability to establish an interaction with the fish that culminates at the moment of capture (Knudsen 2003), salmon farmers interact with salmon throughout their entire life-cycle, from fertilisation to harvest. Put bluntly, the main challenge for fishermen is to know how to capture the fish, while the main challenge for salmon farmers is to know how to make them grow and stay healthy. Unlike in terrestrial husbandry, where farmers can often rely on the accumulated experience of previous generations, salmon farmers and Atlantic salmon are both 'newcomers to the farm'. Before I unpack some elements of this learning process as it unfolds in Tasmania, let my briefly sketch some of the ways in which salmon knowledge comes about.

Knowing how to grow salmon is closely connected to uses of technological equipment, but not reducible to it. From the perspective of a Tasmanian farm operation manager, knowledge of salmon farming takes many different forms. Written sources are indispensable, and include both web and print issues of trade magazines, mostly published in Europe for an international audience. One of my Tasmanian informants even subscribed to the Norwegian trade journal ('*Norsk Fiskeoppdrett*') which he browsed with the help of a Norwegian-English dictionary. Some browse scientific journal articles, although the sheer volume of such publications makes the filtering process a real challenge. The most important arenas of knowledge reproduction, however, are fields of social interaction, through which fragments of information about salmon biology, rearing practices, products and diseases are interpreted. Such encounters are sometimes spurred by geographical proximity, through networks of local salmon growers, thus contributing to giving Tasmanian production practices a certain distinct Tasmanian style, as opposed to Chilean, Norwegian and so on. But social encounters are not restricted to the geographically near; as both researchers, owners and operation managers engage at international conferences and trade exhibitions, and thus sustain transnational networks of their own, while also inviting internationally renowned experts and suppliers to visit Tasmania.

For those who are responsible for the growth and health of salmon, (farm-hands, and operation managers) knowing salmon involves, first and foremost, the salmon pen as a learning arena. Hence, growing salmon means to take part in a collective process of learning, in which the ‘collective’ (cf. Latour 1993) is an entity within which boundaries between human and animal, and between society and technology, are continuously blurred.

Feeding is a key concern, and involves the distribution of specially designed pellets onto the water surface of the salmon pens at regular intervals (meals) [5]. The amount of feed at each meal is a function of the density of the distribution, or ‘speed’ (the amount of pellets hitting the water surface per second) and duration. Ideally, the fish should be given the chance to eat as much as they possibly want while the amount of surplus feed should be kept as low as possible. The rationale for this is related both to economy and environmental pollution (surplus feed contributes to sedimentation of biological waste under the cage). Thus, the operation manager of a salmon farm must try to ensure that that salmon are fed to their moment of satiation, and avoid throwing surplus feed into the water.

In husbandry situations when feed is abundant and surplus does not create waste (cf. sheep grazing on pasture) the question of how much to eat is delegated, so to speak, to the animal. When feed is scarce and surplus feed cannot be retained or recycled, as in the case of farmed salmon, there emerges in addition a need to predict and to monitor the animals’ feeding behaviour. Feeding in intensive aquaculture spurs two different strains of inquiry. One involves skilled judgement of fish behaviour; the other involves the calculation of feed requirements based on fish size, water temperature, and the number of fish in each cage. While the first involves subjectivity and craftsmanship, the second involves a notion of salmon in the abstract, and the domain of science. Both of these strains of inquiry may involve the uses of technological devices, to a greater or lesser degree, and at various levels of sophistication. The application of increasingly sophisticated feeding technologies in salmon farming may be seen as part of the ongoing process of standardisation. I shall argue that it represents a way of simplifying and monitoring monitor the range of variation in individual salmon in order to render them amenable to human intervention.   In the next section, I will explore the implication of a shift towards greater technological sophistication for the human animal interface that took place at the salmon farm where I did fieldwork between 2002 and 2004.

Feeding salmon as sensory-based judgment

In 2002, feeding was essentially done by one of the farm-hands, whom I will refer to as Peter. Peter feeds the salmon four times a day. To do this, he applies a ‘tube feeder’ which pumps air and pellets out of a mouthpiece which Peter points in the direction of the salmon pen. The mouthpiece is connected a container on wheels filled with salmon pellets. Peter normally starts at full speed and gradually slows it down towards the end of the meal which may last 10-15 minutes or longer, depending on the size of the fish.

