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Centring Fish Agency in Coastal Dam Removal and River Restoration

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ABSTRACT: This article considers the agentic capacity of fish in dam removal decisions. Pairing new materialist explorations of agency with news media, policy documents, and interviews related to a suite of dam decisions in a New England, USA watershed, we identify the ways that river herring seem constrained through technocratic discourse to particular human-defined roles in dam removal discussions. We suggest, meanwhile, that existing human relationships with salmonids like brook trout might serve as a bridge for public stakeholders and restoration managers to recognise the agentic creativity of fish in dam removal and river restoration decisions.

KEYWORDS: Actor Network Theory, brook trout, dam removal, river herring, transspecies

INTRODUCTION

Here we build from news media, policy documents, and interviews with New England, USA restoration managers about ongoing dam decisions, coupled with new materialist theories, to suggest that instead of seeing dam removal decisions as strictly technocratic processes, we should recognise the distributed agency at work, where migratory and resident fish may, in fact, be some of the most prominent actors in the network of dam decision-making. Focusing on a series of dam decisions in Rhode Island's Wood-Pawcatuck Watershed, we identify the ways that river herring (both alewives, *Alosa pseudoharengus*, and bluebacks, *Alosa aestivalis*) are rendered as constrained to particular human-defined roles in dam removal, and we suggest that their salmonid cousins – brook (*Salvelinus fontinalis*), rainbow (*Oncorhynchus mykiss*), and brown trout (*Salmo trutta*) – might instead serve as a bridge for public stakeholders and restoration managers to recognise the agentic creativity of fish. We suggest that a current emphasis on technocratic management of migratory alewife related to dam removals – which largely ignores existing multispecies relationships between humans and trout and fails to allow for trout agency outside of trout-human relations – seems to inhibit some of the possibilities for dam decisions in the watershed (and beyond) that could benefit a variety of human and other-than-human actors (Philo and Wilbert, 2000; Haraway, 2008; TallBear, 2011; Woelfle-Erskine and Cole, 2015). We suggest that what we are seeing in the Wood-Pawcatuck Watershed is analogous to the agentic capacities of migratory and resident fish species in dam decisions throughout the USA and internationally. Crucially,

we insist that theorists and managers should attend to, and make room for, the ways these fish actors sometimes defy scientific predictions and technocratic expectations and to the potential consequences of that defiance.

ATTENDING TO THE AGENCY AND PRACTICE OF FISH IN DAM REMOVAL RESEARCH

While river restoration, fish passage projects, and dam removals have become an increasing focus in peer-reviewed literature, the bulk of published research on the subjects represents work in the biophysical sciences (Wohl and Merritts, 2007; Bernhardt et al., 2007; Palmer et al., 2007; Walter and Merritts, 2008; O'Hanley, 2011; Gartner et al., 2015; Magilligan et al., 2016b). And while there are some discussions of dams in the economic (Provencher et al., 2008; Lewis et al., 2008; Bohlen and Lewis, 2009; Smith, 2009), institutional (Born et al., 1998), and regulatory (Bowman, 2002; Orr et al., 2004; Opperman et al., 2011) realms, on the whole, human dimensions research into natural resources attitudes, perspectives, and arguments has only very recently begun to focus on dams, hydropower, and dam removal (Lejon et al., 2009; Gosnell and Kelly, 2010; Barraud and Germaine, 2013; Jørgensen and Renöfält, 2012; Germaine and Lespez, 2014; Fox et al., 2016).

In communication studies specifically, a field that straddles the social sciences and the humanities, limited existing research related to dams focuses on media framing (de Loë, 1999; Rogers and Schutten, 2004; Jørgensen and Renöfält, 2012; Robinson, 2014) and how the framing of dam and hydropower issues shapes possibilities for countering or reinforcing state power (Yang and Calhoun, 2007; Valenzuela, 2013; Tong, 2014; Ozen, 2014; Scherman et al., 2015; Mancilla-García, 2015; Hilbert et al., 2016). While research in human dimensions of dams and hydropower is also limited, current work tends to cluster around several themes, as Lundberg et al. (in press) have reviewed: 1) the role of conflict in shaping hydropower management and dam decision-making (Carruthers and Rodriguez, 2009; Germaine and Lespez, 2014; Huber and Joshi, 2015); 2) the influence of trust and state power within dam decision-making processes and outcomes (Hart and Poff, 2002; Gosnell and Kelly, 2010; Grumbine and Xu, 2011); 3) the engagement of local communities with hydropower concerns and decisions (Braun, 2011; Gosnell and Kelly, 2010; Braun, 2011; Guerrier et al., 2011; Germaine and Barraud, 2013; Germaine et al., 2016); and 4) the need for interdisciplinary research about dams (Sovacool et al., 2011; Nepal, 2012; Magilligan et al., 2016a). Humanistic and critical approaches to the study of dams remain virtually non-existent (Ross, 2008; Öhman, 2016; Hychka and Druschke, 2017; Druschke and Rai, in press).

We see a vibrant future for research into (other-than) human dimensions of dams that builds from the handful of theoretical, critical inquiries into dam construction (Braun, 2011; Öhman, 2016; Öhman and Thunqvist, 2016) to build rhetorical, feminist, and new materialist theories and analyses of dam removal (not just construction) and fish passage projects that support management decisions about dams by integrating the concerns of scientists, stakeholders, and other-than-human actors. We think that interdisciplinary, critical inquiries into the agentic capacities of migratory and resident fish involved in dam removal decisions can work to address and resolve some of the major issues emerging in social-scientific human dimensions research about dams: conflict; trust, governance, and power; and community engagement. We hope here to create a model for that work.

What we offer, then, is not a social-scientific, hypothesis-driven investigation of river herring's and trout's roles in fish passage projects in coastal Rhode Island. Instead, inspired by new materialist explorations of agency and practice, we focus on migratory river herring and resident brook, rainbow, and brown trout in a particular watershed to offer speculative ways of decentring human agency in fish passage projects including dam removal, to consider the inventive possibilities of human-trout relationships, and to offer creative suggestions for how restoration managers might co-create dam removal projects at hyper-local scales, in particular, through the co-production of practices, or intra-

actions, with fish themselves that allow for stochasticity and slipperiness (Barad, 1999; Jasanoff, 2004; Law and Lien, 2012; Woelfle-Erskine, 2015).

Though we are not the first researchers to consider the agentic capacities of fish, fish have largely taken a backseat in human-animal studies, as has a focus on aquatic environments in critical studies more broadly. Extending the small pool of existing work on fish agency, we suggest the framing of fish as agentic actors has untapped relevance not only for critical studies but for resources management broadly and for dam removal research and practice more specifically. As early as 1986, Michel Callon worked to reframe the scallops of St. Brieuc Bay as major actors in discussions over resources management of the scallop fishery in France. To study power within the scientific and economic controversy over scallop fishing, Callon (1986) illuminated the need to check the power and privilege embedded within social-science methods used to examine, analyse, and explain controversies. Instead, Callon (1986) redistributed power and privilege to return autonomy to the human, fish, and other actors playing vital roles in real-life discussions, arguing that social interactions among humans and other-than-humans hold key pieces of controversies that must be rendered visible. Some 25 years later, Christopher Bear (2012) built from his ongoing work on fish agency (Bear and Eden, 2008; 2011) to return to the scallop industry. There he employed assemblage theory to foreground the role of scallops, dolphins, the sea, seabed, fishing technologies, and regulatory practices in the management controversy over Cardigan Bay, Wales, working to point cultural geography towards both assemblage thinking and the sea.

