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Encounters in the Ebb and Flood: knowing marine ecologies in the intertidal contact zone

Forthcoming in *Environment and Planning E: Nature and Space*

Aurora Fredriksen, The University of Manchester
aurora.fredriksen@manchester.ac.uk

Abstract. Shifting rhythmically between land and sea with the ebb and flood tides, shores are places where humans and nonhumans encounter one another in ambivalent relations of deep familiarity and enduring strangeness. Building on Pratt (1991, 2008), I use the space of the intertidal contact zone here to think through a series of uneven encounters between humans and marine wildlife that populate a dispute over tidal energy testing in the Bay of Fundy's Minas Passage. I trace two contact zones through which knowledge about marine wildlife in the Bay of Fundy is generated: first, the contact zone continually (re-)assembled through the encounters of small-scale and traditional fishers with marine wildlife. Second, the contact zone staged in remote encounters between marine scientists and marine wildlife. The article reflects on the role of bodies in and out of encounter in the different ways of knowing about marine wildlife in this case and considers ethical possibilities and limits of knowing through, versus without, contact with nonhuman animals in the intertidal contact zone.

Highlights.

The material and temporal qualities of tidal zones constitute uniquely repetitive/novel staging for more-than-human encounters

The ecological knowledge of independent and community fishers arises from frequent, multiply entangled, and specifically emplaced bodily encounters with non-humans

The specificity and urgency of fishers' practical ecological knowledge conflicts with the pursuit of objectivity and detachment in scientific knowledge

The specificity, attachment and urgency of embodied knowing are increasingly relevant in these times of rapid ecological change

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On the 7th of November 2016 Cape Sharp Tidal - a joint venture of OpenHydro/DCNS and Emera – deployed a 2MW in-stream tidal turbine at the Fundy Ocean Research Center for Energy (FORCE), located in the Bay of Fundy's Minas Passage in the Canadian province of Nova Scotia. Forty-eight hours later, after completing the subsea cable connection, the turbine started delivering energy to the grid. The project's initial success (the turbine was removed a few months later when it stopped working) was generally lauded in the national and provincial press as a demonstration of the potential to generate renewable energy from Nova Scotia's abundant tidal waters. The harnessing of the Bay of Fundy's extreme tides (the largest tidal range in the world) to generate predictable renewable energy was seen by many as a positive step towards decarbonising Nova Scotia's coal-intensive energy supply (e.g. DuBreuil 2017). Yet for others, particularly for some people already living and working on the Bay, the deployment of the turbine represented an unwanted intrusion on, and potential interruption of, existing ecological relations in the Bay. Along with offshore oil and gas drilling, aquaculture and offshore wind turbines, in-stream tidal devices modify marine habitats (McCauley et al 2015) and often enclose previously common access marine spaces (Kerr et al. 2015; Osherenko 2006), potentially threatening localised marine ecologies and the livelihoods that depend on them. In the months leading up to the turbine deployment, the Bay of Fundy Inshore Fisherman's Association, representing 175 area fishermen, tried to get a court-ordered stay on the deployment of the turbines pending a judicial review of the environmental monitoring programme. The Assembly of Nova Scotia Mi'kmaq Chiefs (2016) and the Kwilmu'kw Maw-klusuaqn Negotiation Office (2016) put out press releases in support of the concerns raised by the Bear River and Annapolis First Nations over the potential impacts of the turbine on the ecology of the Bay and the unanswered questions the project presented with regards to access and sea rights (see also Roche 2017). In addition, the Orca Conservancy (2016) raised the alarm over potential effects of the turbine on Harbour Porpoises, citing a series of shortcomings in the project's Environmental Impact Assessment with regards to these small cetaceans in an open letter to Fisheries and Oceans Canada (DFO) Minister Dominic LeBlanc.

At the centre of this controversy was not only the question of how the turbine would affect marine wildlife, but more fundamentally, how these impacts would be known and which ways of knowing the Bay's marine wildlife and ecologies would count. In this regard, while the events of this case present some of the familiar elements of other environmental knowledge controversies in which lay and expert (see, e.g., Whatmore 2009), or indigenous and scientific (see, e.g., Coombes et al 2011), knowledges are mobilised in competing sides of a dispute, they also exceed the typical narratives of local conflicts over renewable energy siting and the anthropocentric frame of competing human knowledges therein. Indeed, this case illustrates how entangled, lively ecological relations are not only the subject of, or enrolled in, human disputes, but also co-constitute these disputes by variously taking part in the generation of different ecological knowledges that get mobilised in these disputes (see also Barua 2014a; Dempsey 2010; Mansfield et al. 2015). As others have demonstrated (see, especially, Bear 2012), entangled ecological relations can frustrate scientific and policy related attempts to know and represent environments, multiplying complexities and acting in unruly ways that make cause and effect difficult to disentangle. As well as furthering this insight, this article shows how entangled ecological relations may *also enable* certain types of environmental knowledge, namely the practical, embodied knowledge that emerges in and through specifically emplaced, more-than-human encounters. In order to interrogate the generation of environmental knowledge through such encounters – and to consider it in contrast to more dominant modes of scientific knowledge – I

draw on the concept of the ‘more-than-human contact zone’ (Isaacs and Ortuba, this volume; Wilson 2019). As elaborated below, by focusing on more-than-human contact zones, I am able to draw attention to the deep attachments and embodied aspects of knowing with more-than-human others through situated encounters, as well as the ways in which this marks a fundamental difference with ecological knowledge about more-than-human others that aspires to detached objectivity.

Following a brief note on methods, I proceed to a discussion of the contact zone and encounters, focusing on the spatio-temporal particularities of intertidal zones as places of more-than-human contact. This is followed by an elaboration of the generation of environmental knowledge about the Bay of Fundy forged through and outside of embodied encounters by area fishers and marine scientists, respectively. I then consider how these different ways of knowing marine wildlife – through embodied encounters versus outside of embodied encounters – underpin different epistemological and ontological positions within the dispute over tidal energy in the Bay of Fundy. A concluding section reflects on the wider implications of knowing within versus outside of more-than-human contact zones in this time of rapid ecological change.