The tube feeder represents an intermediate level of technological sophistication in feeding. The lower end would be ‘to hand feed’, i.e. to scoop out pellets from a wheel barrel, and is done when the fish must be fed small quantities and the tube feeder cannot feed slowly enough. (This happens, for instance, when the fish are very young, or have been traumatised by disease, medical treatment, adverse environmental conditions etc.) At the upper end of the scale is a fully automated feeder connected to digital underwater cameras (see below). In 2002, some digital cameras and sensors were already used experimentally, but to put them into full use would require further investments that the company could not afford at the time.

On a sunny day in summer 2002, at a salmon farm in south-east Tasmania, Peter feeds salmon the way he normally does. Peter's position as farm-hand is at the lower end of the hierarchy of marine farm employees, but he has been responsible for feeding for some months now, and is recognized as a trustable feeder. I watch him as his eyes are fixed on the water surface, knowing that his judgment regarding the speed and duration of the meal is crucial. Most importantly, he needs to know when to stop. He admits that his decision is based on some guesswork, but not only: He knows how old the fish in each pen are and approximately how many they are. He knows the temperature level and the approximate oxygen level in the water (assuming that high temperatures and low oxygen levels reduce appetite). He knows all about a recent disease outbreak that could affect their feeding behaviour. Together, this information enables him to estimate roughly how much they are likely to eat. But beyond this, and most importantly: he watches their behaviour. When salmon are hungry, they normally catch the pellets from the surface, so in the first minutes of a meal salmon will appear just below the water surface, creating a simmering effect on the water. As the meal proceeds, these surface movements become less pronounced, an indication that the salmon are about to reach satiation. But then it is not that simple, because on sunny days the fish tend to cluster at greater depths, avoiding the water surface. Instead, they eat the pellets as they sink, far below the surface, where their movement is no longer visible for the feeder. Part of the competence required of a feeder is the ability to judge when this happens, i.e. to know when a quiet water surface is a sign of satiation, and when it is a sign of something else. This kind of competence corresponds closely to James Scott's notion of 'metis', which consists, not of rules as such, but of knowing how and when to apply the various rules of thumb in a concrete situation. He writes: 'The subltleties of application are important precisely because metis is most valuable in settings that are mutable, indeterminant and particular'. (Scott 1989:316)

Knowing when to stop feeding requires the ability to be able to act upon relatively small sensory clues. Assuming that there is a link between physiological needs and feeding behaviour, Peter focuses his attention on the latter, expecting that the fish will somehow 'show him' what to do, provided that he knows how to make use of relevant contextual information to interpret their signs. This alerts us to the fact that seeing in this case is not a passive gaze, but involves 'skilled vision', i.e. an 'active search for information from the environment, obtained through apprenticeship and an education of attention' (Grasseni 2004:53). In her analysis of dairy farmers' and breed experts' judgment of dairy cows at cattle fairs, Grasseni demonstrates how skilled vision is multisensorial, and rests upon processes of enskilment in a culturally, socially and materially structured environment. In the case of Tasmanian salmon, the process of enskilment remains a tacit competence restricted to the work place. Yet, it is still a socially situated learning process, in an environment '"littered" with objects, images and bodily patterns that structure and guide perception' (Grasseni 2004:44, see also Pálsson 1998). We are dealing here with a form of learning which may be described as a process of 'enskilment', one in which learning is inseparable from doing, and in which both are embedded in a context of practical engagement in the world (Lave 1990, see also Ingold 2000)

The importance placed upon enskilment[6] at the salmon farm is illustrated by Peter's boss, a junior operation manager, who will typically spend most of the day doing calculations on the computer, working with salmon growth charts and feed conversion in the abstract. Yet, he repeatedly insists upon the value what he calls a 'hands-on' approach. He says that even if computer calculations could easily fill a whole day (and he is recognized for being clever at it), if he did *only* that he would soon become useless to the company. A 'hands-on' approach is necessary in order to discuss problems with the farm-hands and make the right decisions. Such competence can only be maintained, he insists, by observing and interacting with the fish on a daily basis.