Also looking "below the sea's surface" as Bear (2012: 35) suggested, that same year John Law and Marianne Elisabeth Lien (2012) employed actor network theory to attend to the character of farmed Atlantic salmon as "an effect of relational practices" (p. 365), in order to discuss the multiplicity of human-salmon relations. Utilising empirical ontology within science and technology studies, Law and Lien (2012: 363) asserted that salmon do not exist within a vacuum, but exist within "a penumbra of not quite realised realities" defined by the intricate practices, acts, and agency enacted on them by human intervention. Employing the concept of multiplicity, salmon – and fish more broadly – are indeed many things to many people – and are things without what they are to people – at varying times. They embody overlapping identities at once; they exist within and as the effect of overlapping ontologies. Through a turn toward choreography – which Law and Lien (2012) use to denote the relational, repetitious, and "more or less precarious" interactions between salmon and humans – they render visible relations, what they refer to as "networks, webs or rhizomes of tangled relationality that give shape or form for a moment to anaesthetised salmon" (p. 366), and the salmon comes to be seen as an actor with individual agency that is so often stripped by human practice (Law and Lien, 2012: 366).

Building from indigenous epistemologies, ontologies, and cosmologies rather than the actor network theory, Zoe Todd (2014), too, centres human-fish relations and the active agency and multiplicity of fish – as complex "fish pluralities" that entail "multiple ways of knowing or defining fish" (p. 217) – to consider the legal-political order of fish in Canadian colonial practices, while Cleo Woelfle-Erskine (2015) borrows Karen Barad's notion of agential realism to consider the role of salmon in the intra-actions that produce water practices in northern California. Continuing to focus on salmon, but highlighting a relational web between salmon, human, and beaver, Woelfle-Erskine and July Cole (2015) build from work in feminist science and technology studies and indigenous, feminist, transboundary thinking to investigate beaver-salmon-human worlds. They aim to reconfigure multi-species relationships by creating an "affective ecology" (Hustak and Myers, 2012), considering, as Woelfle-Erskine and Cole (2015) describe, "How the beavers we met physically decolonised the controlled territories of Manifest Destiny, tying river systems and species back together in ways that increase resilience in the face of devastation" (p. 298). Their emphasis on other-than-humans working as central actors in the creation of river connectivity offers possibilities for considering fish as central actors in dam-removal practice, tying river systems and multiple species back together through connectivity and creating newly constructed realities of river health and human-fish relations.

Outside the realm of fish, but otherwise central to our interests here, Goedeke and Rikoon (2008) build from Bruno Latour (1987, 2004) to focus on the central role of otters in river restoration narratives and subsequent practices. As they conclude, "Nonhuman actors, such as water, soil, plants, and animals, must be included in accounts of restoration and restorative projects. This is because the outcomes of such projects require the compliance of humans and nonhumans alike to scientific predictions, and both are implicated in social conflicts" (Goedeke and Rikoon, 2008: 112). In their assessment, compliance matters to restoration management outcomes. Here, we want to take a different tack: heeding Bear's (2012) aquatic orientation and Steinberg and Peters' (2015) insistence to point geography towards 'wet ontologies' in order to suggest that restoration managers make allowances for noncompliance, evasion, and surprise. Instead of insisting on compliance, we want to suggest that restoration managers involved in dam removals can build from new materialist and transspecies perspectives to more deeply attend to the needs of the other-than-human actors impacted by dam decisions; to consider existing fish-human relationships that might drive public opposition and support of dam removal projects; to free up room for other-than-human (and human) actors to behave in non-compliant and surprising ways; and to find ways to integrate the concerns and interests of a wider set of human and other-than-human actors in dam removal decisions. In short, they might be well-served by allowing space for migratory and resident fish, dams, and water levels, among other actors, to be 'slippery' in the words of Law and Lien (2012).

What dam removal research can learn from this growing body of work about aquatic new materialisms is a focus on distributed agency and emergent practice: a making visible of the distribution of agency throughout a network to fish, other aquatic species, and rivers themselves who participate in, co-produce, and are co-produced by the practices that emerge from connections between fish, humans, rivers, institutions, policies, and more. This is a theoretical position that doesn't so much privilege fish as it does de-privilege and de-centre the role of human activity in dam removal decisions. It is a move that makes fish relations multiple and, thus, makes fish themselves multiple: at once living beings, traded commodities, objects of efficient management, prized trophies, fierce predators, and more.

In our collective experience on Rhode Island's Wood-Pawcatuck River and elsewhere, we began to question the role of fish agency in the abundance of dam decisions over the last decade; to consider the agency of river herring and brook, rainbow, and brown trout; and to foreground "the multiple ways of knowing and defining fish" (Todd, 2014: 217) in dam decision-making in the Wood-Pawcatuck Watershed.

DAM REMOVAL AND FISH PASSAGE ON THE WOOD-PAWCATUCK RIVER

Our collaborative research in the watershed began in earnest with a series of Institutional Review Board (IRB)-approved interviews (n=27) about decision-making and public engagement in aquatic restoration projects, including dam removals. It continued through 2015, 2016, and 2017 in multiple waves of IRB-approved interviews with restoration managers and key stakeholders in dam decision-making and fish engagement (n=15). While our collective research focuses on southern New England watersheds more broadly, including comparative work between Rhode Island and the larger region, as well as northwestern France, our attention was drawn to the Wood-Pawcatuck Watershed because of the watershed's size, its intensity of dams, its multiple dam removal and fish-passage projects, its potential habitat value for migratory fish like alewives, bluebacks, and shad, and its active community-based watershed organisation, the Wood-Pawcatuck Watershed Association.

The 300 square mile Wood-Pawcatuck Watershed, in southern Rhode Island and southeastern Connecticut, US, is considered one of the pristine gems of southern New England. The watershed features 57 river miles abundant with native and stocked brook trout, stocked rainbow and brown trout, turtles, birds, and unfilled wetlands. As of this writing, the watershed is under consideration to be

included in the federal Wild & Scenic programme, a move that would protect the Wood-Pawcatuck's natural resources through the preservation of its "free-flowing condition to protect the water quality of such rivers and to fulfil other vital national conservation purposes" (Wild & Scenic Rivers Act, October 2, 1968).

Rivers in New England, US, are notoriously dam-rich, given their industrial revolution mill history, with the region featuring some 14,000 dams at present (Fox et al., 2016), and the Wood-Pawcatuck system is no exception. In recent years, the watershed has seen a flood of dam-related decision-making, with the Wood-Pawcatuck Watershed Association (WPWA) spearheading efforts – in collaboration with the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service and The Nature Conservancy, among other entities – to improve connectivity and decrease flooding via fish-passage upgrades throughout the river system.

