Saws, sonar and submersibles: expectations of/for underwater logging

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Abstract:

Underwater logging is a relatively novel industry focused on extracting wood from standing trees in deep-water lakes and reservoirs. It emerges through a confluence of technological, financial and environmental interests, primarily within small corporations in British Columbia, Canada. Companies now operate in many countries worldwide and may be promoted by dam owners that are moving from a narrow focus on hydroelectric power revenue to exploring ways of extracting profit from these infrastructures. In this paper we use the example of underwater logging to explore the ways in which expectations for new industries create value for these companies. We show how uncertainty, materiality and control of the storyline become three formative factors in explaining why some expectations are realized while others fail. First, uncertainty can be made to be economically productive as long as it is bounded by methodologically reliable accounting. In the case of underwater logging, while unknown timber quantities could be economically damaging, rare, unknown wood is translated into a niche, high-end market that creates additional value. Second, materiality is at the heart of expectations in that companies need to show they have control over the raw materials and ecological consequences of the logging. Third, controlling the storyline becomes a vital part of marketing underwater wood. This produces a somewhat

cautious reaction to certification schemes and retailers. The performative nature of expectations thus needs to be considered in explorations of the production of capitalist natures and the consequences of these interventions.

Keywords: forestry, sustainability, expectations, underwater technology, British Columbia, finance

1. Introduction

Buried in the water of reservoirs around the world are thought to be about 300 million submerged trees worth as much as $50 billion (Crockford, 2008). These trees were left underwater during the construction of dam projects, particularly in the period from the 1950s through to the 1970s, because the value of timber was low, land clearance was often not completed, and the over-riding imperative was to generate electricity and water supplies. This vast underwater resource located in many different countries has now become an economic opportunity given the rising value of timber from mature trees, the imperatives to reduce land-based deforestation, new underwater technologies and a compelling discourse about rediscovered wood. New companies have emerged since the mid-1990s to harvest this resource and a mini-economic cluster has emerged in British Columbia, Canada. Establishing a new industry however took time and labour, especially since there were significant uncertainties regarding the value, quantity and condition of underwater wood.

Recovering wood from underwater is not new to this emerging industry. Salvage loggers have for many decades recovered lost logs from lakes, rivers and major waterways. In most cases, reliable information regarding the value of timber resources would not have been readily available and the extraction costs would have been prohibitively expensive except for

small-scale log recovery work. Salvage logging enterprises were particularly focused on logs lost during transportation (Bryan, 1969; Cayford, 1960; 1973) and, in general, these were already cut trees and were mostly located in areas where there had been significant use of water-transportation by logging companies. Small entrepreneurial loggers dominated salvage logging and while technological improvements relating to sonar and sawing equipment became available, the challenges of efficiently cutting trees underwater were considerable. Many people died. It was an industry dominated by a culture of individual heroism (Hurst, 2005) and sometimes scant regard for timber recovery licenses.

The value of recovered underwater timber was also variable depending on species and condition. An early example of a full-lake inventory was conducted by forest researchers in Laos on the dammed section of the river Nam Ngum in the late 1980s and contained an assessment of the wood properties and usage of various species (Polacek, 1988; Wolter, 1996). The working supposition in these studies was that submerged timber would be marketable given that in Europe and North America, the forestry industry had stored logs underwater between logging and sawmilling to reduce problems of fungal and other damage (Bjorkman, 1948 for a Swedish example; Osborne et al., 1956, in the U.S.; Forestry Commission, 1996 in the UK; Malan, 2004, in South Africa). These were primarily focused on temperate species, but nonetheless proved the potential value and use of wood that had been stored underwater for a considerable period of time. This was however primarily cut wood and not based in tropical environments, two important facets for the later discussion.

Proponents of underwater logging distinguish their industry from salvage logging, in terms of it being based on leading technology that can recover standing trees at considerable lake depths, safe, and with a regard for environmental, economic and social objectives. Lake owners, whether private or government, often encourage logging operations as they seek to create value out of this lost resource and meet other objectives such as safer passenger

transportation on lakes. The underwater logging industry thus represents a new innovation in forestry that has consequences for communities around the world and that highlights the emergence of the exploitation of new resources to meet niche and environmentally-friendly requirements in wood markets.

From a consumer perspective, underwater wood can be found in standard wood markets where it is relatively undifferentiated from other wood sources, but at the higher value end of the market it can be used to grow niche markets in instruments or quality flooring. It can be appealing through both a discursive value attributed to the story of how the wood was lost and rediscovered, and a material value that derives from, for some, better visual and acoustic quality of the wood. Underwater wood can thus be a distinctive product particularly if it happens to have come from a rare, mature tree that, if it were on land, would no longer be permitted for felling. This highlights the importance of stories about this wood in creating and managing the value of the market, an important component we argue in enabling the industry to create and meet financial expectations.

In this paper, we aim to demonstrate that the ability of capitalism to remake value from productive capacity (in this case, that of the dam) is driven as much by stories as it is by a purely rational economic logic. We draw on our personal encounters with key actors in the sector whose stories illustrate the different forms in which expectations for and of the industry are established and stabilized. Without the stories, underwater logging is simply another forestry operation like any other; rediscovered wood aids marketability that adds value to this commodity in a crowded marketplace. Consideration of the performativity of expectations thus needs to be at the heart of understanding why some capitalist natures are enacted while others are not. To illustrate this argument we first provide a literature review that explores the argument that underwater logging reflects a capitalist requirement of value-creation, before moving on to examine debates in economic geography and sociology that

have considered the role of expectations and discourses in shaping economic activity. We argue that there are three types of expectations that are important in underwater logging: first an economic expectation that is about the potential value of underwater wood; second how expectations need to be materialized through proving the usability and ecological suitability of the operations; and third how expectations are maintained through retaining control of the story-line. We conclude by suggesting that expectations are temporally and spatially specific, tying histories and futures together in diverse ways, that add to our knowledge of how innovations are enacted within resource-intensive industries.