Feeding with a camera

When I returned to Tasmania in 2004, underwater cameras were routinely used in most feeding operations. Having read about the use of cameras in trade magazines a few years earlier, the director had decided to try it out. After some trials, they decided the pay-back time would be rather short and installed underwater cameras at all farm sites. The camera was lowered to about 8 meter below surface. From this position, it would produce a live image in black and white onto a screen inside of a monitor. While the farm hand previously fixed his eyes firmly on the water surface, his gaze could now alternate between the water surface and the monitor on the trolley beside him. Through the monitor screen, he was able to observe salmon feeding directly in front of the camera and the pellets as they sunk past the camera lens. A large amount of pellets is interpreted as an indication that the salmon have reached the moment of satiation.

According to the operation manager, the camera had given the feeder much more accurate information about when to stop feeding than simply watching the surface. Firstly, as he explained, many salmon will never feed at the surface, and their appearance will vary according to the position of the sun. Secondly, the transparency of the water surface changes depending on wind and darkness, making it difficult at times to judge ripples correctly. As the camera reduces the farm-hand's reliance on such multisensory information, the practice of skilled vision becomes, in a sense, more 'visualised' and also more standardised.

The farm-hand must also fill out a pre-prepared chart for each feeding, which provides an estimation of body mass in each salmon cage. On the basis of such charts, indicating the speed of feeding and the duration of the meal for each cage, the operation manager may later calculate how much each salmon has been fed and divide it that by estimated growth in the same period, which gives him the so-called 'feed conversion rate', or FCR (see below).

In addition to having eliminated the unpredictability of sun and wind, the introduction of an underwater camera facilitates a more precise judgment of satiation. This is because the entire feeding operation is now set up in a way that optimises, or even produces, a detectable stop signal. This is achieved through a specific combination of the key parameters of feeding: speed and the duration. Obviously, the combination of slow speed and long duration provides the same amount of feed as fast speed and short duration. However, if the fish were fed at a very high speed, they would only be able to eat a small amount of pellets before they sank, and the camera would show great amounts of pellets going down long before the fish reached satiation, thus making it difficult to judge when the fish had had enough.. If the fish were fed very slowly, they would eat most of the pellets before they sank, so few pellets would ever be visible in the camera, which would also not provide a clear stop signal. Feeding slowly would imply less waste, but was also seen to cause another problem: It is generally believed that low feeding rate favours the bigger and more active fish, and thus aggravates competition for food in the pen in a way that would make the big fish grow bigger and the small remain smaller[7]. The feeding procedure would produce fish of different sizes, which is seen as a problem as it does not optimise the growth potential of each individual fish. Thus, the optimal speed of feeding is one in which all salmon get an equal chance to eat, while the surplus amount of feed gradually increases from virtually nothing to a noticeable amount. This example indicates how the application of underwater cameras in feeding serves to configure the feeding behaviour in a way that facilitates a more precise notion of a threshold. Thus, the underwater camera serves to configure a more precise 'stop-signal'. [8]

Feeding salmon as universalising knowledge

'Skilled vision' in human-salmon relations is always local in the sense that it is socially reproduced in a situated context, and because it involves a local population of salmon, enrolled in a particular production regime with a range of local characteristics (water currents, environmental conditions, predators, disease profile) that are not identical across nations and continents. However, there is also a significant field of experts in marine farming that see their knowledge as delocalised, and through whom what we may call 'universalising knowledge' about salmon farming is continuously reproduced. These are people whose career which rests upon their ability to transform own and others' experience to a generalised form of expertise. Such processes of abstraction are encouraged within the institutional structures of multinational corporations providing feed or technological equipment, as they suit corporate strategies for growth through transnational expansion. Some of these experts are referred to as guru's in their field, and attract large audiences as they travel from one production region to another, presenting 'the latest' in the field of salmon farming. As innovations in feeding technology are highly valued and seen as crucial for attaining a competitive edge[9], the notion of 'best practice' changes quickly, hence the need for frequent update.