The main stem of the Pawcatuck River long featured six small (6-13 ft.) century-old dams upstream of its outlet into Little Narragansett Bay and Block Island Sound beyond, many of which, until recent improvements, featured poor or no fish passage. From 2010 to 2018, collaborating entities including WPWA have worked on restoration projects on all six main stem Pawcatuck dams: 1) the Lower Shannock Falls Dam removal (2010); 2) Horseshoe Falls Dam Denil fish ladder installation (2011); 3) Kenyon Mill Dam nature-like fishway installation (2012); 4) White Rock Dam removal (2015); 5) Potter Hill Mill Denil fish ladder renovation (2016); and 6) Bradford Dam nature-like fishway installation (2017/2018) (Figure 1).

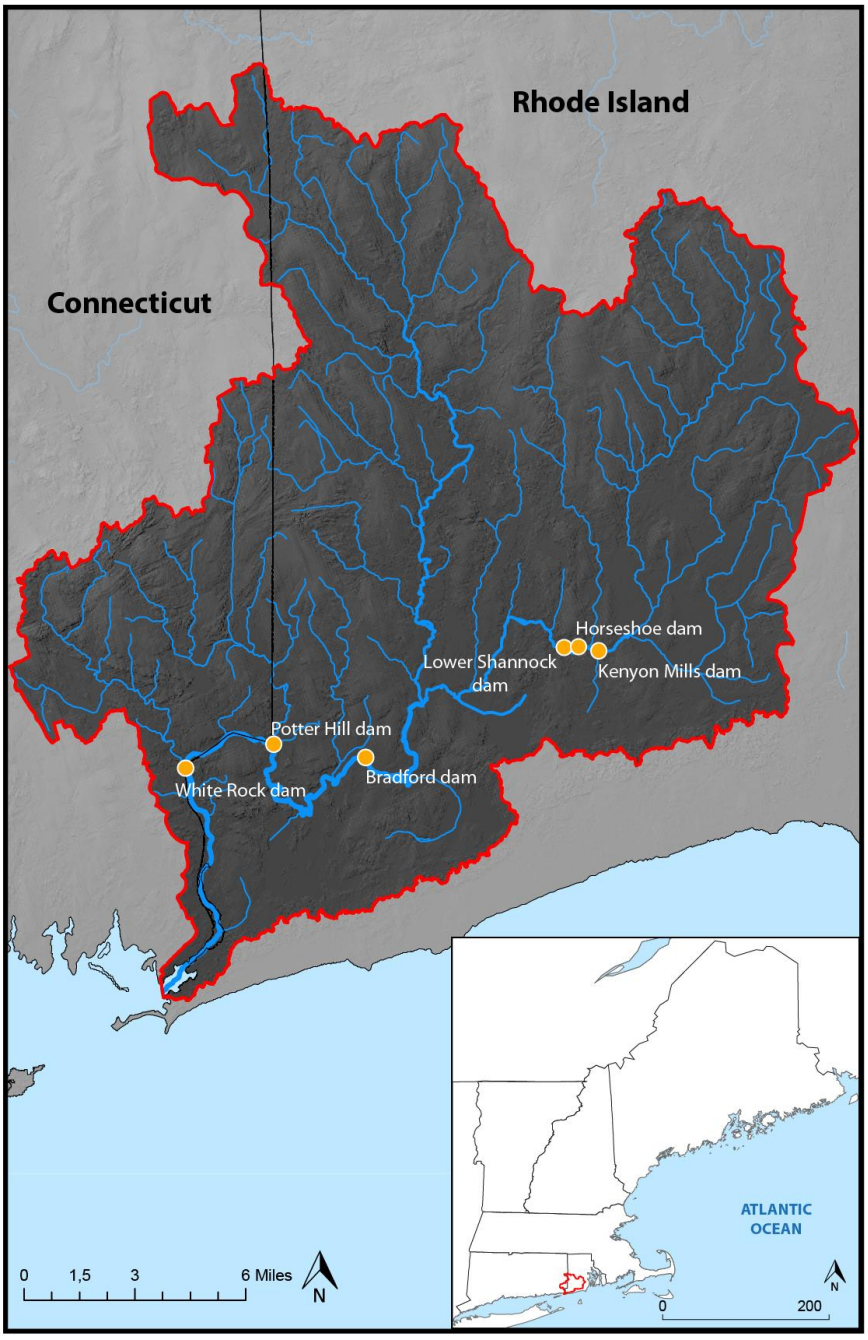
These fish-passage improvements should theoretically open approximately 1300 acres of upstream spawning habitat for anadromous fish like alewives, blueback herring, shad, and sea-run brook trout, as well as clear passage for catadromous species like American eel (WPWA, 'Upper Pawcatuck River'). WPWA argues these improvements to fish passage would also increase food supply for recreational and commercial fish; restore river connectivity; improve flood storage by creating a more natural floodplain; improve recreation; contribute to job creation; and remove liability of dam owners (WPWA, 'Upper Pawcatuck River').

THE ROLE OF RIVER HERRING IN DAM PROJECTS ON THE PAWCATUCK RIVER

In coastal areas like Rhode Island, dam removals and related projects are deeply intertwined with migratory fish like river herring and American shad. In coastal areas, metrics of success for federal agencies and many local organisations involved in dam removal and fish-passage projects, in practice at least, were reported by managers we interviewed to be related to either quantity or simple presence and absence of post-removal migratory fish. This focus on the presence and absence of migratory fish is partly due to a frequent lack of funding for post-project monitoring that would include more robust information for things like diversity and abundance of fish and arthropods, sediment transport, or nutrient budgets. And this emphasis on migratory fish in coastal areas – in both metrics for success and in the narratives and arguments told about dam removal – is no doubt bound up with funding sources available for improving habitat and passage for migratory species via dam removals and the installation or upgrading of Denil fish ladders or nature-like fishways.

As the restoration managers we spoke with described crafting funding proposals for dam-related projects and working to interact with public stakeholders about these projects, they tended to offer sentiments like one shared by a non-profit manager we refer to as 'Matt' involved in the 2015 removal of the White Rock Dam on the Pawcatuck River:

Figure 1. Map of the Wood-Pawcatuck Watershed, including the six main stem dams that have been a focus of restoration work from 2010 to 2018.



Note: The six dams are: White Rock Dam (removed), Potter Hill Dam (Denil fish ladder renovated), Bradford Dam (nature-like fishway installed), Lower Shannock Dam (removed), Horseshoe Falls Dam (Denil fish ladder installed), and Kenyon Mill Dam (nature-like fishway installed).

> So there were two main arguments that we used, and they really boiled down to fish passage, you know, and flood abatement.

Fish passage in these contexts tended to relate to hoped-for outcomes like presence, absence, and abundance of diadromous fish species, including alewives, bluebacks, and New England's iconic

American shad, rather than native and introduced resident salmonid species like brook, rainbow, and brown trout, or other fish species. (Atlantic salmon were long ago extirpated in Rhode Island.)