A note on methods

The empirical material in this article is drawn primarily from two periods of ethnographic field work carried out in Nova Scotia in July – August 2017 and July 2018. During these field visits, data was gathered through a series of observations, in-depth, unstructured interviews, and encounters in scientific labs, fishing boats, government offices, power stations, visitor centres, university campuses, beaches, homes, trucks and cars. In addition, video recordings were made of some interviews, guided go-alongs at a fishing weir and in other coastal places, and the work of lobster fishers at the wharf and onboard a boat. Video recordings allowed for capturing non-verbal aspects of embodied mobilities, affects and encounters (Bates 2015) as well as for deeper engagement with the presences of nonhumans (Bear et al 2017), especially the dynamic and rhythmic mobilities of tidal waters. Additional data was collected outside of the two field visits in the form of a wide review of relevant secondary sources, including traditional and social media coverage of the dispute, industry, government and NGO reports and grey literatures, and the published results of scientific studies on marine ecology and tidal energy.

The intertidal contact zone

In Mary-Louise Pratt’s original formulation (1991, 2008), ‘the contact zone’ was used to name the social space of encounters between different cultures, the place where transculturation – the process of cultural exchange and reinvention – happens, and where discourse and practices from one culture are elaborated, appropriated, and contested by another (see also Sundberg 2006). Given this focus on human cultures, the contact zone may initially seem an odd place to start in exploring the more-than-human generation of environmental knowledge. However, if one leave’s aside Pratt’s specific focus on human cultures, two aspects of Pratt’s formulation of the contact zone are particularly useful for thinking about knowledge generated through more-than-human encounters¹. First, there is Pratt’s

¹ ‘Encounter’ is used here to denote more than a simple meeting of parties; it is a meeting that focuses attention on bodies, borders and difference (Wilson 2016), one which may take place in a limited space and

(2008: 8) emphasis on “the interactive, improvisational dimensions” of knowing and doing in the contact zone. Without access to mutual human (contact) languages through which to read the effects of an encounter, one must attend more closely to the role of response and embodiment in the composition of new ways of knowing and doing within more-than-human contact zones (Tsing 2014; Barua 2015). Attending to how bodies are involved in encounters, in turn, emphasises the ‘embodied practicalities of knowing’ (Despret 2013: 69) that emerge in and through more-than-human contact zones. Haraway (2008), for example, positions inter-species contact zones as embodied spaces of becoming-with companion species (Haraway 2008), while Despret (2013) considers how more-than-human contact zones can be spaces for forging embodied empathy between species as a knowledge practice.

Second, there is Pratt’s recognition that knowing and doing within contact zones often coincides with radically unequal power relations (*ibid.*). In contrast to Haraway’s and Despret’s more hopeful take on the possibilities of inter-species contact, other studies of more-than-human encounters emphasize the negative aspects of uneven power relations therein, exploring, for example, non-companionable encounters between humans and animals in scientific settings (e.g., Burnett 2012; Johnson 2015; Singleton and Lidskog 2018), deadly encounters of humans with wild animals (e.g., Collard 2012; Margulies 2019), or the multivalent violences of human-wildlife encounters underwritten by shared post-colonial traumas (e.g. Barua 2014b; Hovorka 2016). Though emphasizing different aspects, both positive and negative takes on the possibilities of more-than-human contact zones retain Pratt’s original attention to the ways in which historically and geographically specific relations between parties can both shape and be subverted by new and hybrid ways of knowing and doing emerging within the space of encounters. As well as focusing attention on bodies in encounter, then, more-than-human contact zones draw attention to the wider ecological and material relations of place that are at once folded into, and participants in, encounters. In place-specific controversies over environmental knowledge, the more-than-human contact zone is a critical space for the generation of practical, or embodied, ecological knowledge.

As well as its many specificities, the timespaces of the Bay of Fundy share with other tidal zones temporalities and materialities characterised by an ever repetitive/surprising shifting and (re)mixing of elements. Mirroring the nature of encounters as characterised above, tidal zones are at once routine and familiar and open to shock and surprise (Wilson 2016). Indeed, if, as Stefan Helmreich writes, the ocean is “both familiar and strange ... us and not us” (2009: x), the seashore is doubly so. For many humans the seaside and its nonhuman inhabitants have a firm hold in collective imaginaries, personal memories, seasonal migrations and/or the daily rhythms of life and livelihoods. At the same time, and alongside familiarities, these liminal places at the margins of land and sea often possess an enduring strangeness to humans. In “contemplating the teaming life of the shore” Rachel Carson writes evocatively of a sense that something about tidal places remains always “just beyond our grasp” (1955: 250). The apparent differences in bodily forms and the contrast between airy existences and watery ones (Bear and Eden 2011; Jones 2000), surely contribute to the mystery of marine wildlife that Carson alludes to. But something must also be said for the shifting materiality of the shore. As Owain Jones (2011) writes, tidal seashores are spaces of constant movement that entangle the edges of land and sea, and of fresh and salt water in a dynamic patterning of space that cannot be

time, but which also folds in different times and places to that moment (e.g., Ahmed 2002; Anderson 2014; Johnson 2015; Wilson 2016).

meaningfully separated from the rhythmic temporalities of “tidally animated waters” (2011: 2290). The resulting “rhythmpattern” of timespace in tidal zones enacts “endless repetitive/novel sets of relational processes” (ibid.). It is this repetitive/novel rhythmpattern that sets tidal zones apart from other types of places, lending them the distinction of enacting a constantly shifting timespace in which elements are mixed, separated and remixed in ways that are at once knowable in their predictability and unknowable in their persistent capacity to surprise (see also Steinberg and Peters 2015). Moreover, unlike the rise and fall of mountains or the drift of continents, the repetitive/novel movement of tides happen within a timescale that is sensible in the day-to-day lives and relations of humans and other living things currently inhabiting tidal zones. The “chaotic but *rhythmic* turbulence” (ibid: 248) of tidal zones is thus not just the physical background to life and encounters in tidal zones, but integral to the mundane experiences of place and knowing for the living things that inhabit tidal ecologies.