It is often assumed that abstract or 'delocalised' expert knowledge is by definition more mobile than knowledge that is contextually embedded in a specific place. However, as Penny Harvey has argued, it is not that simple, as the wider circulation of expert knowledge beyond the group of fellow 'experts' is entirely dependant on relationships of authority and persuasion. Thus, expert knowledge 'still requires convincing social dramas [in order] to have scalar effects' (Harvey 2006:xx). Harvey's point is relevant to an understanding of the difference between the global dissemination of information, and the sharing of knowledge. Masses of applied scientific information are continuously made available through the internet. The process of filtering and selecting relevant information relies, however, on knowledge that is to some extent constituted through social encounters. In Tasmania I had the chance to take part in some such 'social dramas' in the form of staged encounters between travelling experts and local aquaculture stakeholders.

In what follows, I shall describe an encounter that took place in 2002. The meeting had been announced through email invitations and attracted around 50 researchers, veterinarians, marine farm operators and operation managers. The key-note speaker was a fish biologist whom I shall call Scott, renowned for his research and scientific knowledge on feeding fish. Scott was affiliated with a multinational company, but had secured a research position of high independency and integrity, which probably also explains his reputation as someone worth listening to. He was based in Europe, but, as he told me during coffee break, he spent at least 150 days of the year travelling. Scott's topic was 'Optimising production results in modern fish farming'. The term 'modern' refers to a notion of what is currently best practice, and is closely connected to the idea that knowledge in the field of fish farming is universal knowledge, as opposed to local knowledge, some of which he compared in his presentation to local myths and superstition.

Later, he explained to me that local beliefs and accepted truths often evolve from largely anecdotal observations by farmers, and from fragments of local academic input with little significance to production. Since the inception of intensive aquaculture, there has been what he calls ‘an explosion of research’, and ‘from this learning curve there is also debris that accumulates’. Scott suggests that this is especially a problem in isolated places like Tasmania, where, as he says, ‘academics may build up an understanding almost separate from the day-to-day activities of salmon farming’. In this way, Scott sees his role not only as a researcher, but also as a mediator posed between academics and local practitioners. This position requires a solid understanding of what he calls ‘the biological laws of the fish’ but also of the commercial context of intensive aquaculture. Scott contends that the physiological ‘laws’ governing growth and food requirements in salmon are universal and the fish’s response to local conditions will be predictable regardless of where it is grown.

Scott’s role vis-à-vis the salmon farmers is comparable to that of marine scientists vis-à-vis the fishermen as described by Pálsson (1998), Finlayson (1994) and Knudsen (2003) in their respective analyses of Icelandic, Canadian and Turkish fisheries. However, there is an important difference: While these studies of marine scientists describe the efforts to understand and monitor fish populations in specific coastal regions (as well as migratory patterns), and focus on the convergence or conflicts of interest and knowledge amongst fishermen and scientists *in relation to specific localities*, Scott’s expertise rests upon his knowledge upon salmon in the abstract. As we shall see, Scott’s fame as an international expert implies that his knowledge of salmon is fundamentally mobile. In this way, aquaculture expertise allows, and forges, the accumulation of knowledge that is *disembedded from situated localities of production.*

Scott's presentation was an attempt to convince local salmon farmers to move fish farming 'from an art to a science'[10]. A key element in this process involves counting and weighing the fish at regular intervals, calculating specific growth rates (SGR = % gain in body weight per day), feed conversion ratio (FCR = quantity of feed /biomass gain), and to analyse the resulting relationships between feed rate, SGR and FCR to see if the feeding had been done correctly. This resulted in 'growth-ration curves', and was presented as a unifying technique that would allow an objective analysis of the reasons why certain SGRs and FCRs were obtained. In 2002, calculations of FCR and SGR were routinely carried out at Tasmanian salmon farms, but were often estimated on the basis of uncertain data. According to Scott, an FCR should ideally be close to 1.0, a figure that had been achieved in Norway[11]. In Tasmania, it was considerably higher, but Scott argued that there was no reason they should not be able to get it down to 1.1.