Matt reflected on the prioritisation of migratory fish like river herring post-removal – who have been prohibited from harvest in Rhode Island since 2006 – over resident, recreational species like trout in the removal of the White Rock Dam. Of the dam site post-removal, Matt explained:

> I don't think the river being open really changed the fishing experience that much, maybe a little bit, but we were trying to hit the top line things… Things like shad and [river] herring.

River herring and shad appeared as the 'top line things' in this case: the major focus of the USD2 million-plus removal at the White Rock Dam.

Even beyond the interviews we conducted, there is strong evidence to suggest that alewives (and, to a lesser extent, blueback herring) play a starring role in dam decision-making in the Wood-Pawcatuck Watershed, as they seem to in other coastal watersheds up and down the Atlantic US coast. News media, too, demonstrate this move to highlight the role of migratory fish in dam decisions in the watershed. Of the 32 articles focused on Wood-Pawcatuck Dam removals in online-accessible state and local, southern Rhode Island newspaper archives (*Providence Journal*, *The Westerly Sun*, *Beacon Communications*, and the *Kent County Daily Times*) from February 1985 (the month of introduction of the US Electric Consumers Protection Act, which required the Federal Energy Regulatory Commission to formally consider and discuss resource agencies' recommendations) to June 2016, all but one mention the migratory fish that would benefit from dam removal, including river herring, shad, American eel, and sea-run trout, but none of these articles mention resident trout populations.

Alewives and dams seem to go hand-in-hand in Rhode Island media coverage about dam decision-making, with many news articles telling a triumphant tale of the return of migratory river herring enabled by dam removals and installations of fish ladders and nature-like fishways on the Wood-Pawcatuck. Articles frequently pointed to migratory fish passage as the driving force behind dam decision-making. Terry Sullivan, Nature Conservancy Rhode Island State Director, was quoted in one article making this point directly:

> The primary driver for taking out the White Rock Dam was to allow fish passage for migrating species – we saw that 90% of the river herring were not making it past that dam. So to have the river flowing there and having the river herring going to their historic spawning grounds is an amazing accomplishment (*The Westerly Sun*, 6/21/16).

The same article also included a quote from United States Senator from Rhode Island Jack Reed who put the White Rock Dam removal in historical context:

> The White Rock Dam was 245 years old, and it is running free now for the first time since 1770 (*The Westerly Sun*, 6/21/16).

Echoing Senator Reed, The Nature Conservancy Associate State Director, Scott Comings, was quoted in several articles, casting the dam removal within its historic trajectory. As Comings offered in one article:

> It's a heady thing to think that in a few weeks this river will run free for the first time since 1770 (*Providence Journal*, 9/5/15).

To grasp the magnitude of the dam removal, The Nature Conservancy's Sullivan is quoted as highlighting that the last time the river ran unimpeded through that reach was:

> Before we were a nation (*Providence Journal*, 9/5/15).

This historical context emerged in our interviews with restoration managers, as well. One federal manager we'll refer to as 'Tom' pointed to historical runs of migratory fish as a means of addressing

contemporary conflicts between mill dam proponents and his central task of removing dams for the sake of migratory fish. As Tom explained:

> Ah there's one that's a local couple guys that run this old historic mill. It's kind of a museum-like feature and stuff (…) They've got a passion for history, which is fine. I mean, but it often conflicts. You're saying, 'Okay, but which came first, the fish or the dam?' You know, it's like, the fish did. I mean, you had native peoples that spent hundreds of years surviving on those fish runs. And then European colonisation came along and started building dams and destroyed a lot of these fish runs. And so all's we're trying to do is put fish runs back.

These migratory fish become part of the march of history in these contexts, but we want to heed the theoretical work of Law and Lien (2012) and Todd (2014), among others, to consider this historical rendering as just one of many possible ways of knowing and relating to migratory fish (and to dams and dam removal) in the Wood-Pawcatuck Watershed. Indeed, in this historical frame, rather than understood as active agents, the Wood-Pawcatuck's alewives, bluebacks, and shad are easily treated almost as historical backdrop, as natural resources to be viewed with wonder, to be managed, and to be stewarded.

There is no affordance for stochastic response here (Woelfle-Erskine and Cole, 2015); this is not a rendering of a 'wet ontology', the label Steinberg and Peters (2015) propose, "not merely to endorse the perspective of a world of flows, connections, liquidities, and becomings, but also to propose a means by which the sea's material and phenomenological distinctiveness can facilitate the reimagining and re-enlivening of a world ever on the move" (p. 248). Though we are not talking here directly of the sea, we are talking about a tidal river and its sea-running, physiologically transforming fish that could seemingly tell us a great deal about flows, connections, liquidities, and becomings in ways that might help us reimagine and re-enliven a world ever on the move. Instead, migratory fish in general and alewives specifically seem rendered flat of affect. Bounded by historical narrative. They are represented as distanced objects without agency, managed by the humans who seem to remain fully in control.

In that vein, one *Providence Journal* article opened with the following scene, emphasising the managerial logics of migratory fish passage including dam removal in the watershed:

> Larry Lofton and Kevin Cheung backed their US Fish and Wildlife Service truck toward the Pawcatuck River at the Bradford boat landing and prepared to pump 240,000 tiny shad into the river's gin-clear waters. Each fish was just a few days old, and so small it was difficult to see a dark head and a transparent body, about half an inch long. Lofton says he can tell when they eat because you can see the food right through their flesh. By fall, biologists expect these fish will be 3 or 4 inches long and ready to swim down the river and out to sea, where they should remain for the next four years. The hope is that when they return to spawn, they will reinvigorate a fishery that has been in a dramatic decline (Lord, 2010).

The Westerly Sun, too, picked up on this theme of management and stewardship, describing the installation of a nature-like fishway at Kenyon Mill this way:

> On a frigid morning, water courses over the dam at Kenyon Industries before crashing and splashing through a minefield of rocks. With curving river bends just upstream and downstream and woods all along the opposite bank, you just might think you were looking at a natural set of rapids. In reality, however, this short rocky stretch of the Pawcatuck River is a manmade solution to a manmade problem. Just completed, it's designed to help vertically challenged fish – face it river herring, you'll never leap like salmon – use the rocks like linemen to block the current and enable them to swim up to, and over, the dam (Salit, 2014).

These migratory fish are pumped, stocked, and assisted via a 'manmade' engineered structure referred to as a 'nature-like' fishway. They prosper, the argument seems to go, only with the technical assistance of the state and the aid of federal funding, largely through Denil fish ladders, widespread stocking and assisted movement, and nature-like fishways that, instead of returning rivers to their pre-dam water levels, actually preserve altered river depth formed by the since-removed-dam because they rely on a

series of weirs to function. In a 2015 article in *The Westerly Sun*, the Rhode Island State Supervising Biologist for Freshwater and Diadromous Fisheries pointed to the technical assistance of stocking efforts after the removal of the Kenyon and Lower Shannock Falls dams and the construction of a Denil fish ladder at Horseshoe Falls:

> What we have done is stock the upper systems. We have stocked adult river herring broodstock into Worden's Pond and Watchaug Pond. What happens is, those fish spawn and they exit the system, but the eggs hatch, and the juveniles stay the summer months in those freshwater systems. During the fall, they migrate to the ocean and they're now imprinted for the Pawcatuck River, so after three or four years, they will return (*The Westerly Sun*, 11/20/15).