2. Expectations and the forestry industry

Planning for the future is central to the forestry industry with a production model that is based on planting trees in the present to generate a profitable yield in future decades. Plantation forests are organized around the economic logics of the forestry industry: investing money in ensuring that the best varieties are chosen, sufficient care is given to maximizing growth rates and there are efficient logging and marketing operation at the end of the cycle. Improving, intensifying, and accelerating the production cycle of trees as 'organic machines' (Prudham, 2005: 113) is central to enhancing financial expectations in the industry. Prudham (2005), further, demonstrates the importance of biotechnological interventions that enhance the commercial availability and profitability of timber. Yet as the critical literatures on sustainable yield forestry has demonstrated (e.g. Demeritt, 2001; Prudham, 2005; 2007), trees are not infinitely malleable to capitalist imperatives with sustained yield sometimes failing on ecological and, later, economic grounds. Expectations are thus at the heart of the forestry industry as efficient trees are imagined, researched, trialled and, eventually, enacted.

The forestry industry highlights the importance of the time-spaces of capitalism as capital is tied up for decades in living organisms in anticipation of delivering future economic value. More broadly, Castree (2009) has argued that capitalism seeks out investment opportunities in infrastructure when surplus money is available, but that they often fail to deliver a satisfactory rate of return leading to a remaking of that capital in a different form. As he puts it: "Great splurges of fixed capital investment come back to haunt capitalism 25-35 years later." (Castree, 2009: 51). Dam projects are an example of infrastructure that haunts capitalism, because they are often constructed in an era of capital availability (this was particularly the case from the 1950s into the 1970s) as a means to generate new forms of cheap electricity and sometimes ensure water availability. These projects had significant environmental and social consequences with displaced communities and with much of the in-situ vegetation left standing when the land was flooded.

One such example of a large dam is the Nechako reservoir in northern British Columbia constructed in 1952. After removing First Nations people from their land, a private company reversed the flow of one of the rivers and created a new tunnel for the river. Mistakes in calculation, however, led to a large vertical drop for the river from the tunnel. The river was a perfect opportunity for a hydroelectric power plant so they built a dam and installed power lines across the coastal mountains to power a new aluminium smelter on the coast. Given that bauxite is not produced locally, the smelter also needed raw materials shipped in from across the Pacific Ocean. The dam itself resulted in a new lake within which were an estimated 15 million trees and several floating islands. At the time, the value of the timber for these trees was very low and they were simply abandoned in the desire to extract economic value from the water in the form of energy. The initial capital investment, however, proved to be rather less attractive over time not least because the primary justification for it,

namely powering the smelter, became less economically appealing. The capital investment began to look haunted to borrow Castree's (2009) descriptor.

In the 1980s and especially the 1990s, things began to change and a new investment cycle was started to accrue economic value from the dam. This was driven by a change in the economic value of timber, which soared largely owing to increased timber prices in the USA (Buongiorno, Chavas and Uusivuori 1988). The USA is the most significant market for Canadian timber, accounting for four fifths of all Canada's forest products (Canadian Forest Service, 1999). With increased prices and environmental concerns about deforestation, 15 million forgotten trees underwater represented a significant economic resource that was not apparently subject to environmental restrictions and concerns, and the reservoir owners, Alcan, pushed for the re-capturing of this lost value in the lake. This established a new productive circuit within the same infrastructure (the dam) to turn the environmental consequences of the initial capital investment into opportunities for new investment. This can be described as the remaking of productive capability in the same place, yet in an expansionary way (Castree, 2009). Capitalism finds new ways of making infrastructure re-saleable in investment terms by profiting from the environmental consequences of the earlier production stage. This is not dissimilar to arguments about carbon markets as new investment opportunities for dealing with the pollution of former investments (Bachram, 2004), though unlike carbon markets, underwater logging is spatially fixed by the material presence of particular kinds of trees in particular lakes.

An economic argument about investment, however, fails to explain how and why underwater logging occurs in some places and not others, and why it is a relatively small group of entrepreneurs that dominate this market. Here, we argue, it is at least as much the stories, the romance, the allure of the industry that is as important as structural forms of capital flow in explaining the development of underwater logging. There are two primary sets

of literature we draw upon to illustrate the importance of storytelling as part of the aspiration to create new investment opportunities from previous sunk capital. The first are the literatures in economic geography on the power of discourses in shaping flows of capital and the second are literatures in the sociology of expectations that highlight how future prospects are made actionable in the present.

In exploring the power of stories in shaping capitalist enterprise, it is instructive to turn to Thrift's (2001) paper on the power of attachment in establishing some enterprises as worthy of continued investment rather than others. Thrift argues that the 'new economy' that had been built around the Information Technology bubble was created by investors and stakeholders that became reality through the changes in management practice that were precisely aimed at performing a new economy. In other words it is a new market culture, a romance, that comes to produce the new financial circuits to these new economy businesses rather than the other way around (Thrift, 2001). These are circulating references that are materialized in practices. To draw upon a different example, de Goede's (2012) work traces the way in which certain forms of finance or type of account owners become labelled as suspected of terrorism. An initial suspicion is translated through risk management techniques as a certainty of suspicion that performs a distinction between acceptable financial transaction and one that might be for the purposes of supporting terrorism. By pre-emptively engaging in stopping suspicious flows, the category of terrorist finance is produced as the consequence of the apparatus of techniques and suspicions with material effects on account owners, charities and financial organizations (de Goede, 2012).