According to Scott, there are two main reasons why an FCR is too high: overfeeding or underfeeding. If you overfeed, feed is simply wasted, and your feed rate is unnecessarily high. If you underfeed, the salmon will not grow at an optimum rate and your FCR will increase as a result of a suboptimal SGR, or a low salmon biomass. The problem for many farmers, he maintained, is that they may complain about a high FCR, yet they don't have any idea whether this is due to overfeeding or underfeeding, and thus their response may actually aggravate the problem. Alternatively, they attribute the high FCR to some external factor when, according to Scott, the problem is due to errors of judgment by the farm workers themselves. The significance of cost-control serves as an underlying force of persuasion as exemplified in his comment to the audience: '*It is amazing how many will throw thousands of dollars worth of feed into the water without the slightest idea of how it is actually utilized.'* Scott explains that in order to reduce your FCR you need to know your SGR and your salmon biomass, which means you have to weigh the fish in each cage every month, count them, and measure the amount of feed fed to each cage. This is labour-intensive, but Scott argues that if you know these figures, you can make simple growth-ration plots that will enable you to respond to the problem in a better way. Not doing would, he says, be to base production on notional ideas, or as he put it, *'to walk into a chicken pen with a bucket of feed, blindfolded, and to [decide how to feed] by listening to the sounds of the chicken cackle.'* He argues that salmon farmers need to think of themselves more as chicken farmers. They need to take on a more systematic approach, in short, '*they need to move fish farming from being an art to being a science'*. This basic division structured his presentation, and was integral to his persuasive force. During our discussions some time later, I had the impression that this is also what motivates him as a consultant; he genuinely wants to improve (i.e. rationalise) fish farming worldwide, and he holds a position of authority from which he seems able to do it.

Putting knowledge in motion

By emphasising the importance of knowing the SGR and the FCR, Scott insists upon a way of 'knowing salmon' that is universally valid, and through which the characteristics of different groups of salmon (and other farmed fish) may be compared. The routinisation of such calculations represents a practical effort to make the world conform to the conceptual, and thus a form of virtualism as discussed by Carrier and Miller (1998). The FCR also facilitates comparison for financial investors with limited knowledge of salmon farming, as they enable them to evaluate a key parameter of cost-effectiveness, and thus the probability of future return. Thus, a figure that is intended to clarify a practical problem and suggest a scientific solution, may effectuate an abstraction which, in turn, contributes to virtualism in the economic domain (Carrier 1998).

Scott serves a mediator of universalising knowledge To the extent that he succeeds in convincing his audience to collect the necessary figures, he also indirectly contributes to a process of calculating, collecting and comparing information which, following Latourian terminology amounts to ‘cycles of accumulation’. Through such processes, Scott strengthens his role as a transnational expert, and indirectly, his company’s role as a global disseminator of knowledge (a ‘centre of calculation’ cf. Latour), essentially a win-win situation for both. As a matter of course, he makes situated salmon knowledge globally mobile, provided that such knowledge is codified in a standardised way.

Referring to scientific networks, Latour writes: ‘[T]he results of building, extending and keeping up these networks is to act at a distance, that is to do things in the centres that sometimes make it possible to dominate spatially as well as chronologically the periphery’ (Latour 1987:232). The Latourian approach goes a long way to account for the persuasive power of transnational research centres (commercial and academic), and the concomitant techno-scientific innovations in the salmon industry. However, the scalar effects of knowledge indicated by Latour require cultural work to be effective (Tsing 2000a, Harvey 2006). Furthermore, the notion of universal knowledge implies a universal object (artefact) that such knowledge can act upon. This begs the question as to under what circumstances such up-scaling of networks is in fact realised, and what it is that may prevent them from achieving their potential ‘scalar effects’?

After Scott had made his presentation, many of the comments took the form of questions based upon specific local experiences that were seen to affect Tasmanian salmons' propensity to eat. Among these were references to conditions that were seen as fairly unique to Tasmania, such as the (high) water temperature, (low) oxygen level, and the frequency of seal visits. Australian fur seals are a significant problem for the Tasmanian salmon industry as the presence of seals in the vicinity of a salmon pen effectively curbs the salmons' appetite, and, in the case of seal attacks, causes significant loss (Lien 2005). Although these relations may also be subject to scientific experiments, in this context they were mostly presented as reflections on possible connections, couched in the language of anecdotes and subjective experiences rather than in scientific discourse. Such speech acts may be interpreted as attempts to serve as alternative witness testimonies (cf. Shapin and Schafer 1989), but in this context they did not succeed in attaining such status. Scott discarded most such comments as *'esoteric issues'*, and in doing so he also, in effect, played down the potential value of a local approach to what was seen as specific Tasmanian problems. Concluding the discussion, he repeated: *'There is no reason why your production problems shouldn't be shared, - a fish does what a fish does, it does not know it is living in Tasmania.'*