Migratory fish passage on the Wood-Pawcatuck system is a highly managed enterprise, through stocking efforts, like those described above, and through a wealth of biophysical assessments. As Nils Wiberg, the project manager on the White Rock dam removal, described in a 2015 article:

> The studies, the data collection and the assessments are necessary so that we can develop a strategy to optimise fish passage. We want to get as many fish upstream with as little effort as possible, so they can move through the fish ladders and get to their spawning areas (*The Westerly Sun*, 11/20/15).

The efficient management of migratory fish emerges as a major interest in news media about dam removals and other fish-passage projects on the Wood-Pawcatuck system, while river herring and shad, specifically, emerge as the poster children for and primary beneficiaries of these projects.

Just as migratory fish, like river herring, emerge as a key driver for dam removal decisions in the watershed, this emphasis on efficient management – which seems to undercut fish agency in part by foreclosing the multiplicity of possible human-fish relationships through its emphasis on migratory fish as stocked resource – is supported, too, through the codification of management documents that govern the practices of migratory fish management in the state; these policy documents tend to amplify, rather than dull, the impulse towards efficient management of fish populations in the watershed. Efforts to support migratory fish passage in the state are regulated and directed through a complex network of interlocking agencies at the watershed, state, and federal scales, but largely reside under the guidance of the Rhode Island Department of Environmental Management's Strategic Plan for the Restoration of Anadromous Fishes to Rhode Island Coastal Streams (Erkan, 2002). The Strategic Plan outlines strategies for restoring migratory fish populations in Rhode Island streams which consist of technical solutions that include constructing manufactured fish passages, stocking of migratory fish species, and ongoing monitoring of fish populations.

As it details, "The primary goals [of the Plan] are to minimise passage-induced mortality allowing expansion into unutilised and underutilised habitats with the most cost-effective method available. Reintroduction of spawning broodstock is another critical component of the restoration efforts" (Erkan, 2002: 7). Technical-managerial logics are evident in the language of mortality rates, cost-effectiveness, and fish stocking, and these logics guide restoration efforts throughout the state. Migratory fish species like Atlantic salmon, alewives, blueback herring, and shad were heavily impacted in New England by the construction of dams region-wide in the early industrial era. In these management documents, as well as in news media and our manager interviews, the solution to restoring these species is likewise often envisioned through human control of natural processes and landscapes: through breeding programmes and stocking that contribute to the cost-efficient monitoring and management of fish populations. In Todd's (2014) language, these managed fish seem almost like fish singularities, not pluralities. Instead of multiple ways of knowing and defining alewives and shad, there is one dominant social representation, one constrained ontology: that of a dominant managerial, historical relation to migratory fish.

Indeed, as we mentioned at the outset, it makes financial sense that migratory fish would be highlighted in news articles about fish passage projects in the Wood-Pawcatuck Watershed – in both

the voices of journalists responsible for the pieces and in the quotations featured from local, state, and federal fisheries managers involved in the projects. As Matt and Tom and other interviewees detailed, funding for much of the work on the Pawcatuck dams came from NOAA's Restoration Center and from Post-Hurricane Sandy Department of the Interior coastal resiliency funding. First, a USD130,000 Shannock-Kenyon Fish Passage feasibility study was funded through a joint NOAA and American Rivers Open-Rivers Initiative grant, along with funding from the Rhode Island Coastal Habitat Estuary Trust and the US Fish and Wildlife Service (USFWS). This first study, conducted between 2006 and 2008, aimed specifically at finding means to improve fish passage on the Pawcatuck. In 2009, NOAA's Restoration Center, which focuses especially on restoration of migratory fish habitat, awarded USD106 million nationwide to implement restoration projects thanks to the American Recovery and Reinvestment Act. A portion of this money came as an opportunity to complete the passage construction at the three upper dams on the Pawcatuck (Lower Shannock; Horseshoe Falls; Kenyon Mill). Minor funding came from sources such as the USFWS and the Natural Resources Conservation Service, which brought the three projects up to a cost of USD4.3 million overall. Funding for the White Rock Dam removal and Bradford nature-like fishway project came from Post-Hurricane Sandy Department of the Interior Relief funding, with additional funding coming from various sources, including NOAA-National Marine Fisheries Service sources for fish passage. Because the general goal behind the Hurricane Sandy funding was to improve coastal resilience, projects such as opening rivers to improve fish passage and prevent flooding were financed. Migratory fish passage played a major role in securing funding for these projects on the Pawcatuck River, as it presumably does in other coastal watersheds, so migratory fish passage seems to drive the stories that are told in news media and interviews about these projects.

The power of discourses supported by, and circulated through, federal calls for funding, state and federal management documents, and state-based fish stocking practices produce dam removal practice in Rhode Island and similar coastal watersheds as a technical-managerial practice that supports and prioritises the stewardship of migratory species like river herring and American shad. In Rhode Island, dam removal is practised against a backdrop of – and becomes a result of – a variety of circulating narratives: news media that cultivate a sense of wonder about or need for stewardship of migratory river herring on the part of readers; management documents contributing to this emphasis on technical assistance and stewardship; and restoration manager discourse that frames dam removal and fish passage projects in the language of migratory fish benefits understood as efficiency of movement and quantity of fish bodies.

But we take seriously the indigenous and new materialist perspectives that opened this article, reminding us of the multiple ways of knowing and relating to fish and understanding the character of the Wood-Pawcatuck's alewives and shad as "an effect of relational practices" (Law and Lien, 2012: 365). And so, while dominant, we want to caution that this managerial logic is just one way of knowing – or, more apt, co-*producing* – the Wood-Pawcatuck's fish, and that, at present, it seems to foreclose the agency of migratory fish like alewife and shad in dam decisions in the watershed. Quite simply, the river herring that are the focus of management discourse and practice related to dam removal in the watershed come to be seen only as the effect of representations of them in funding proposals, final reports, and news reports. On the Pawcatuck River, particularly, these migratory fish rarely even get rendered through scientific discourse. For instance, while proposed research in the watershed would track returning alewife and shad past these former impediments, to date there is minimal understanding of how these migratory fish respond to recent dam removals, aside from raw counts of returning fish at a number of barriers in the watershed, and there is virtually no understanding of how the river itself responds to these changes because of a current lack of monitoring of fish passage structures (though that work is now proposed). In short, there seems to be no room for slipperiness and stochasticity of migratory fish (or water levels or sediment, and so on) in these dominant narratives.