The argument that discourses generate material effects has been explored in the context of environmental sustainability too. Bridge and McManus (2000) for example showed how sustainable development rhetoric was taken up in the forestry and mining sectors enabled companies to present themselves as legitimate, environmentally-aware actors

that obscured the political and ecological implications of their activities. Discourses, thus, come to highlight some practices and obscure others with consequences for both the business and the environment. It can become what Luke (2005) calls a system of 'sustainable degradation.' Hammond (1991) likewise describes 'forestry management' as the pursuit of a set of regulations and interventions that have precisely enabled logging to continue. Discourses about sustainability thus are questioned as to whether they really enhance the triple bottom-line nature of organizations.

Equally useful for our analysis is the literature on the sociology of expectations. As Pollock and Williams' (2010: 527) summary of the sociology of expectations literature points out: "Promises are seen to be 'fundamentally generative' in the production of artefacts and knowledge." The expectations literature points to the constitutive nature of claims about the future in that they are frequently performative, enacting the reality they purport to merely describe. Brown and Michael (2003) discuss two processes in the creation of expectations: Retrospecting Prospects and Prospecting Retrospects. The former accounts for the way futures have previously been presented, while the latter explore the ways in which these prospects are enacted as futures in the present. Tracing this through cycles of innovation, Brown and Michael (2003) illustrate the context-specific nature of expectations built within networks of associations and patterns of uncertainty that have important repercussions for how some expectations become performative and stabilized, while others are exposed as hype or fail to achieve targets. Over time, a particular innovation can move between these outcomes. For example many biomedical innovations are stabilized for a while before being revealed as insufficiently profitable, as Mirowski's (2010) analysis of university start-up companies has illustrated. Expectations may also enact futures in ways that lock in particular kinds of models, networks, activities, and ideas. MacKenzie's (2003) work on financial markets is a good example of this, where models, formulae and technologies coalesce to

generate the modelled financial market. The Black-Scholes-Merton pricing formula enables a particular kind of financial activity in the marketplace that then confirms the validity of the formula. Subsequently, however, the formula remains as a symbol of reliability and trust in financial actors despite the fact that it no longer matches the nature of trading in the market (MacKenzie, 2003). A certain expectation was established, performed, but remained in place despite a seeming breach in its ability to explain the empirical data. Over time, then, expectations morph into new forms, but may or may not decline even if they are revealed as hype or misaligned with reality. There is thus a temporal component to expectation.

The spaces of expectation are equally important, though much less well examined, and Milne's (2012) work has been most useful in beginning to construct a geographical approach to expectations. Milne (2012) calls attention to the place-situatedness of biopharming, in which places shape and are shaped through these future imaginaries. Milne suggests there are three geographies of expectation present in bio-pharming: geographies of hope, concern and control. Hope is displayed in the ideal of translation of laboratory work to a broader medical intervention. Concern, on the other hand, points to the risky geographies as field trials lead to local resistance or new diseases create issues of containment. These inspire needs for geographies of control, that is that new biopharmaceutical futures emerge in controlled spaces (Milne, 2012). Promise, therefore, is geographical in that purveyors of expectations must both manage current spaces and discourses, but also act to create new future geographies to manage and enhance those expectations. Along the way places are described, imagined and transformed (Milne, 2012).

Returning to Castree (2009), important research questions arise about how the time-spaces of capitalist enterprise mesh with these geographies and temporalities of expectations. How are expectations produced within the context of capital availability at particular times in particular places? Is there a higher propensity to hype when capital is readily available and

what impact does this have on the performativity of particular expectations at particular times? How are past capitalist legacies (the retrospecting of prospects) tied into these future aspirations and how do the discourses about the future become financially actionable in the present? Economic expectations have come to shape the forestry industry, whether through enhancing yield rates, a material engagement to produce future value quicker (Prudham, 2005), or developing and then enacting the idea of an environmentally-friendly consumer desiring environmentally-friendly wood (Kortelainen, 2008). While this paper cannot offer answers to all of the questions posed, it suggests that expectations not only stabilize discourses about the future and profitability, but also must manage material constraints and opportunities deriving from the past and present relations of capitalist enterprise.

3. The Underwater Logging Industry

Underwater logging emerges through a set of contingent, interconnected processes that emerge from the construction of dams and reservoirs through the 1950s and 1960s in particular when trees were often left *in situ* when the area flooded. Industry experts estimate that there may be as many as 300 million trees submerged in reservoirs across the world (Crockford, 2008, based on an industry report from 2004). This represents big business considering that many of these dams resulted in prime forest cover being flooded; forests that would often be strictly regulated for loggers if they remained on dry land. While dam construction continues, especially as countries in South East Asia expand hydroelectric power facilities, the amount of flooded forest continues to grow, but it is increasingly likely that, unless pressed for time, a company will remove the trees prior to flooding.

There are diverse types of economic operations involved in recovering wood from lakes and rivers. Handloggers traditionally operated as individual operations where trees

would be cut down on steep slides near a valley and tipped into the water to make the recovery process easier in taking wood to the marketplace (Jackson, 1974). Salvage logging is generally conducted by small organizations or individuals and is focused on recovery of already cut trees and logs that have fallen from boats or have been otherwise abandoned. Sometimes divers use saws to cut standing trees underwater, but it is often difficult to do this by hand and it can be a slow, risky process. An early example of this type of activity occurred in Lake Tucurui in Brazil where the reservoir owners contracted with a local organization in 1989 (although unofficially an operation had been running since 1987) to remove the trees (Brooke, 1990). Underwater loggers define their industry as distinctive based on the fact they have the technology to cut the trees underwater. While salvage logging is performed on the banks of lakes throughout North America and in other places around the world, underwater loggers have been concentrated in British Columbia. This clustering can only be explained by a set of contingent factors, not least the close proximity of a Canadian naval technological industry through which submersibles could be sourced, a long history of unusual forestry operations to recover wood, the pressure to explore non-traditional sources for mature timber, and finally a network of people that have an attachment for the region.