Scott's point, as he later explained it, is that although salmon growth rate will be dependent on local temperature, the source of variation in FCR between individual cages is most often due to the human-animal interaction as it is mediated through feeding. The point he tries to make is for the salmon farmers to pay more attention to their husbandry practices, and less to external factors that are beyond their control. Scott's persuasive power thus rests on his ability to convince the audience that the salmon they interact with on a daily basis should not be seen primarily as locally embedded, but rather as exemplars of a species that is basically identical throughout the world of aquaculture. This understanding is substantiated through standardised procedures for 'knowing' salmon, of which the routine use of FCR is but one example.

The turn towards more widespread uses of FCR's and underwater cameras resemble James Scott's account of scientific forestry, a technical and commercial discipline that could be codified and taught, because it *'severely bracketed, or assumed to be constant all variables except those bearing directly on the yield of the selected species and on the cost of growing and extracting them*' (1989:20). The standardising potential of the FCR may be interpreted as a means to the construction of salmon as universal biogenetic substance, as much as an end in itself[12]. It is *because* the salmon is understood as essentially identical, that growth-ration plots gathered from locations elsewhere attract some interest. What we encounter here is not so much 'global expertise' posed against 'local knowledge', as the systematic translation of particular experiences so as to make them amenable to standardised procedures of intervention, and hence mobile, in relation to a universal field of expertise. But what does it take for a particular form of situated knowledge to become mobile?

Configuring 'salmo domesticus[13]'

In an article on the articulation of knowledge, Timothy Choy treats translation as one 'technology that makes knowledge move and come to matter as expertise' (2005:10). In the case above, situated knowledge and experience failed to be translated to a language that the transnational expert could take on. We may conclude that situated knowledge failed to articulate or to 'to mobilize and be mobilized in a collective' (Choy 2005:14). Following James Scott, we may conclude that the type of competence exemplified here through Peter's skilled vision fails be mobilised because its value is, by definition, locked in the particular. I suggest, however, that its failure to articulate was not due to localness as such, but rather to the fact that situated experiences of the complex relationships between weather, temperature, wind, seal visits and observable feeding behaviour in Tasmanian salmon pens were not yet configured in a way that would make them connect wider networks of knowledge. Instead, ‘skilled vision’ became, for the time being, locked in the particular. Through this process, the peripheral position of Tasmania in relation to global salmon farming was, in a sense, reproduced.

A sharp distinction is often made between local, situated knowledge and universalising knowledge. Tim Ingold (2000) distinguishes between what he calls the ‘cognitive scientist’ and the ‘skilled practitioner’[14], while Scott (1998) distinguishes science from ‘metis’. While such distinctions are relevant for Peter’s and Scott’s respective approaches to feeding salmon, I suggest that the difference is not as absolute as the analytical distinction might indicate (see Pálsson 1998 for a similar discussion). Their experiences are intertwined, and Scott’s persuasive style of lecturing does not prevent him from entering a balanced dialogue with salmon practitioners on other occasion. Nor should we interpret the case as an example of one ‘world-view’ potentially replacing another. The fact that Scott appeared to ‘win the argument’ at this meeting, does not indicate a total victory for a universalising approach to salmon. Resistance may be voiced in different ways, including silence.

Nevertheless, technological innovations in salmon farming in Tasmania and elsewhere indicate a general, gradual movement towards a more techno-scientific production regime, as exemplified above. Partly, this is because the marine farm environment is one in which the human-animal relation is configured through the use of standardised techno-scientific equipment, in which the assumed universality of salmon as biogenetic substance is already inscribed. As technological innovations are designed to be used anywhere in the world, they systematically configure the human-animal interface in ways that do not take variability into account. Local variation becomes the deviation, to which the procedures must adapt, shared and standard processes experiences become the norm. Through such processes, situated enskilment is also affected. As exemplified through the introduction of under water cameras, 'skilled vision' may then increasingly require the ability to interpret standardised representations of salmon behaviour (pellets pr. second) rather than paying attention to complexities of the situated environment, as well as the fish itself. A production regime in which the salmon 'talks' indirectly through such standardised translations is thus more likely to nurture an understanding of salmon as universal biogenetic substance, simply because local variability is systematically silenced.