HUMAN-TROUT RELATIONSHIPS AS A MODEL FOR RECOGNISING FISH AGENCY IN DAM DECISIONS

As we have described, migratory fish are rendered an effect of a very limited set of relational practices in news media, management documents, funding regulations, and manager discourses related to dam decisions in this coastal watershed. But there is some evidence that the force of these prevalent dam removal discourses elides a more nuanced story about the drivers behind dam decisions and a sensitivity to the wider impacts of dam removal projects for species beyond migratory fish. That expanded vision came to light in small hints in two specific interviews. As one nonprofit restoration manager, we'll call her 'Jennifer', reflected:

> It would be nice if there was like a pot of money for folks to just take out their dams for safety reasons or whatever. I mean then you can find another reason. There's always a reason, an economic reason, or just, I mean, it's always good to restore a river even if there's not anadromous fish there. There's trout or other local fish that would really love and benefit from having a free-flowing river. So it's just – the way it has been with the Federal grants. You kind of have to have an endangered – an endangered fish or a fish of concern or whatever it is.

In other words, Jennifer was focused on many reasons for dam removal, and many of its beneficiaries – including the trout species we'll discuss below – but recognised that funding for dam removal and fish passage projects in these coastal watersheds typically came through projects' potential impacts on migratory fish restoration. And, thus, the official narrative about dam removal in this coastal state foregrounds migratory fish species, despite potential impacts on resident fish.

Another nonprofit manager we'll refer to as 'Donna' addressed this same point, that funding for dam removals and alterations in this coastal state usually comes through migratory fish passage priorities. But Donna explained that, in her role with a local watershed group, she is (or at least wants to be) focused on resident – what Donna referred to as 'river' – fish. She emphasised the importance of these resident 'river' fish versus migratory fish, explaining:

> When we talk about, you know, doing sampling on the rivers, or doing fish sampling, we really wanna see that there's river fish in the rivers. (…) And so that's also kind of the message that we have been trying to get across to people. We want river fish in the rivers.

Talking with Donna, there was a sense that migratory fish were prioritised in dam-removal decisions in coastal watersheds, but that Donna, focused as she is primarily on the freshwater portions of the watershed, instead prioritises the river fish that populate the river system all 12 months of the year.

As we detailed above, we do think it is important for restoration managers involved in dam removals to better incorporate the multiplicity of relations with *non*-'river fish', those migratory species like alewives and American shad, and, in fact, to make room for the multiplicity of relations that lay outside the scope of human understanding or perception. In other words, to allow for not just wet ontology, but wet ontologies: for fish-ness and fluidity outside of human control. We hope that dam-removal practitioners and researchers will more deeply consider the agentic capacities of these migratory fish to consider their active roles co-creating – through distributed agency and emergent practice – the narratives and practices and consequences of human-fish-dam relationships in the watershed. And we wonder whether there might be a lesson for that sort of fluidity from 'river fish', from the constellation of other fish (and other aquatic beings) impacted by dam removals: in particular, wild brook trout and stocked brook, rainbow, and brown trout with whom, we have noticed, watershed stakeholders vocal in dam decisions seem to have much deeper relationships than they do with river herring or shad. Because of these existing human-salmonid relationships, however fraught, maybe human decision-makers would be more predisposed to listening to and learning from salmonids. We suggest that the brook, brown, and rainbow trout largely ignored in managerial discussions and media reports of dam decisions offer creative possibilities for re-centring the agency of fish in dam decisions in coastal watersheds. Further, we wonder whether allowing for those agentic possibilities – through human-fish

relations and fish-fish relations – may, in fact, offer benefits for public support of dam decisions that restoration managers so desperately seek.

While we understand that dam-removal impacts on trout would be most significant in tributaries rather than on the main stem dams in question, we note the seemingly complete absence of resident trout in dam-removal discussions on the six Pawcatuck River dams. Just as none of the news articles about dam removal in the Wood-Pawcatuck Watershed mentioned resident trout, the restoration managers we interviewed also did not focus on dam-removal impacts on resident trout. But it seems clear that many local residents, and even some watershed managers, share an attachment and personal connection with resident trout. For instance, when one of us revealed late in an interview that, "I'm not in love with alewives", Donna actually chimed in with a laugh:

> I'm not either. I love my brook trout.

While Donna may not have been speaking here of a one-to-one, being-to-being relationship with a particular, individual brook trout, her attitude towards brook trout as a species does come from years of interaction with individual brook trout at the end of her fly line. In part because brook trout are less frequently encountered than stocked rainbows and browns, that angler-salmonid relationship, though one of domination in some ways, does foster an intense intimacy as individual angler and individual brook trout are held together for even a brief moment through the lightest balance on the end of a line: held in tension together, responding to each other to run upstream or down or be brought into the net. The longstanding connections between watershed residents and the trout they fish for throughout the year might offer a sort of sensitivity towards the possibility for new kinds of human-trout (and trout-trout, and trout-dam, and so on) relations.

When asked directly about human relationships with fish in the watershed and if those extended to river herring, Donna responded that while some Rhode Islanders are interested in the seasonal arrival of river herring each spring:

> Most people, their relationship is with the trout that they catch on opening day.

Intensive fish stocking by the Rhode Island Department of Environmental Management ensures that 175,000 licence-holding recreational anglers (ages 16 and up) in Rhode Island – 16% of Rhode Island's population – have direct personal contact with recreational fish including trout each year, a far different statistic than the small handful of people who hold state scientific collector's permits to interact with river herring through manual lifting over mill dams. The state closes its trout fishery in March and early April, giving the Rhode Island Department of Environmental Management approximately eight weeks to stock designated ponds and river reaches for opening day, the second Saturday in April: the day that Donna suggested continues to structure and cement many Rhode Islanders' relationships with trout.

That personal connection, we suggest, is both a blessing and a curse for dam removal efforts. Though the agency of brook, rainbow, and brown trout is highly underestimated in technical-managerial logics of stocking, these stocked fish offer points of contact with human actors in the watershed and a shared narrative of transspecies interaction on which to build. Rhode Island trout have become in large part the effect of relational practices fostered through trout fishing in the watershed. And they have also become an effect of human-fish relations built through public education and engagement like the Trout in the Classroom programme in various Rhode Island public schools. As a restoration manager, 'Michelle', from one of the urban river systems in the state described, in the programme:

> The kids learn about science, biology, um, water quality, math, ecology, through growing young fish in their classroom… young trout. So they have to like host these trout and take care of them and they learn about their lifecycle and they learn about what they need to live and you know, what does the water have to be

> like and how does the water get polluted, you know, so there's just so many things, so many pieces that they can learn around these fish.

As Michelle continued:

> And they get kind of attached to their fish and then at the end of the programme they go release them into the river.

We want to emphasise that this attachment matters. The existence of education and engagement strategies and the fact that 20,000 Rhode Islanders – almost 2% of the state's one million-plus residents – are drawn from their homes on opening day by the lure of trout are key ways in which attachment and lines of human-trout connections have been drawn. Stocked trout and classroom trout as they are produced through transspecies practice have the potential to act in dam decision-making as the charismatic face for their wild trout relatives, who are potentially impacted by dam-removal decisions. And these forms of transspecies engagement take place beyond classrooms and opening day, as well; non-profits and community-run fishing clubs also act in ways large and small that work to bolster human-trout, transspecies connections.