Since the initial projects in the mid-1990s these Canadian companies have sought partnerships and opportunities in countries around the world including Ghana and Panama, although they have developed no major operations in other Canadian states (although salvage loggers operate in Ottawa) or in the United States (where legislation in some states prevents reclamation of lost wood). This appears to be driven by the greater economic value presented by tropical lakes and the opportunities for the industry to engage in triple bottom-line projects that achieve sustainable development objectives. Clark Sustainable Resources Development (CSRD) for example, while headquartered in British Columbia had its primary focus on Lake

Volta in Ghana. The company's staff have personal and political ties that enable direct working relationships with people in Ghana.

There are variations amongst underwater logging companies, with some focused primarily on technological development while others look to manage resources, with some engaging in operating underwater logging contracts on behalf of other corporations or governments while others stake control of the whole process from resource to harvesting to sales. Probably the most contentious aspect of this is the ownership of the resource. In the case of the Nechako reservoir in Canada, the project was effectively co-managed with the reservoir owning company, the underwater loggers, the British Columbian government and the First Nations community working together. In many of the tropical countries, particularly in the early stages, it has been a bit more 'wild west' (as one company director described it) with some companies owning resources and others operating contracts. Some companies wish to distinguish themselves from a legacy of Canadian 'gold-stakers' in resource industries, while others see the ultimate value of the company as being the ownership of the logging concessions. The industry is thus diverse in approach, but regardless of the specific ownership of wood, there is a consistency in discourses of economic, social and environmentally sustainable practices with all companies claiming they strive to achieve these goals as part of their operations.

The research for this paper was conducted during the period of 2008-2009, updated to include industry changes in 2010. It involved extensive secondary data research (newspapers, industry documents, proposals, research reports etc), including research in the Canadian Ministry of Forests Library in Victoria B.C. and the Imperial Forestry Institute Library, University of Oxford. This was supplemented with nine interviews with individuals involved in the industry, including the primary industry participants based and interviewed in various locations around Vancouver Island, B.C. Key informants were located through Internet

research and semi-structured interviews were conducted to seek more detailed accounts of stories that were revealed in the secondary research. The research was therefore focused on the individuals and companies leading the industry rather than exploring the individual social and environmental aspects of particular projects. The quotations from the interviewees have not been tidied up grammatically and the participants are referred to in generic terms rather than their formal or company title that would often give away their identity in such a small industry.

4. Underwater logging expectations

The marketability of underwater wood is central to the creation, maintenance and fulfilment of expectations of the future value of the industry. In this discussion, we pursue three angles through which to discuss the power of expectations in shaping the financial flows to the underwater logging industry. We argue that there are three kinds of discourse at work in the industry. First, we explore the financial expectations for the industry suggesting that these emerge through a combination of being of known marketable value, but also a product of unknown values. Second, we suggest that expectations for underwater logging, inasmuch as the unknown becomes generative of action, requires the management of the materiality of the activities whether through asserting the manageable biological properties of underwater wood or the impacts of logging on lake environments. This stabilizes discourses against risks of hype or critique by proving the material deliverable of underwater logging as an investment product. Third, we examine the way expectations are maintained through control of the storyline such that the industry remains in charge of marketing the wood rather than losing the power of the storyline in mass marketing the product. Distinguishing these

expectations points to the importance of specifying the types of discourses and practices that come to enable some expectations and disable others.

4.1. Creating unknown value: "Unknown wood is just an opportunity" [1]

Of prime importance in developing a new industry and creating a new market is attracting financial capital investment. This might be considered to be primarily a case of generating an expectation of financial return. In the less technology developed salvage-logging field, the majority of operations are small family firms with relatively few scalable business opportunities. Hurst (2005), for example, details the accounts of individual loggers struggling with trotlines[2], gloomy water and mud to recover cypress logs in southern Georgia. Significant risks attend the recovery of underwater logs especially given that the profit margins may be relatively small, but the story of the recovery of lost wood is enrolled as a discourse that invests the operation with the promise of financial profit. As Jeffrey Schwartz, at the time Chief Financial Officer of a salvage logging company suggested, "This (company) has been a half a breath away from death many times, but it was such a great and romantic idea that no one wanted it to fail." (Cited in Smith, 2000). The discourse of rediscovered wood is as central to investment as any specific profit ratio of capital; stories come to shape the flows of capital (Thrift, 2001). Clearly there are limitations to this generosity given that underwater and salvage logging companies have failed, but these great, romantic discourses are central to the ability to attract capital investment. They need, however, to be allied to an empirical grounding i.e. while the story attracts initial interest, full project finance depends on an analysis of costs and profits, whether the value of timber in a lake outweighs the costs of recovery.

[1] Quotation from an interview with an underwater logging company director.
[2] Trotlines are fishing lines with hooks often set across the width of a river channel. They are sometimes illegally set and not always monitored, so in murky environments can easily entangle humans as well as fish.

This is particularly the case for underwater logging given the expensive equipment required for timber recovery and the questions about the preservation and quality of the wood. Companies seek to create expectations of future timber volumes and profits to enable capitalization of their proposals. Early projects in British Columbia however suggested that the financial success of projects was by no means guaranteed. In a report produced by Bluewater Marine Services Ltd. for logging operations in Kinbasket Lake, their financial analysis suggested that the merchantable timber quantity in the first year of operations would generate an average of $50.60 per cubic meter, compared to the cost of the operation of $87.15 per cubic meter (Bluewater Marine Services Ltd., 1997). While enhanced logging efficiency such as that provided by the patented Sawfish technology developed by Triton would bring down the cost of operations, many companies explored alternative locations where the value of timber could be much higher. This has irresistibly drawn companies towards lakes in tropical regions such as in Brazil, Ghana, Malaysia, Panama and Thailand. Here the story of recovering lost wood is allied to a story of the exotic tropical timber in producing value.