To say that the rhythmpatterns of tides are essential and unique elements of tidal contact zones, however, is not to say that they are determinative of the conditions or outcomes of encounters within them. As Juanita Sundberg argues in her analysis of conservation contact zones in Guatemala, there is a need to always attend to “the specific constellations of power and knowledge” and the ways they “privilege and attempt to fix particular social and environmental formations, thereby rendering others unlivable or invisible” (2006: 242). In the past hundred years or so, humans have accelerated their modification of the rhythmpatterns of many tidal zones around the world, building breakwaters, seawalls, and causeways, impounding bays to create perpetual high water, and dredging, draining and damming estuaries. These modifications all aim to reshape tidal zones to be more amenable to particular modern (often capitalist, industrial), timespaces – a process Jones (2011) calls ‘smoothing’ – by controlling to greater or lesser extents the movement and placement of tidal waters. In the Bay of Fundy, the last century has seen many of the rivers entering the bay transformed by tidal barriers, which act to exclude most or even all of marine tides from the rivers. Excluding tidal waters in this way has unravelled many of the rich socio-ecological relations of the formerly tidal worlds behind the barriers, disrupting the lifeways of a diversity of living things, from spawning fish to wading birds to human clam-rakers. In their place, new worlds have been constructed with more clearly separated spaces of land and water, and of salt and fresh water, both of which are more amenable to farming, transport and/or other forms of economic development. In the 20th century, certain imaginaries of socio-economic progress acted to privilege a particular type of socio-ecological formation around the Bay of Fundy, one based on asserting power over the tides, while making other such formations – those reliant on the rhythmpatterns of tidal rivers – unlivable. In the 21st century, these constellations of power and knowledge are shifting, with various voices for removing tidal barriers gaining recognition, and new visions of high tech and ‘sustainable’ industries reshaping government visions of the ‘right’ socio-ecological formations to pursue.

As the following analysis will show, the rhythmpatterns of the timespaces in the Bay of Fundy are integral components in the co-composition of shifting worlds. Fishers order their lives and livelihoods around the tides – boats can only enter and leave dock when the tide is in, at low tide they sit on the exposed seabed. And, as with the case of scallop dredging in Cardigan Bay explored by Bear (2012), the powerful, ever moving tidal forces in the Bay of Fundy complicate attempts to know them through science, exceeding the capacities of monitoring equipment and mixing the subjects of analysis through constant movement. Thus, the movement of tides – with their “dynamic pattern of repetition and reformation” of the environment (Steinberg and Peters 2015: 248; Serres 1996) – is a

powerful actor in this case, both providing the setting and participating – making itself heard – in the two contact zones discussed below.

The fishing contact zone

Understanding how ecological knowledge is generated through the more-than-human encounters involved in fishing on the Bay of Fundy is essential for understanding the opposition of many fishers to the Cape Sharp tidal energy development. As this section explores, the practical ecological knowledge of fishers is deeply attached to the specific – to places, times and embodied encounters. The specificity of this practical knowledge, moreover, is linked with a deeply felt urgency of knowing within a livelihood where serious injury and death are persistent threats. The practical ecological knowledge of fishers, as shown here, is in many ways incompatible with the detachment and abstraction involved in the marine science used for the FORCE/Cape Sharp Environmental Impact Assessments (EIAs). The urgency of knowing within the fishing contact zone, moreover, resists the ‘wait and see’ approach of FORCE/Cape Sharp’s Environmental Effects Monitoring Plans (EEMPs).

Fishing has long been a central practice through which humans become entangled within the ecosystem of the Bay of Fundy. The earliest human residents of the area, the Mi’kmaq, have fished in the Bay of Fundy for millennia and it continues to be an important source of food and income for many of the coastal Mi’kmaq Nations in Nova Scotia. The right to fish in the Bay of Fundy on their own terms (rather than those imposed by the settler-colonial federal and provincial governments of Canada and Nova Scotia, respectively), is also an important flashpoint in movements for sovereignty and sea rights for some area First Nations (see, e.g., Steigman and Pictou 2008). European colonisers, meanwhile, were drawn by the rich fisheries of the region and fishing has been a central industry and livelihood in Nova Scotia since the 17th century. But while the fishing industry continues to play a significant economic and cultural role in supporting coastal communities in Nova Scotia – annual catches in the herring, lobster and scallops fisheries are the highest of in Canada by quantity and value (DFO 2018) – small-scale fishers are in decline in Nova Scotia, with independent operators being squeezed by declines in historically important fisheries (most notably cod), competition from vertically integrated, high volume corporate fishing vessels, DFO quotas and the high cost of commercial licenses (Nikoloyuk and Adler 2013).

Within this context of already threatened livelihoods and ways of life, some independent and community fishers² have viewed tidal energy development in the Bay as yet another potential threat. In the immediate term, fishers recounted how the Cape Sharpe tidal turbine test at the FORCE site has resulted in significant losses for lobster fishers who set traps in the area, as the large, multi-day operations for deploying and retrieving the turbine have prevented fishers from going out on prime days, and resulted in lost gear as the vessels contracted to take the turbines in and out of the Bay have inadvertently cut lines connecting lobster traps to bouys, making them impossible to retrieve. In the longer term, fishers believed that, while the FORCE site only has five berths, the ultimate plan was for hundreds of turbines to line the floor of the Bay, a belief reinforced by rumours of Cape Sharpe’s corporate pitches to investors promising rapid expansion. As well as these very concrete and more

² By ‘community fishers’ I refer both to First Nation fishers who operate under community fishing licenses granted by DFO, and to the collective fisheries of those First Nations which operate independently of, and in protest against, such licenses.

speculative complaints, fishers opposed to tidal energy have drawn on ecological knowledge of the area grounded in practical, ongoing encounters and entanglements with the Bay's ecologies in order to critique the environmental knowledge mobilised by the government and tidal energy companies.

The ecological complexity of the Bay of Fundy's tidal waters means that encounters between living bodies there are always multiple. Fishers don't just encounter one species in their work; even when they are targeting just one species, like herring or lobsters, they necessarily encounter and interact with a multitude of other marine animals, especially other fish and marine invertebrates, but also seabirds and seals opportunistically fishing alongside humans, and cetaceans that occasionally come to swim alongside boats or that breach unexpectedly. These encounters between animals (human and otherwise), moreover, are mediated by plants and by seawater, by mud and rocks, by the weather, by fishing gear, boats, nets, onboard GPS and radar tracking devices, and above all by the perpetual movement of the tides. These bodily encounters cannot sensibly be isolated, detached from all the other encounters and entangled relations around them. In other words, in contrast with the marine science discussed below, knowledge generated within fishing encounters is not amenable to detachment from specific places, nor to the abstraction of single subjects from their dense ecological entanglements.