Fixity and flow

A case like this one runs the danger of reifying the notion that people that tend to stay in place share a kind of knowledge which is fundamentally different from experts that move, thus reproducing a dualistic understanding of 'the global' and 'the local' as distinct spheres of knowledge (cf. Nustad 2003) . This is not my intention. Firstly, the sociological distribution of knowledge in salmon farming defies clear cut distinctions between local and global. While practical knowledge is shared within a marine farm unit, it is rarely shared with those that operate a unit for competing company nearby. However, it may be shared through personal, contingent transcontinental connections to Norway, Scotland or Chile, facilitated through the frequent movement of people in the industry. Secondly, Scott's 'locationless logic'[15] in relation to feeding practices should not be seen as absolutely external to, or discontinuous with practices and ideas held by farmhands like Peter. Peter's skills are also of a recent kind, and a product of transnational dissemination of technology, knowledge, research and personnel. Transnational expertise not only travels, it is also appropriated quickly by people who reflect upon their local experiences in the light of knowledge disseminating from ‘elsewhere’. Thirdly, the event demonstrates both the dynamics of standardising knowledge in salmon farming, and its limitations. Therefore, this event should be seen not primarily as a global/local interface, but rather as a small but significant event in the ongoing process that makes aquaculture a transnational production regime in which almost everything moves swiftly and with minimal friction. But what is it that does not move?

Studies of globalising processes often foreground mobility and flow at the expense of stabilising structures (Tsing 2000b). As a result, the inherent dialectics of fixity and flow in globalising processes are often ignored. Assuming that relations between mobility and immobility are mutually constituted (cf. Lien and Melhuus 2006), we may ask: what kinds of immobilities are implied in the ongoing mobility of salmon expertise? As we have seen, the dissemination of knowledge and technology in salmon farming rests upon the ontological configuration of farmed Atlantic salmon as a universal biogenetic species, replete with a standardised vocabulary of characteristics and with a standardised technology for being known and acted upon. Routinised use of the FCR in feeding may be seen as a means to this end. Problems that were attributed to features of the Tasmanian coastal or biogenetic environment were, as we have seen, not enrolled in a body of universalising expertise. We may conclude that locally contingent dimensions of salmon remained largely unarticulated, while its universal dimensions allowed expertise to travel. Thus, it is by downplaying the local variability of salmon, and highlighting its properties as ‘universal biogenetic substance’, that practically everything else in the industry becomes highly mobile.

The disembedding of knowledge from locally situated salmon farming operations, and the configuring of salmon as a universal, biogenetic artefact are processes of abstraction with important implications for the epistemology and the economy of aquaculture. Firstly, aquacultural research is a growing field of scientific expertise which both sustains, and is sustained by processes of abstraction such as the one described above. In a food production regime characterised by mobility and change, the notion of farmed salmon as an artefact with a predictable set of biogenetic properties thus represents a stable, scientific fact that does not, in itself, 'move'. Secondly, the world of business corporations searching for investments that will ensure a profitable return are reliant on translations that make their potential field of investment is legible, credible and broadly comparable to other fields or regions. Thus, the case illustrates the role of global capitalism as a powerful force of homogenization, but also the role of science in facilitating 'legibility' in local production. It is the alliance between scientific and economic interests that continuously pushes towards technological sophistication, and, in turn, for a standardisation of salmon as a global universal artefact.

An implication of this is that the local component of salmon farming gradually becomes less prominent, not because currents and water temperatures are no longer there, but because their impact becomes less legible to practitioners, and thus less significant in the day-to-day practices of growing and knowing salmon. . Thus, the ongoing process of techno-scientific innovation in aquaculture and its enrolment in transnational capitalist production regimes may, in fact, contribute in realising Scott's claim that *'a fish does what a fish does, it does not know it is living in Tasmania'*.