One of the interesting rumours in the case of Lake Volta, Ghana, was the expectation created by some within the industry (although interestingly not directly by the company involved in the project) that rare and valuable timber had been discovered. References to extinct teak found in Lake Volta circulated through the industry, although forestry surveys suggest that if there is any teak in the lake, at most this would be young trees in plantations that had *introduced* teak to Ghana. Another possible source of the rare timber story may be the presence of the species *Talbotiella gentii* that has particular conservation interest (see Swaine and Hall, 1981) or mahogany (*Swietenia macrophylla*). What matters is that rarity or exoticness comes to symbolize economic opportunity in a market where some tropical timbers are already highly valued and sought after. Expectations for underwater logging are

thus enhanced by the whispers amongst the prospectors; indeed formal denial of a story would only serve to heighten suspicion that something special has been found. This is where expectations can quickly turn into hype. Inasmuch as hype can be constitutive, enabling action in the present by rapidly generating large amounts of capital investment, it can quickly turn to disappointment when that economic value is not realized (Brown, 2003). Given that it can take 20-30 years to clear a large lake, the possibility of the presence of a rare timber will not be extinguished in the early years of an operation.

Does this mean that *any* expectation can be constructed and capitalized? Brown and Michael (2002) suggest that scientists have increasingly moved from an idea of authority to one of transparency in their dealings with the public, replacing a culture of trust in science with an open display of the workings involved in scientific enquiry. Similarly underwater logging companies requisition scientific reports to provide independent estimates of timber volumes in particular lakes. In other words expectations must be transparent and cannot be completely detached from the materiality of scientific reports, datasets and archives. Pure hype will be exposed as such. At the same time, surveys of possible underwater lake resources have both the qualities of being fixed, quantitative estimates and open to divergent interpretations. The uncertainties are significant and while this may be thought to disable investment, it is equally productive of enhancing expectations. The extinct teak case is a good example of hype that has been spun out of a report which indicates a very small possibility, but a possibility nonetheless of certain species being present in the region. Rather than establishing accuracy then, reports establish credibility and a reliable (i.e. independent) approach to constructing estimates. What are the major challenges for reports of timber volumes in lakes? This can be broken into two types: firstly the quantity of timber available and secondly the species present.

The quantity of timber available to extract is vitally important to the financial sustainability of the underwater logging company. Some salvage logging operations use digital side-scanning sonar equipment to reveal where logs are in the lake, but this only reveals possible harvestable logs and without a time-consuming large scale survey it provides only limited spatial estimates. Underwater logging companies have in some cases chosen to produce rough estimates and/or hire researchers to produce more statistically precise estimates of the lake timber volume extracted from archival sources. This was central, for example, in constructing a business case for the project in Ghana, but this is not a straightforward process. As a forestry expert told us, the historical surveys have weaknesses in identification of vegetation type, especially when it comes to boundary areas (e.g. between savannah and dense savannah), problems relating to the trustworthiness of observers including isolated pockets of trees, and subjective interpretations of landscapes. Ecosystem classifications are political because they also act to re-make those landscapes (Helford, 1999) and here classification becomes critical to estimating species numbers as photographic patterns are digitized into maps of ecosystem types. Photographs such as those reproduced in Figure 1 thus act as representative indicators for particular areas, but they suffer from the fact that foresters often took them to record an interesting species rather than a panoramic vista. Other historical records can be derived from statistical surveys of trees. Surveys from the air enabled overall stock and ecosystem types to be established, but they failed to differentiate species as clearly (Adey, 2010). Other land-based surveys, for example, one published in Douglas (1948) highlights that much of the Afram Plains, now submerged in Lake Volta, was covered with savannah vegetation rather than closed forest, suggesting that timber volumes may not be especially high. There could, however, have been clusters of closed forest and various forms of woodland and Guinea savannah. This is likely to be the predominant land cover type in the area of Lake Volta according to maps of ecosystem types (Oppong-Anane,

2001). Logging companies also make estimates based on biological grounds such as the likelihood that trees near former riverbeds, for example, would be larger as they would have had a higher nutrient quality.

Secondly, the species mix is also important to financial expectations. Agreements with governments mean that many underwater logging operations have other social goals to achieve in the removal of trees, for example improved safety for boat transportation, so all trees will be removed and thus the species mix of trees is often declared to be unimportant. Company directors would frequently state that they will sell whatever timber they discover "whether it's incredibly rare and incredibly expensive, or whether it's fairly common, our goal is to price at the market price." (Underwater Logging Company Director). This quotation, however, hints at the potential range of values in particular the *incredibly* expensive, rare timbers. It would therefore be somewhat naive to think that species mix is totally unimportant to these companies. It appears that by finding a use for all timbers and basing economic models on the use of all kinds of timbers, companies are trying to play down the risks of hype. The species mix in a lake, which is not made visible through sonar equipment, but can be revealed to a limited extent by the historical resources, has the power to shape the expected financial value of a lake.