As well as inescapably multiple, fishing encounters, though many elements become expected and familiar over time and generations of knowledge sharing, still maintain the potential for surprise, rupture, learning. In these encounters, bodies need to always be attuned to one another, open for response. Tales of the perils of getting distracted, failing to pay attention, were a common theme in my conversations with fishers: a captain breaking his back climbing onto his boat from the wharf just as a wave rolled the deck; a friend getting stuck in quicksand while walking out on the mudflats at low tide who could only be pulled free by a pickup truck; the two young guys who walked too far out along the beach at Cape Blomidon and drown when they couldn't outrun the flood tide. These cautionary tales and the frequency with which they came up are reminders of the deeply felt urgency of embodied, emplaced knowing for fishers in the intertidal zone. Failing to attune one's body to the many entangled nonhuman bodies involved in fishing on the Bay can exact a heavy toll, from serious injury to death.

As well as the more dramatic examples noted above, there are many more mundane instances where bodily attunement to more-than-human bodies is an urgent matter. Take the safety measures explained to me aboard a lobster boat, while I was watching the traps get pulled up and laid. Although a few small lobster fishers still use single line traps, many independent boats use a system of tethered traps, where 15-20 traps are tethered to one another on a long, strong rope, with an anchor at one end to drag them to the seabed, and a bouy at the other for retrieval. To lay the traps, the anchor is tossed off the back of the moving boat and the traps are pulled out to sea, in tandem, very rapidly, by the combined forces of the sinking anchor, the moving boat and the tidal current. Indicating the stack of traps and the looping ropes connecting them on deck the boat captain told me, matter of factly, "if you get tangled in any of this, you're dead ... there's no second chances".³ Being attuned to the relation between one's own feet on the rolling deck and the swiftly uncoiling rope that connects the traps, not to mention the traps themselves (which together with the rope take up the majority of

³ Interview 10-Jul-2018, Bay of Fundy

space on deck), is essential for avoiding being swept out to sea and pulled deep underwater with the traps.

While avoiding trap lines is specific to lobster boats (though other vessels have some version of this need to avoid entanglement with gear), there are other attunements that are more general, if no less urgent. In particular, almost all of the fishers I spoke with talked about the need to be attuned to the weather and the tides. For independent fishers, every day they don't go out during season is money lost, and with the pull of a booming market in some fisheries or a faltering one in others, the lure of big money or the need to just make it through the season are both huge incentives to go out in bad weather, but not so bad that one's life will be at risk. Each storm requires calculating this risk. And even in the absence of storms weather can cause problems, as when the wind and tide flow again one another; "when the tide's up the Bay and the wind's down, makes the waves stand up really high, really steep, close together"⁴. When the boat is rolling in high waves people can get washed overboard. Even though the day I'm out on the lobster boat is clear and calm, the captain directs me to stand sideways against the rails, saying "you never stand with your back to the rail, 'cause your knees will bend than way right? ... the boat can roll and trip your knees out from under you... sideways is your best choice"⁵. It seems that all the fishers I talk to know someone who's gone overboard in storms and high waves, everyone knows someone who's lost their life this way. Weather forecasts and apps on smartphones have become essential tools for fishers, but most of them still feel it out for themselves, going outside and attuning themselves to the wind, sky, sea and other bodies to make the final decision. And even then, there are surprises, weather changes course, waves roll the boat just at the wrong moment. Despite recent improvements in safety regulations and DFO enforcement thereof, the risk of injury or death in commercial fishing in Nova Scotia remains high relative to other livelihoods (Burke 2017).

Beyond these very real life and death situations there are other, less dramatic, ways in which bodies encounter and attune to one another within fishing practices in the Bay of Fundy. One fisherman described how he would know where to fish for schooling fish by driving a small motor boat out into the open water of the bay and turning the engine off to be carried by the flood tide. He traced the currents with his body, putting himself in the place of a fish. This practice was unusual, especially with advances in predicting marine conditions becoming available at the tap of a phone app, but independent and community fishers often described using a variety of embodied senses alongside experience and technology in deciding where to go. Many small owner-operated vessels now have GPS and/or radar tracking equipment on board, and all fishers check the weather forecasts and tide charts before going out. These technologies and sources of information have made fishing easier in some ways, helping relocate traps, charting courses through varying conditions. But while they vastly augment fishers' ability to navigate waters and track fish, they do not replace experience and the human senses, not entirely. Onboard the lobster boat, when the captain notices my apparent interest in the shearwaters gliding along behind us, skimming the surface of the water with the tips of their wings, he says he's been watching the 'seahags' too – they only come so close to land when a storm is on its way. Going outside and feeling the weather, navigating the currents, feeling the roll of waves and watching the behaviour of wildlife complements the technology, it helps fishers triangulate

⁴ Interview, *ibid.*

⁵ Interview, *ibid.*

information they get from their technology and make final decisions on whether to go out when they are unsure.

For fish and sometimes other marine wildlife, of course, encounters with fishers are often violent ones. In fishing encounters target species of fish and bycatch die in airy suffocations and flash freezing; lobsters are shipped alive to distributors for a delayed death somewhere else. Even non-target species are often drawn into violently unequal encounters with fishers, when they are killed incidentally as 'bycatch' or targeted for harassment if, like seals, they compete with fishers for fish. At the same time, many independent and community fishers in the Bay of Fundy are taking measures to allow non-target fish to survive and to protect the sustainability of populations of target species. Lobster fishers use traps with holes that allow smaller lobsters to escape. Using bottom long lines instead of trawlers to catch groundfish (e.g., bottom dwelling fish such as halibut, plaice, flounder) means less bycatch and ecological disruption. At a fishing weir fish that are not being targeted for catch are herded by net, hands and sometimes whole bodies to a hatch that releases them into a holding pond where they can survive in shallow water before the flood tide releases them back into the open water. One weir fisherwoman estimated that they see around 50 different species of marine animals in their weir over the fishing season, 80 percent of which they release: "If we don't want it or we can't sell it or we're not allowed to take it, our job is to keep it alive, so continuously we're always trying to improve our system of how we keep things alive" (Lockett 2015).