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Endnotes

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[1] Intensive aquaculture implies efficient market-driven systems and most often control of both reproduction and feed. Extensive aquaculture, in contrast, has been practiced for thousands of years and involves ponds or lagoons in which the rearing space provides the main source of food.

[2] The term salmon or salmonids is used in aquaculture to denote all species of the salmonid family, including most importantly Atlantic salmon (*Salmo Salar),* Coho *(Oncorhynchus Kistuch),* Rainbow trout (*Salmo Gairneri)* and Salmon trout *(Oncorhynchus Mykiss.)* (Bjørndal et.al. 1999).

[3] Two years later, major acquisitions had led to a significant restructuring of the Tasmanian industry, and reduced local Tasmanian ownership. The changes reflect a tendency of restructuring that have taken place in practically all other major salmon farming regions in recent years.

[4] To illustrate, a medium sized Tasmanian hatchery sourced its oxygen from Britain, the oxygen transmitter from Canada, a re-circulation filter from France, feed from Norway and Denmark, a grading machine from Italy, another grader from Germany, a high pressurizer from Scotland, an incubator from the US, an ozone generator from Brisbane, Australia, a feeding system from Finland, counting equipment from Iceland and oxygen diffusers from Canada, while the hatchery manager himself had recently arrived from Scotland.

[5] Salmon pellets are designed to meet the nutritional needs of a growing salmon and produced and distributed by multinational feed suppliers The impact of salmon farming on global marine resources is a highly contested issue in public debate, and a main objection to salmon farming from an environmentalist perspective (cf. Naylor et.al. 2000). In this article, I will leave these questions aside and focus instead on challenges in relation to feeding as they are experienced from within.

[6] Lave contrasts 'enskilment' with 'enculturation' which denotes a form of learning favoured by cognitive science. The latter relies upon a body of knowledge in the form of rules and schemata, a process of acquisition in which learning is separated from doing (Lave 1990:323).

[7] This causal relation is often mentioned by salmon farmers, but the evidence in scientific literature to support this is contested.

[8] A more automated feeding technology is also available, in which the role of the farm hand becomes one of surveillance, rather than actual decision making. This happens when he images that the cameras produce are transferred electronically to a computer that is programmed to produce a signal when the flow of pellets exceeds a certain predefined limit. This signal may then 'tell' the tube feeder to turn itself off. This set up is increasingly common in salmon farming world wide, but was not widely used in Tasmania.

[9] Innovations are also celebrated at international exhibitions and fairs. In August 2005, AKVAsmart, which is a leading supplier of automatic feeding systems was in August 2005 awarded an innovation price for its work on the software "Fish Talk", which 'helps the fish farmer organise a number of factors in the value chain, from egg to end product' (fishupdate.com). 'We make fish talk' has been the company slogan for years. Incidentally, AKVASMART started in Tasmania under the name Aquasmart, and later merged with a Norwegian company.

[10] By 'art' he referred to interpretations based on guesswork and anecdotes, the lack of analysis, and often the lack of reliable data. By 'science' he referred to a system for turning data into meaningful information, and rational management decisions based on objective analysis of such information.

[11] According to Statistics Norway (2002), the feed conversion ration in Norway in 2002 was 1,21.

[12] I do not argue that the use of FCR is not significant from an economical perspective. Yet in the Tasmanian context, where seal attacks are a major problem, installing measures to prevent Australian fur seals from breaking into the pens may in some cases be just as effective as a means to improve 'cost efficiency' as achieving a slightly lower FCR (cf. Schotte and Pemberton 1999). However, as Australian fur seal attacks remain a local problem, such solutions barely enter the transnational debate.

[13] The term 'salmo domesticus' is coined by zoologist Mart Gross (1998) in an article discussing distinction between farmed Atlantic salmon and Atlantic salmon in the wild.

[14] According to Ingold, for the cognitive scientist, 'every act has to be thought out in advance', 'attention *precedes* response'. The skilled practitioner, by contrast, 'is able continually to attune his movements to perturbations in the perceived environment without ever interrupting the flow of action, since that action is, in itself a process of attention' (Ingold 2000: 415).

[15] The term is further discussed by Penny Harvey (Harvey 2007 *fortcoming*).