The statistical interpolations derived from these raw data, necessary to predict broader patterns where there is no direct empirical data (which may be a large percentage of the area), add another layer of uncertainty. Expectations for attracting capital investors to the company must be built on verifiable evidence rather than completely fabricated guesses. The report on Lake Volta in Ghana is not designed to be a factual representation of timber volume as such, but rather a methodologically valid one; it helps constitute the market to engage the investor as MacKenzie's (2009) work noted in a different context. Accuracy is not invoked, because there is no empirically verifiable way of testing that. The focus is on reliability incorporating

both the reliability of the estimates based on historical surveys and the reliability of the statistical processes to calculate the timber volume. This reliability and, in some cases, the presence of an independent scientific assessment provides the investor with rational reasons for investment. This expectation is what enables the company to begin harvesting. The archival data reports thus become generative. Without a strong expectation of return, the company would find investment difficult, and the lake would in all probability remain unharvested. The expectations, assuming the reliability quotient given by the statistical analyses of historical resources, can only later be contested during the timber extraction stage, a process that may take decades to complete for large lakes. In other words, there are limits to realizable expectations.

4.2. Stabilizing unknown materials

Creating financial expectations of underwater logging depends on the archives and the story to aid capitalization, but it also relies on the malleable materialities of wood. Wood that has been underwater for a considerable period of time may decay or may have different biological properties that can diminish or enhance the quality of the material. Likewise underwater logging companies have to confront the materiality of lakes and lake ecologies that may be transformed during operations to recover the trees. Expectations are challenged by the material properties of objects and these objects must thus be stabilized as part of the expectation to ensure the continuation of interest in the investment.

Essentially softwoods that have been underwater for a considerable period of time may have rotted, but most hardwoods survive extensive periods of inundation in water or equally under snow cover. One complication for the underwater logging industry has been questions about whether tropical lakes are more likely to have enabled the decomposition of

trees than temperate lakes. Current logging practices suggest that if treated properly, tropical wood survives equally as well as temperate wood. Regardless of geographical provenance, the wood, however, is not quite the same. It requires extensive drying to be able to be fashioned into wood products and in this drying process it becomes a little softer. Underwater logging experts also suggest that the wood has slightly different biological properties as a result of inundation. While this matters rather little for wood that is to be used in flooring or shelving for example, one of the mysterious facets of underwater wood is its claimed acoustic quality that results from biological processes, essentially the hollowing out of cells in the wood, taking place while the tree is still in the water (Kaiser, 1997). This has led salvage and underwater logging companies to direct a sales pitch towards the market for musical instruments. The story of the wood's production combined with the 'lush sound' generated by the wood when used in guitars provides a niche music market that provides another marketing opportunity for the industry (Micheletti, 2009). For example, some news stories have suggested that these guitars are prized by musicians such as Johnny Cash (Freeze, 2001). The pull of unknown or rare wood must be combined with biophysical attributes to enable the financial expectation to be realized in the logging activities. In other words, expectations are tested and must meet potential challenges arising from incompliant materials.

Even if the properties of the wood seem to be established, the material effect of logging on lake environments represents another potential challenge to the expectations of the underwater logging industry. This has been dealt with in two primary ways: using technology and ecological studies to minimize impact and through comparisons to the impacts of terrestrial forestry. Tenanbaum (2004) argues for the advantages that the Sawfish™ technology pioneered by Triton Logging Inc. has had for reducing environmental impact. By sawing the trees underwater and then floating them to the surface using airbags, the

technology avoids destabilizing lake beds with any kind of root disturbance that would increase sedimentation levels. Other companies, however, seek to use technologies that pull out trees by the roots, such that the root stock can afterwards be replaced into the lake to create habitat, an initially highly disturbing intervention but one that offers a longer-term benefit. The most ecologically friendly of the different strategies to minimize the effects of logging is not an immediately resolvable question through ecological science, because of the very limited studies to date and difficulties ascertaining what these lake environments *should* look like (e.g. some of the few studies include Brooks, 2000, Winsby et al. 1997 and some studies of salvage logging and the effects of logs in lake ecosystems e.g. Moring et al., 1986; Newson and Bearley, 2000; Northcote and Atagi, 1997; Noss and Lindenmayer, 2006; Sedell et al., 1988; Smokorowski et al., 1999). Are these trees 'matter out of place' (Douglas, 2002) and/or crucial parts of the ecosystems? Companies want to be actively engaged in these studies because visible environmental impacts would risk the industry's sustainability discourse and claims forethical practice. As such, one underwater logging company is establishing its own data monitoring network to explore the effects of its activities, a feat made necessary by the seeming unwillingness of lake ecologists to become overly interested in 'artificial' environments. This points to the experimental nature of the logging activities, testing and re-testing, figuring out what might be important ecological impacts or not, what might be the best technological strategies for reducing impact, what kinds of objects might be used to replace habitat, and so on. Experimental ecology in action (Gross, 2010), but one that might be based largely on the industry's own datasets with potential risks for the independence of studies built on a private set of tools and practices (as e.g. Lave et al., 2010 demonstrate).

Underwater logging companies, perhaps because of all the uncertainties about ecological impacts and how to minimize them, promote a discourse of sustainability in terms

of the comparison between underwater and terrestrial forestry. As one company director put it:

> "Does the idea of underwater logging sound appealing? Yes. And do environmental groups or agencies that provide certification around these issues do they, can you capture their attention with the idea that you're going to harvest er you know 300 hundred million trees that aren't alive and use that fibre to potentially displace wood in the supply chain that came from trees that are alive, do you have people's attention? Yes."

To state the argument simply: no living trees are cut down in the process, so every tree recovered from underwater resources saves one on land. This has concomitant benefits for reducing carbon emissions through reduced deforestation (that potentially opens up the carbon credit market for underwater forests) and protecting biodiversity in terrestrial ecosystems. The comparative claim thus turns underwater logging into one of the most environmentally friendly forms of industrial forestry. It is through the stabilization of this discourse that the materiality of forests can be contained and, though there have been a number of minor ruptures arising from some environmentalist resistance to the industry, these have rarely troubled the expectations of the underwater logging companies. By translating the issue of environmental sustainability into one of 'avoided deforestation', a global environmental narrative, other ecological stories have received much less attention. Expectations must translate material impacts in ways that make them amenable to the primary storyline to successfully support the value of the new product.