Learning about fish and marine wildlife – how to kill fish, deter seals, care for bycatch – is an ongoing, reiterative process of daily, bodily encounters that cannot be separated out from the endlessly complex, changing ecological relations and material conditions of the Bay. Independent and community fishers directly handle their catch, coming into close bodily encounter with fish and other wildlife. Clam-rakers and scallop divers handle each shellfish as they pick it from the shore and seabed, respectively, attuning to tiny bubbles in the soft sand or variations in the seabed as well as to the tides for safety. Fishers of longline groundfish and lobsters remove each animal from the hook or trap, handling them with enough skill and care to deliver intact, and for lobsters that are sold alive, healthy, bodies to market. Even in these unequal encounters between fish and fishers, where the latter have the power to kill or throw back, fish and other marine wildlife retain some agency, a capacity to surprise, to not show up. Seabirds and seals learn to follow boats to find prey and pick up easy scraps. These encounters and the power relations therein are repetitive across years of experience and generations of learning (for fishers and wildlife), yet they are also continually reassembled, sometimes in the moment as conditions change unexpectedly, slowly as fish stocks are depleted or recovered over time, or as a step change following new advances in and access to technologies like GPS and smartphones.

In the last few decades climate change has been a large factor in the reassembling of fishing encounters, as the seas rise and warm, changing the character of storms and the composition of ecologies. And, of course, climate change has been a major impetus for the development of renewable energy, driving the push to develop tidal energy in the Bay, a process that will undoubtedly reassemble fishing encounters, but in ways that are as yet uncertain. The ways in which fishers have come to know the ecologies of the Bay of Fundy through the encounters described above inform their resistance to the Cape Sharp tidal energy project. This is a way of knowing the local ecology that balks at the idea of a detached way of knowing the ecology, at the abstraction of subjects from their entangled surroundings, and that sees the potential for serious peril in a 'wait and see' approach. By contrast, the ideal of objectivity, the desirability of studying species one at a time, and the need for

longer term monitoring are central to the ways of knowing generated through marine science carried out in association with the FORCE/Cape Sharp project.

Marine ecology and remote encounters

An average flood tide in the Bay of Fundy brings approximately 14 billion tonnes of sea water flowing through the 5km-wide Minas Passage into Minas Basin and tidal currents in the passage can exceed 10 knots (5metres/second) (FORCE, n.d.). In this extremely energetic underwater environment, FORCE – an R&D hosting site for tidal energy technologies, jointly funded by the federal and provincial governments and private companies – has established four berths with subsea cable connections to the Nova Scotia power grid, where companies can bid to test their in-stream tidal energy devices in the final stages before scaling up for commercialisation. In-stream tidal energy (hereafter tidal energy), refers to energy generated by placing underwater turbines (often resembling either underwater wind turbines or the turbines embedded in dams, depending on the device) in the path of tidal streams. The size of the ‘tidal resource’ in the Minas Passage, estimated at 7,000 megawatts (FORCE, n.d.) makes it attractive to potential tidal energy developers as well as to the governments of Canada and Nova Scotia as they look to decarbonise their energy supply. But while the potential for renewable energy generation in the Minas Basin is huge, so are the challenges of developing technologies capable of withstanding this extreme environment. This goes for the tidal energy devices themselves, as well as for technologies and devices for monitoring the impacts of tidal energy on the surrounding environment.

In the emerging tidal energy industry, environmental assessments tend to draw on a range of study types, ranging from tagging studies involving close bodily contact with the subjects of research to computer modelling studies in which entirely virtual scenarios of ‘collision risk’ are calculated by inputting recorded data alongside ‘reasonable’ assumptions into sophisticated algorithms. The EIAs and EEMPs for the FORCE test site and the Cape Sharp turbine deployment rely primarily on encounters that fall somewhere in between these two modes, in remote sensing and monitoring studies in which scientists observed wildlife presence at a distance in visual surveys or used computer models to analyse daily data returned from underwater acoustic or visual monitoring equipment deployed at the test site. For almost all the environmental monitoring research carried out in association with the Cape Sharp deployment at FORCE, bodily encounters between scientist and other living things were either absent or mediated by technological devices.

This is not to say that the marine scientists that I met in my field visits to Nova Scotia did not have direct bodily encounters with their objects of study. Indeed, most spoke of regularly enjoying some form of recreational activity in and around the Bay, such as coastal hiking, boating or rafting in the tidal bores. Others engaged in regular bodily encounters in the course of their research, whether that involved handling live fish, birds or other marine animals for tagging studies, or wading into or boating out onto the Bay to get measurements or deposit and retrieve monitoring devices. Through these bodily encounters in the intertidal zones, these scientists – not entirely unlike the fishers – had amassed rich, embodied knowledges of the ecologies and tidal dynamics they studied. And yet, very unlike the fishers I spoke with, these extra-scientific knowledges, the ones based on embodied experiences and fleshy encounters that were specific to times and places, were almost entirely discounted when it came to establishing what they knew about the environment. Only the ‘actual data’ methodically collected from designated equipment and fed through appropriate scientific

models was understood as constituting ecological knowledge. While thinking and learning with one's body in contact with others is sometimes embraced in the scientific study of wildlife (e.g., Despret 2013, Shaw et al 2010), such personal, embodied encounters were dismissed in my conversations with marine scientists as an aside to true environmental knowledge, at most a helpful background for deciding what to measure when or how, at least irrelevant.

In some ways, the parameters of what counts as knowledge in environmental assessments and monitoring are defined by the rules and regulations they are subject to. Whereas the contact zone in which fishers encounter fish and other marine wildlife in the Bay of Fundy shifts with the tides and sea currents, changing shape with the type of fishing apparatus (stationary weirs versus mobile vessels, longlines versus lobster traps etc.), and often moves with the fish, in the scientific contact zone of EIAs and EEMPs, the spatial parameters in which knowledge about marine wildlife is produced is spatially restricted to the 1.0 x 1.6km area of seabed leased by FORCE and the water column above it. As laid out in the 2016 EEMP,

The EEMPs are intended to monitor potential effects from the initial demonstration scale project, rather than from a potential commercial scale project that may occur in the future. To this end, the EEMPs are limited to effects within the FORCE Crown Lease Area (CLA), and do not attempt to measure effects in the much larger Bay of Fundy. (FORCE 2016: ii)

Companies deploying turbines at the FORCE site are responsible for monitoring the 'near field' environmental effects of their turbine, defined as those occurring within a 100m radius of their device, while FORCE is responsible for monitoring the 'mid-field' environmental effects of turbines, defined as the remaining area within the bounds of the CLA (FORCE 2016: iii). Potential environmental effects of turbines outside the CLA are not monitored as part of the EEMP.