WPWA, for instance, while leading the charge on dam removal and fish passage efforts throughout the watershed that explicitly benefit anadromous species, also offers fly fishing courses, free coffee on trout opening day, online content about trout fishing in the watershed, learn-to-fish courses for kids, watershed-based education units, and field days. These activities get humans interacting with their piscine neighbours in close proximity, putting scale-to-skin (Rozzi and Jiménez, 2014) to begin to develop new forms of shared relational practices that might produce the sort of trout that becomes visible and thus considered in dam decision-making: creating, as Woelfle-Erskine and Cole (2015) pointed to, newly constructed realities of river health and human-fish relations.

The Wood River Fly Fishing Club, too, has created possibilities for human-fish, scale-to-skin interaction, as they have historically joined forces with the Rhode Island Department of Environmental Management stocking programme to wade the Wood River and float stock catchable rainbow and brown trout. As Donna described of the Wood River Fly Fishing Club's work:

> They'll actually meet the [state] stocking truck up at Route 165. And they'll take the fish by net and put them into these float boxes. And they'll get into their waders and they'll walk down the river and stock very gently that way.

While float stocking is potentially problematic, as it conflicts with national policies for groups like Trout Unlimited against stocking hatchery trout on top of wild trout species, this 'gentle' form of interaction and relational practice, continued over years, has been described by at least one source as instrumental "in the preservation of this [trout] fishery" (*On The Water Staff*, 2011). While some would take issue with that statement, at the very least float stocking puts scale-to-skin, connecting anglers and hatchery trout in visceral ways. The human-trout relationship that is constructed and fostered through this transfer of hatchery-raised trout from one reality to the next is built and expanded on through the acting of humans on trout through collaborative stocking efforts. As the Wood River is, as the same source described, "generously stocked with rainbow and brown trout" numerous times throughout the year (*On The Water* Staff, 2011), there are many occasions for humans to connect with stocked trout, as in this example of float stockings practised by non-profit, state, and public collaborators.

These scale-to-skin relational transitions – a visceral practice that transitions trout from abstract stocked commodity to individual embodied fish – are, in part, what makes some anglers see the Wood River, in the upper Wood-Pawcatuck Watershed, as the prime fishing area in the state, and it helps to create a profound relational experience for these anglers. Trout's transition from one constructed reality to another – from trout as 'commodities' produced thousands at a time by artificial, technological means in trays and runways, to the individual fish placed ever so gently by individual

human into flowing Wood River waters – continually reconstructs what it means to be a trout and what it means to be an angler. And this deeply held understanding of what it means to be an angler – co-produced through distributed agency and emergent relational practice, through the intra-actions of human and trout – plays an essential role in public support of, or opposition to, dam removals in the watershed.

Crucially, we do not mean to suggest that the human-trout relationships created through freshwater angling offer the only agentic possibilities for fish: that fish only exist as agents in dam discussions in their relationality to anglers or humans more broadly. Rather, we want to suggest that this public disposition towards trout could offer some interesting opportunities for harnessing public interest and energy about dam decisions in coastal and non-coastal watersheds, though these intra-actions are currently absent from media and management discussions of dam decisions in our study watershed. In Rhode Island at least, because humans have been prohibited from landing, catching, taking, or attempting to catch alewives in Rhode Island fresh waters since 2006, and because river herring are usually only visible during their multi-week spring spawning season as they migrate from the ocean to inland freshwater ponds, human-fish relationality when it comes to river herring emerges largely from the management genres and news media described above. Instead, possibilities for transspecies connection that could shape dam decisions might emerge from human-trout relationships already in existence – from a multiplicity of human-trout transspecies ties – to apprehend the moments when fish are out of compliance: when these multiple 'wet ontologies' come into presence as fish act in unexpected or irreverent ways.

TROUT (AND HUMANS) BEHAVING BADLY

Given the strong human-trout relationships we have just detailed, what then happens when trout (and their humans) aren't so well behaved? For one example, the identity of wild – not hatchery-raised – brook trout in the Wood-Pawcatuck system creates and is created by a set of actors and relational practices that is overlapping but distinct from the multiplicity of stocked trout. And so, for instance, one local community group, Protect Rhode Island Brook Trout (PRIBT), has helped to co-produce a different wild brook trout from those stocked in the state hatcheries for opening day: celebrating wild brook trout and advocating for the preservation, protection, and restoration of the iconic New England actor in the watershed. PRIBT argues that the continued state practice of stocking rainbows, browns, and especially brook trout is in direct conflict with the conservation of wild brook trout, detailing in their proposal for a brook trout sanctuary on the Wood River the top five threats to eastern US stream-dwelling wild brook trout populations as "riparian condition; water temperature; agricultural practices; urbanisation; and non-native species", and insisting that:

> Four of the five threats to stream-dwelling wild brook trout cited above do not apply to this watershed. The sole remaining threat, that imposed by [state] stocking on non-native species, is within the state's control (Custodio, et al., n.d.).

The co-created reality of wild brook trout offered here contrasts sharply with stocked trout. The argument that stocked trout negatively impact wild trout populations is not a new argument and has been widely discussed in literature in recent decades (Hindar et al., 1991; Einum and Fleming, 2001; Valiquette et al., 2014). Within this human-fish plurality, wild brook trout manifest as fragile creatures once again at the mercy of human agency and practice. But PRIBT's arguments advocate for recognising the multiplicity of relations with the Wood-Pawcatuck's multiplicity of fish and for co-producing new practices related to stocking and dam decisions. And while PRIBT does advocate for dam removal in the upper Wood-Pawcatuck Watershed (Custodio et al., n.d.), PRIBT's major argument is the creation of a brook trout sanctuary that depends upon the preservation – *not* removal – of the Wood River's Barberville Dam, which would serve as:

> An effective barrier to the upstream intrusion by hatchery-reared fish (Custodio et al., n.d.).

PRIBT's plan depends on understanding the ways that wild trout use impediments like dams and how brook trout might, somewhat surprisingly, sustain a blow to their populations in the wake of a dam removal. And so, while the prevailing management (and media and public) logic seems to dictate that free-flowing rivers are best for fish, PRIBT has recognised the production of an entirely different brook trout than the one created through trout's relationship with state managers, and one that confounds prevailing logics of dam removal. In light of this, PRIBT argues for the cultivation of new practices, but admits that this is a difficult move. As one brook trout advocate, 'Kevin', argued of state stocking practices in an interview:

> The reality is that [the state has] a bureaucracy. They have a fairly nice hatchery system. They're capable of producing 180,000 fish a year. They dump 180,000 fish a year. People buy licences for whatever level there is. But the idea of doing something new or making a change in any way, it's just obvious to us at this point that the only way we're really gonna be effective is if we can bring them to court and we're just not in a position to do that at this point in time.

Even as PRIBT advocates for creating transspecies relationships, recognising the multiplicity of relations with trout and trout's 'slipperiness', and making decisions about systemic dams accordingly, they explicitly recognise the difficulty of this move. Indeed, this anxiety about 'something new' was on display in an interview with a representative of a local trout fishing group, 'Frank', who discussed negative impacts of future potential dam removals on the smaller Wood River in the Wood-Pawcatuck system:

> Now we can get to dams. Let's go to the worst case. Take all the dams out. Take all the dams out from here to the Pawcatuck River. What's it gonna do to here? What's going to happen to the water level? We can't handle lower. I mean, look at the flow chart. We're already lower than we possibly can be for fish survival.