4.3 Retaining the storyline

Finally, the third crucial aspect of expectations in underwater logging is in retaining control of the storyline particularly for marketing purposes. To maximize the value of diverse, rare timbers and material properties of the wood within the industry, then the storyline being sold must be maintained and protected from external co-optation. To maintain the expectations generated by some organizations, other organizations and stories must be excluded. In biomedical terms this would be constituted by a debate over intellectual property rights and material transfer agreements; keeping control of the ownership of the thing from which expectations are derived. Here, maintaining expectations is about managing the storyline, retaining control of the discourse by telling a particular kind of tale that might otherwise be co-opted by, in particular, certification providers and mass-market retailers. We can identify three ways in which the storylines are controlled: first through the story of rarity and the exotic, second through the story of history, and third maintaining control of the story in light of the attempts to receive certification of the wood.

It is the unknown or rare nature of the wood that is central to its marketing value so maintaining this rarity is important for establishing expectations of economic value. The importance of the storyline can be seen in the following quotation from an underwater logging company director:

> "There are some trees that are extinct, some are very rare, and others are just unknown... Researchers in the tropical forestry service that I know have a hard enough time identifying a live tree let alone one that's missing its branches. And so our approach again: It doesn't matter to us. If it's sound and solid wood there'll be a use for it and we'll find a use and we'll make revenue regardless of what it is."

If as we suggested earlier it is the story that comes to shape the economic value of underwater logging, then retaining control of the story is of the utmost importance. Here we explore how the management of stories is central both to the marketing of the wood and the ways in which underwater logging companies engage with other corporate partners including certification agencies. Economic expectations are to be controllably realized within the industry rather than enabling others to profit from the value of the discourses. Marketability is in the fact that most Western consumers will not previously have encountered most of the Ghanaian species of wood.

Even with wood from local reservoirs, there can be a sense of recovering a lost wood that might be more distinctive than a common plantation species. This all creates an expectation that a discerning wealthy purchaser will recognize the value of having a rare, lost timber on their apartment floor. Even if the wood is not that rare a species, it is the distinction that is given by this wood's aesthetic quality or the story of connection to the past that underwater logging provides, that affords consumers a superiority in interior design. As Bob Fields (cited in Wadler, 2005), a homeowner in Massachusetts put it in relation to the salvaged birch on the floor of his master bedroom

> "When the sunlight comes in, the floor is like a museum piece... Because these logs were soaking underwater for 200 or 300 years, they were soaking up the coloration of the clay bed... I go to some friends' houses -- $800,000, a million, a million three – they've got floors that come out of some liquidator or Home Depot... These manufactured, sterile, nude, oven-baked floors. Who wants to eat vanilla ice cream every day?"

It is the distinction that the product provides that makes for a unique product enabling an important marketing opportunity for companies selling the wood to consumers. In some cases, the wood is marketed as reacquainting people with their past histories. Salvage loggers in states like Wisconsin and Ottawa have traced the histories of particular logs to package this as part of the marketing of wood products and educate consumers about the commodity process of logging. Invariably this storyline draws some connections and obscures others. The wood, rather than being seen as the forgotten impacts of industrial attitudes to the environment, absorbs a romanticized conception of the past translating that past into an imagined era of natural wonder and exploration now rediscovered. Underwater forests, inasmuch as they represent the environmental consequence of significant capitalist outlays on dam projects, become re-cycled as new investment opportunities for companies and consumers with an environmental conscience. The time-spaces of capitalism are complemented and challenged by changing ethical conceptions too.

The storyline of rare, re-discovered wood becomes a key marketing point perhaps more than any specific sustainability claims, and thus it is vital for the industry to maintain expectations through managing and controlling the storylines about the industry. This is most visible in the context of forestry certification, but is also demonstrated in the rejection of corporate partners that might wish to offer a different storyline about their products. Underwater logging companies sought certification (for example through SmartWood) to both prove sustainability to the marketplace and to enable the wood to be sold to major wood consumers that increasingly demand certificates of the type of production. As Morris and Dunne (2004) have noted, lack of certification essentially restricts market access to large ‘green’ corporate consumers in ways that economically imperil forestry operations, essentially driving business towards certification providers.

In underwater logging, likewise, certification did not appear to be a financial motivator in terms of adding value, indeed company directors stressed that "we've never based the business plan on premiums, higher margins, because of environmental certification" (Underwater Logging Company Director). It is rather considered as a necessary requirement to enable entry to global wood markets. As Klooster (2005; 2006; 2010) points out, the Forestry Stewardship Council has been successful in its certification scheme at tying together retail pressure for sustainable practices and improved social and environmental performance from producers. The forestry NGOs come to perform a leading role in standardizing certification practices that forces participants in the market to adopt their branded certificate as a means of market access. This is supported through technical work in verification and monitoring (Eden, 2009), but it is not just about formal economic and political intervention. The imagined green consumer comes to perform a significant role in formulating these new green forestry markets too (Kortelainen, 2008).