As well as this clearly defined spatial zone, the generation of knowledge about marine wildlife within this area is focused on five bounded 'subject areas': lobsters, fish, marine mammals, marine seabirds, and acoustics (marine noise). Each of these subjects has its own monitoring plan, separated out from the others and from other organisms and ecological processes that do not fall into these subject areas. Reducing the parameters of relevant encounters in this way takes work, first and foremost work to distinguish different species and isolate them from others in the data. In calm waters remote visual and acoustic monitoring can capture detailed images that make this work of separation possible (if not simple), but in the extreme tidal environment of the Bay of Fundy, it becomes a challenge even for the most experienced scientists with the best equipment. The extreme turbulence of the tides in the Minas Passage are really tough on gear, dislodging or destroying equipment that has been developed and used successfully in other tidal environments. Echo-locators deployed on the sea floor and 'looking' up through the water column in the Minas Passage can capture detailed images of fish presence and movement at slack tides, but as the currents pick up in the ebb and flood tides the images start to blur as air becomes entrained in the turbulent tidal stream, reflecting sound and making the data returned to scientists unintelligible. Traces of fish and other marine animals in the acoustic data are 'obliterated' at peak flows, hidden behind a veil of entrained air.⁶ Generating knowledge with the returned data is not impossible, but it is slow going. "You know there's just some

⁶ Interview 2 Aug 2017, Wolfville

days are really bad and some are fine” one researcher explained, “with enough days of data collection you can get enough good information to balance [unusable data] out”.⁷

In visual surveys of harbor porpoises carried out for the FORCE EIA, meanwhile, the space between shore-based observers and lively marine mammals swimming in the passage led to other limitations. In a letter assessing the sufficiency of the science informing FORCE’s EIA and EEMP, the DFO (2016) was particularly critical of the harbor porpoise surveys, noting that shore-based visual survey periods that were limited to six days per year with no one month surveyed over multiple years; that visual observations were collected only in the period from high tide through ebb tide, excluding the period from low-tide through flood tide; and that no information was recorded on weather conditions likely to affect visibility – and therefore the ability to visually detect the presence of harbor porpoises. In addition, the DFO questioned the EEMP’s conclusion that, because porpoises were usually seen near the surface they were unlikely to interact with a submerged turbine, noting that no information on diving depth was recorded to support such a conclusion (DFO 2016: 5). The harbor porpoise study is an extreme case of where the distance between bodies – that is, the absence of embodied encounter – can distort ecological knowledge.

Following DFO’s criticism of visual surveys, FORCE’s EEMPs are moving toward studies using better remote sensing gear, of the sort used in the fish study discussed above. In these studies, state of the art acoustic monitoring devices are deployed underwater, where they sit on the seafloor and record for a month, maybe two depending on the particular kit’s battery life. Once retrieved, data from the devices is collected: echoed sound traces translated into data points and transmitted to computers where they can be cleaned and fed into models for analysis. ‘Bad’ data days are balanced out with good days for analyses. Bodies are still part of this knowledge production – bodies of scientists deploying equipment, sitting at desks, typing code, writing reports and, elsewhere, bodies of marine animals swimming, schooling, rushing, colliding, leaving traces in the data – but outside of the few tagging studies involved, not bodies in direct encounter with other bodies. Of course, studying fish presence in the turbine site does not require the bodies of scientists and fish to come into bodily encounter, not directly at least. The use of remote sensing equipment to mediate between the bodies of humans and marine wildlife, moreover, allows an extension of human observations into watery worlds, spaces outside the reach of embodied human senses. In addition, the absence of direct contact does not mean that fish and other marine mammals are not participating in generating knowledge about themselves, they co-constitute this knowledge at the point of passing a sensor, of coming up for air on a visual survey, or in carrying around a tag on their person. By encountering fish in their own underwater world, monitoring devices allow these animals to make themselves known in ways that are in some aspects more representative of their experiences than those moments when they are dragged to the airy surface in traps, nets or at the end of hooks. At the same time, the research through which these underwater encounters are interpreted is designed to smooth over this agency, looking for general patterns over individual ones, balancing out the ‘bad data’ with the good. Fish are observed in their own worlds but the translation of their presence is imperfect in other ways, smoothed out and abstracted. The knowledge generated through these remote observations is detached from the specific; it is one in which individual bodies are agglomerated and where happenings in one place and time are added and averaged.

⁷ Interview, *ibid.*

Bodies and knowing in the intertidal contact zone

The ecological knowledge on which independent and community fishers base their opposition to the FORCE/Cape Sharp tidal energy test project is grounded in frequent, routine encounters, around the year and over decades or even generations of working in an area and with particular living and non-living others. These encounters fold in different spaces and times (Wilson 2016), most especially the 'rhythmpatterns' of tides (Jones 2011), the seasons, and years of personal and intergenerationally transmitted experiences, but also the uncertain future of warming seas and associated changing ecologies. Fishers occupy an ambivalent position of power in these encounters. On the one hand, they hold power over the fish and other marine animals they target in the violent, asymmetrical encounter of fishing. On the other hand, they are always at the mercy of the physical conditions in the Bay, their movements are constrained by the tides and weather conditions are predictable only to a point, and always hold the possibility of inflicting injury or death on fishers. Knowledge gained through fishing encounters in the intertidal contact zone is always specific and multiply attached; it is a way of knowing informed by the urgency that comes with the constant threat of bodily harm.

In contrast, much of the scientific ecological knowledge of the Bay is based on the remote monitoring of marine wildlife within carefully bounded study parameters. The fish studies being carried out at the FORCE site aim to generate knowledge about the presence and movement of fish bodies in the area of the turbines at different points in the tidal cycle, and to thereby make tidal energy safer for fish populations. In the encounters through which this scientific knowledge is generated, machines mediate between living bodies, bringing them into a sort of remote encounter and translating between parties. Power relations in such encounters are less certain, more diffuse than they are in fishing. While the marine scientists working on this project are also constantly at the mercy of tide tables and turbulent waters that ruin equipment and return unusable data, they are almost never at bodily risk – they don't go out if conditions are considered dangerous. And while fish and other marine animals are not targeted for killing by scientists, the whole encounter is premised on the possibility that marine wildlife may be injured or killed by the tidal turbine, a situation the scientists are not trying to prevent in the present, but to first observe. In the name of reducing risk to marine wildlife in the aggregate (cf Dempsey 2013), the immediate agencies and fates of individual marine animals are minimised in these translations, transformed into species or population averages (cf Fredriksen 2017) and abstract numbers circulating in computer models and reports (Bear 2006).

Reflecting on the scientific research being done to monitor fish at the FORCE test site, one area fisherman and vocal opponent of the Cape Sharp tidal project explained to me that

The problem we see is that, when it comes to managing this environment for tidal energy, the fish are no longer alive. They're numbers. And we call it ink on paper. Right? So instead of a living organism it's literally ... just a dot on a paper, on an excel worksheet, you know? Or an R programme. These aren't living organisms to these people, these are numbers. And that's a problem. And we even try to get all them out here, all the number people ... I want them to put their hands on them.⁸

⁸ Interview 02 Aug 2017, Bramber

This point underlines a decided push back against the abstract, generalised knowledge used to support the FORCE/Cape Sharp project; it seeks to re-attach the detached knowledge of averages to specific place-times, to re-empower abstract numbers in living fish bodies.

Knowing the force of the flood tides through the narrow Minas passage, knowing the multitude of marine life that is forced in and washed out of the basin twice daily, fishers are incredulous when industry spokespeople predict that fish will swim around the turbines and scientists working on the data say they can't say either way until the research is completed. Prompting me to imagine myself as a little herring being pushed through the narrow passage by the powerful flood tides with millions of other schooling herring, one retired fisherman told me that, in a school "you can't crowd your buddies and all this and they're not gonna be able to move one way or the other so they're gonna go through [the turbine]".⁹ Other fishers asked how, if schooling fish cannot evade fishing weirs or purses seines from industrial vessels, they could be expected to evade turbines? A fish biologist working on the EEMPs for the FORCE site acknowledged these points, but insisted on the need to track and record fish movements as the only 'real' way to know whether the fish can evade the turbines or not – everything else could only be speculation. The remote sensors recording echo-located fish traces in the water column are posed as objective observers that will reveal the truth in this dispute. And yet, it is exactly at the height of the rushing flood tide – the point when fishers cannot see how anything could navigate its own path through the Minas Passage – that the remote sensing gear stops working. As the technology improves and researchers find new ways to 'pick apart' the noisy data at peak flows, direct observations of the entire tidal cycle may become possible, but not yet. For now, the incessant movement of the tides prevent scientific certainty (cf Bear 2012).

For opponents of tidal energy testing in the Minas Passage, the 'not yet' part of the equation is central, the 'wait and see' approach rubs up against the urgency of practical knowing in the intertidal zone. For marine researchers, it is reasonable: the effects of tidal turbines on marine wildlife is a new area of study, it will take time to develop better methods and technologies. Moreover, the sentiment that 'we' need to just get the turbines in the water and do the research before we can say how they will affect wildlife was frequently repeated to me throughout my research by scientists and supporters of tidal energy. As well as clashing with the sense of urgency felt by many area fishers, this patient temporality of scientific knowing also carries the assumption that nothing is known about local ecological relations until it can be shown by scientific study. It relies on dismissing as anecdotal ways of knowing forged through emplaced, bodily encounters with marine wildlife and ecologies and shuns the rush to judgment that comes with urgency. This dismissive stance is not lost on the many local fishers who have looked on in disbelief when the environmental monitoring studies for the FORCE project record a 'first documentation' in the area of a fish species that the fishers have seen and known for years (though often not by its scientific name), or when animals fishers know are present, that they have seen with their eyes and touched with their hands, are treated as absent in the reports because they have yet to be scientifically surveyed.

Indeed, the entire process of separating out different species for one-at-a-time studies, as is the norm for EIAs and EEMPs, was an affront to those whose knowledge of area wildlife was inextricably tangled up with the vast web ecological and material relations in the Bay. Exemplifying this, a

⁹ Interview, 3 Aug 2017, Annapolis

fisherman angry about the way studies were missing less frequently spotted wildlife related the following:

I've seen them not write the whale down. Two whales is coming through. And he [another fisherman] said to them, he said, well aren't you gonna write the whales down? He [the researcher] said I'm not doing whales today. ... And that's what our problem's been.¹⁰

From the point of view of researchers conducting visual surveys for harbour porpoises, not recording the presence of whales makes sense. The information that whales were present is not relevant to their report on harbour porpoise presences. For the fisherman relating this story (and presumably for the other fisherman in the story), not recording the two whales for the EEMP study was worse than a missed opportunity, it felt like an out and out lie about the local ecology¹¹. The abstraction involved in single species surveys, a common practice in scientific ways of knowing, is antithetical to the multiply attuned nature of the fishermen's practical ways of knowing.

While the complaints of independent fishers are readily dismissed by proponents of tidal energy as uninformed, the latter are careful to tread more carefully in addressing the concerns raised by local First Nations, who hold specific legal rights under Canadian law. Treading more carefully, however, does not necessarily equate to serious engagement. In Canada environmental impact assessments are legally required to include traditional ecological knowledge surveys (TEKS), yet they often do so in a way that separates these surveys from the scientifically grounded conclusions and plans of EIAs and EEMPs. Thus, while the EIA for the FORCE test site included a traditional ecological knowledge survey of area Mi'kmaq Nations, this survey is cordoned off into its own sub-report, with no part of its findings appearing in any other part of the larger EIA or EEMP. At best such traditional knowledge surveys become tools for documenting indigenous uses of the area and identifying potential species for monitoring. At worst, the traditional ecological knowledge survey is just a tick box exercise in which participation is sought but where the outcomes are known in advance (cf Rose 2013: 7). As one Mi'kmaw activist put it

[indigenous] knowledge gets discounted, but they're the ones that are out there on the water, they're the ones who knows what's happening, they're the ones who see the fish dying, they're the ones who know when the temperature is rising, they're the ones who know when something's not right, and it just seems to be dismissed.¹²

By keeping practical and traditional knowledge collected in TEKS separate from scientific knowledge in environmental impact assessments, an extensive, rich base of knowing that could inform and guide scientific development is missed. Beyond this, however, there is also a question of who must bear the risks of scientific study. For the opponents of the Cape Sharpe tidal test, the answer to this question is clear: the living marine wildlife of the Bay and the coastal human communities who depend on the continued flourishing of these animals. Not the tidal energy companies. Not the Provincial or Federal governments.