For underwater loggers, then, there is a risk that the certification label is heralded first and foremost above the imagined consumer value of the story of underwater wood that is vital to enhancing the industry's visibility and reputation. While underwater wood is sold in diverse markets not all of which matter in terms of the discerning of underwater from terrestrial wood, the imagined consumer is nonetheless someone who can buy in to the storyline of a rediscovered resource. This is why other corporate clients for underwater wood have been rejected. Several interviewees noted the discussion between IKEA and the underwater logging specialists Triton as a defining moment when underwater logging came of age in being able to attract a purchaser that demands sustainability, yet is turned down because the company wanted to retain control of the marketing of this wood. While some aspects of the story may be somewhat apocryphal, the important point is that the underwater wood has achieved a certain brand recognition within the marketplace that is distinct for its

being underwater wood and the loss of this storyline to a general consumer where underwater and terrestrially-sourced wood is mixed, would disrupt the economic, social and environmental basis upon which the underwater logging industry has built its claims. It protects the industry from co-option by another set of interests in the way that for example celebritization of fair trade has mainstreamed the industry in ways that might divert attention from what was precisely supposed to be marked out as different (Goodman, 2010). Expectations are controlled when they are so critical to the stability and success of the industry and there is a clear parallel here to Milne's (2012) geographies of control in biopharming. As we noted earlier, the unknown nature of the wood becomes part of its value, so mass-marketing this wood without the storyline of recovery of lost timber could damage the productivity of the storyline: the unknown might become more of a constraint than an enabler of value.

5. Conclusions

Expectations are at the heart of innovations as they coalesce materials, discourses, interests and practices to enact the imagined future. It is not just that a product is invented to solve a problem and then is sold, but it is as much of a story, a projection, a vision of past and future that is created and marketed that enables that product to come into being. In other words future imaginaries have a performative element and that it is these stories as much as market forces that enables the circulation of finance to borrow Thrift's (2001) analogy. These expectations may be contested and may fail, but even in the case of resource-intensive industries, they play an important role in engaging investor interest in emerging markets. Expectations are both temporally and spatially specific, drawing in past, present and future

economic conditions, at the same time as they may be geographically bound. The underwater logging example illustrates both of these features.

Underwater logging emerged in the confluence of technological developments, economic opportunities and an environmental sustainability agenda in the mid-1990s most especially in British Columbia. Through an unintentional industry cluster, these Canadian foresters have subsequently expanded operations to other countries particularly in the tropical regions where the value of wood is likely to be higher. Each lake is specific and has a different historical economic reason for its creation. Industry discourses promote the recovery of lost timber as both an opportunity to prevent land-based deforestation and as a re-connection to a past history of dam projects. This storyline is crucial to maintaining the value of the financial expectations of investors for the industry as Brown and Michael (2003) show. The expectations are thus spatially specific – tied to valuations of particular lakes and control of the material consequences of logging in those locations – and temporally specific – underwater logging emerges as dam owners search for other economic opportunities from their sunk capital while the context of using the past consequences of environmental destruction for the purposes of preventing future destruction is an innovative line of reasoning.

In this paper we have argued that while underwater logging to a certain extent reflects a capitalist imperative to re-deploy capital from expensive dam projects in particular in the 1960s and 1970s, the industry itself emerges through a set of interventions that construct new expectations from old materials, in the process attempting to stabilize other interests and retain a valuable storyline. As such, we suggest that there are three important factors in stabilizing expectations for a new industry like this. First uncertainties are translated into economic value and can become productive as long as they are the outcome of methodologically acceptable approaches. Economic expectations are not hampered by

uncertainty; rather the ‘exotic unknown’ can be luring particularly if the ability to disprove the hypothesis of rare timber is likely to take a considerable length of time. Profit can be made from the expectation of future highly valuable wood and to the extent it fixes capital investment now, that capital can and may well be re-invested in a new product, place or opportunity in the medium term.

Second, and related to this, expectations need to stabilize both the viability of the materials involved and the consequences of the production (and consumption) process to enable maximization of financial opportunities. While, arguably, speculative capital might be more focused on delivering increases in asset values (i.e. a rentier regime) rather than future biotechnological commodity profits as Birch and Tyfield (Forthcoming) argue, nevertheless this materiality matters in enabling industries to show that they have been able to manage the possible risks and rewards of a particular enterprise. Rotten wood or severe ecological consequences would both haunt these expectations and potentially destroy them. There is thus a material enactment of expectations but equally a requirement for and tests of that material practicability.

Third, expectations need to be controlled and maintained, they are not simply immutable portrayals of particular future imaginaries. Enacting futures has to be worked at and in many practices this will take the form of engineering the storyline about a future industry, technology or product to ensure it retains its power in the face of competing storylines. In the case of underwater logging, this is an important part of the viability and continuity of that expectation as an attraction for investors. If there is no distinctive consumer value to be realized from this underwater wood, the industry looks less innovative and consequently less valuable. When exploring the ways expectations are created then, there must be an assumption that these are continually being translated, to borrow from Latourian (e.g. Latour, 1987) language, in the process of enrolling allies to realize that expectation.

We have resisted drawing simple conclusions about the 'real' sustainability of underwater logging, not least because we have tried to demonstrate that these debates are always translated within the context of the industry. Is it better to save terrestrial forests by using underwater wood as a replacement? Or does underwater wood simply drive a demand for rare species that cannot legally be cut down on land? Does underwater logging pragmatically deal with the problem of sourcing wood in the best possible way or does it simply continue economic cycles of industrial forestry? Underwater logging is an interesting example precisely because it focuses attention on the questions of trade-offs in environmental policy. As Castree (2000: 3) notes "The capitalist production of natures... therefore means that in particular times and places in relation to particular environments capitalism is ecologically harmful whereas in others nature is produced in ways that have positive social and ecological effects." There is no simple answer, but we have suggested that the performative role of expectations in constituting the material enactments of particular natures need to be explored more deeply to understand how and why some capitalist natures are produced while others are not.

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Figure Captions

Figure 1:Ashanti forest, Vigne 1935. Pictures of forests are used to predict vegetation cover prior to inundation in this case in the region of Lake Volta, Ghana.