The opponents of the Cape Sharp Tidal project are angry about this distribution of risk. As the Mk'maggy activist I spoke with pointed out, being experimented on evokes specific histories of

¹⁰ Interview, 2 August 2017, Windsor

¹¹ Interview, *ibid.*

¹² Interview, 10 Aug 2017, Halifax

violence for indigenous Canadians whose forbearers were subjected to nutritional and other experimentation at residential schools.¹³ For the non-indigenous fishers I spoke with, being made to bear the risks of tidal energy testing evoked more generalised feelings of being devalued and silenced in a society and economy where independent fishing was a diminishing presence. The fish and other marine animals who share this risk can only speak indirectly through their encounters with humans on both sides of the debates. Their voices and agencies are translated, imperfectly, incompletely, through monitoring equipment that cuts out at flood tide, or through fishers they interact with in life and death encounters.

After carefully reviewing the available technologies in light of what they know about the tidal waters of the Minas Passage, Fundy United (an association of independent fishers opposed to tidal energy) has requested nearfield visual monitoring of the turbine blades, using a device similar to the one the company uses to monitor things approaching the turbines (such as ice or rocks that could damage the turbine). The device, they hope, would make it easier to know what is happening in the encounter between marine wildlife and the tidal turbine in real time. It would, they hoped, make scientific monitoring a little more attentive to specific times, places, and bodies. When the company installed a monitoring device different from the one recommended by Fundy United, the latter's spokesman expressed his frustration:

“Last night we heard it ain't workin'. I knew it weren't workin'. I told 'em it wouldn't, I have that email too. 'That camera will not work' I told them, a fisherman, a dumb fisherman, right? And that's how we feel ... We should be lookin' at what's hittin' them blades. We should be lookin' if there's any death here [gestures to floor as seabed] ... We want to see, that's how we learn. We're visual learners, right? We wanna see.”¹⁴

The opponents of tidal energy have conceded that remote monitoring might be what is needed to arbitrate the question of collision risk around the turbine site – after all they know very well that the human body cannot withstand the turbulent underwater environment of the passage at flood tide. However, they want to use monitoring in a way that allows them to see the presence of particular marine wildlife in the specifically emplaced context of the turbine site as best as they can – to gain knowledge that is sensible in its multiplicity and messiness, rather than the abstract points on a graph that come out of cleaned data fed through computer models. They want the fish to be knowable as living bodies, not as 'ink on paper', and they want to know these things urgently.

Without access to this visual, and without the power to demand it, Fundy United is looking for death where it can: calling on its members and members of the public to report dead marine animals that have washed ashore, to collect them if possible for examination and at the least to photograph the damage. It's unlikely the evidence collected in this manner could be definitively linked to tidal energy devices. It's difficult to know for sure what has caused injuries and some damage – like ruptured swim bladders caused by sudden changes in pressure around turbines – are invisible from the outside. Fundy United knows that their call to document dead marine wildlife is unlikely to change the course of tidal energy development, but they maintain the importance of this act of witnessing. Their goal is not to end killing and death or to affect some overarching care in general (cf Haraway 2016) for the environment – after all, as fishers they depend on killing fish for a living. But they maintain the

¹³ Interview, *ibid.*

¹⁴ Facebook live video post, 17 January 2017, used with permission.

importance of specifically emplaced, practical knowing, of practicing care, and killing, in encounter with marine animals who are themselves capable of agency, or response.

Conclusion

Embodied ecological knowledge and scientific knowledge are not inevitably opposed to one another. Some fishermen have been working with scientists to try to bridge practical and scientific knowledge of marine ecologies in the Bay of Fundy (e.g. Desveaux 2017). However, in these encounters, it is almost always a matter of translating practical or traditional knowledge of independent and community fishers into the language of marine scientists, and not the other way around. In the case of the EAs and EEMPs associated with tidal energy in the Bay of Fundy, it is the scientists and the industry and government officials they work with who determine the parameters of what can count as knowledge (Sundberg 2006). This framing of what is allowed to count matters because it often means attempting to remove the particular, to consider species as units in isolation from all others, and thus to remove specific bodies in encounter from the accounting, and when this happens something is lost in the knowing. Knowing in embodied encounters is a well of knowledge that is never detached, never nowhere, but always deeply emplaced and embodied, and always in contact with and attuned to other, more-than-human bodies. Analyses of remote data, by contrast, progressively erases the agencies of marine wildlife as traces are turned to data points cleaned of 'noise' and run through complex computer models. The former are not always more desirable than the latter, and both are imperfect translators of the presences of nonhuman others. However, while the scientific models generated from data collected in remote monitoring may predict a lot about abstract groups of wildlife in general, they tell little about marine animals as particular, individual living beings inextricably entwined in rapidly shifting area ecologies.

In this exploration of the fishing and tidal energy contact zones in the Bay of Fundy, I have shown that different ways of knowing and rendering the presence of non-human others in the more-than-human contact zone matters. Haraway (2008) and Despret (2013) have argued that bodies become responsible to one another through encounters, that is, they make it possible to respond. Yet, as Pratt (2008) and those researching less convivial human-wildlife encounters (e.g., Barua 2015; Collard 2012; Johnson 2015; Singleton and Lidskog 2018) have shown, contact zones are also places where bodies become irresponsible towards one another, spaces not only of unequal power but also of grave bodily and cultural violence. Thus it would seem that the promise of the contact zone in this time of rapidly unravelling ecologies is less an assurance of more ethical engagements with the other, and more a possibility of creating a space where the presence of others may make itself known, even if imperfectly. The possibility of responsibility to others may be opened up in encounter, but there is no guarantee it will be realised. The intertidal contact zone is a deeply entangled place enacted through myriad more-than-human encounters – sometimes caring, sometimes violent, but always open to the agency and presence of both humans and nonhumans in the specific. The smoothing of data in this case, like the smoothing of tidal rhythmpatterns (Jones 2011), attempts to reduce complexities, to render complex, shifting ecologies more predictable and amenable to scaling up the knowledges and technologies of late capitalism (Tsing 2012). As anthropogenic climate change warms the seas and speeds up the pace at which ecological relations shift and unravel, however, smoothing out complexities and scaling knowledge is becoming less tenable for solving local problems – the

specificities of place are increasingly intruding as the nonhuman world becomes stranger to us, defying easy prediction.

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