While Frank admitted to liking the possibility of fishing for sea-run brook trout as far up as the Wood River (above the six main-stem restored dams), he continued the theme of concern about the unknown. He was cautious about the impacts of sea run brook trout on fish population dynamics in the river because, as he described, they are:

> Pretty predatory, pretty predatory, and that would certainly have an effect on the type of fish that were gonna be in here.

But what effect on fish? No one exactly knows. Dam removals would change fishing as Frank and other anglers now know it.

What we want to suggest here, though, is that uncertainty and slipperiness is precisely the point. Intensely felt human-trout relationships might offer a gateway to seeing fish, listening to fish, even recognising or at least allowing for misbehaviour and surprise: admitting stochasticity and noncompliance into the dam-removal process, no matter how unsettling. Trout work to shape, cut, and reshape boundaries, allowing for movement and porosity among species, rivers, and imaginaries. Trout-human relations can be employed to create, as Woelfle-Erskine and Cole (2015) describe, an 'affective ecology': agency and action that spur inland dam removals that are miles from anadromous fish access, playing a role in shaping decisions for a collective future. The recognition of trout as agents of transboundary relational practice can cut and reposition, refocus, and reconfigure relationships to human-fish-river in the context of dam removal.

We want to emphasise in conclusion: we do not mean to suggest that trout exist only in their renderings via human actors – through policy documents, management decisions, media accounts, and even human-trout interactions. While we think that trout might offer fertile ground for engaging human stakeholders about dam decisions, in part because of the existing relationships between

humans and trout, we suggest that trout offer creative possibilities precisely because of their slipperiness.

For instance, rainbow trout hold their own surprises. Hatchery-raised rainbows are said not to reproduce in Rhode Island streams, but there have been credible reports of the presence of juvenile young-of-the-year rainbow trout: evidence that rainbows are, in fact, producing offspring in the wild in the watershed. In other surprising behaviour, Kevin reported that a friend of his had seen rainbows successfully swimming up the water streaming over the seemingly impenetrable 11-ft. Barberville Dam. And who knows what else? In short, these fish are slippery. Non-compliant. Wily. They use dams – and are impacted by dam removals – in surprising ways. And these surprising, sometimes non-compliant, wet ontologies are ones that dam stakeholders seem at least somewhat poised to attune to, consider, and be shaped by.

Brook trout, too, have proven remarkable in our experience. As PRIBT alludes to, salmonid research literature would suggest that barriers like dams impact trout species (Kondratieff and Myrick, 2006) and that these impacts may, somewhat surprisingly, include offering protection from competition (Fausch and White, 1981) and genetic introgression (Marie et al., 2010) by prohibiting interaction with non-native trout and other predators. Brook trout can holdover in tiny pools and endure drought and heat to survive through the following year (Baird and Krueger, 2003). They are notorious for being easily spooked by the slightest human movement on the river bank, but, as we found out earlier this summer, they do not so much as flinch when you snorkel alongside them.

Beyond our own experience, through a series of experiments over multiple years, Shannon White has described how the personality of individual brook trout account for surprising impacts on trout learning. White worked with colleagues to demonstrate that brook trout make use of transitive inference, a cognitive process that used to be thought to belong only to humans, which allows individual brook trout to create associations that allow them to understand social hierarchies (White and Gowan, 2013). The following year, White and Gowan (2014) determined that social learning impacts brook trout acquisition of search images, which brook trout use to recognise and distinguish between food and non-food in their environments. By training particular individuals to develop a search image for a previously unknown food (canned mealworms), White and Gowan (2014) demonstrated that bystander fish quickly learned to eat the canned mealworms from the trained brook trout. Finally, in recent work on individual behaviour, White et al. (2017) found that shyness rather than boldness in individual brook trout was related to quicker learning about cues for hidden food. This work allowed White et al. (2017) to draw close lines between individual personality, learning and memory, and brook trout behaviour that have implications for plasticity and, thus, conservation. If White and her colleagues found these surprising behaviours and capacities in recent studies, this work begs the question of all that humans do not know about our brook trout neighbours.

In short, brook trout and their salmonid relations can surprise us, and we suggest here that existing human-salmonid transspecies relations might open humans to recognising, accommodating, and even building from that surprise and slipperiness. Through our research on the Wood-Pawcatuck system, then, we advocate for recognising the multiplicity of relations that interpellate migratory and resident fish in watersheds and beyond. We encourage restoration managers to step outside of technocratic perspectives on fish passage and dam management by attending to and deepening existing human-fish and fish-fish relations, allowing room for stochasticity and transspecies connection, and recognising and even cultivating the co-creation of slippery new dam removal practices and transspecies intra-actions that recognise and co-produce a multiplicity of human-fish relations.

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REFERENCES

Ambers, R.K. 2007. Effects of a small, century-old dam on a second-order stream in the Virginia Piedmont. *Southeastern Geographer* 47(2): 181-201.

Baird, O.E. and Krueger, C.C. 2003. Behavioral thermoregulation of brook and rainbow trout: Comparison of summer habitat use in an Adirondack River, New York. *Transactions of the American Fisheries Society* 132(6): 1194-1206.

Barad, K. 1999. Agential realism: Feminist interventions in understanding scientific practices. *The Science Studies Reader* 1-11.

Barraud, R. and Germaine, M.-A. 2013. Defining and achieving good water status: From the rule of experts to local inhabitants. Case studies on dam removals. In Arnaud-Fassetta, G.; Masson, E. and Reynard, E. (Eds), *European continental hydrosystems under changing water policy,* pp. 233-246. Friedrich Peel Verlag.

Bear, C. 2012. Assembling the sea: Materiality, movement and regulatory practices in the Cardigan Bay scallop fishery. *Cultural Geographies* 20(1): 21-41.

Bear, C. and Eden, S. 2008. Making space for fish: The regional, network and fluid spaces of fisheries certification. *Social & Cultural Geography* 9(5): 487-504.

Bear, C. and Eden, S. 2011. Thinking like a fish? Engaging with nonhuman difference through recreational angling. *Environment and Planning D: Society and Space* 29(2): 336-352.

Bernhardt, E.S.; Sudduth, E.B.: Palmer, M.A.; Allan, J.D.; Meyer, J.L.; Alexander, G. and Rumps, J. 2007. Restoring rivers one reach at a time: Results from a survey of US river restoration practitioners. *Restoration Ecology* 15(3): 482-493.

Bohlen, C. and Lewis, L.Y. 2009. Examining the economic impacts of hydropower dams on property values using GIS. *Journal of Environmental Management* 90: S258-S269.

Born, S.M.; Genskow, K.D.; Filbert, T.L.; Hernandez-Mora, N.; Keefer, M.L. and White, K.A. 1998. Socioeconomic and institutional dimensions of dam removals: The Wisconsin experience. *Environmental Management* 22(3): 359-370.

Bowman, M.B. 2002. Legal perspectives on dam removal. This article outlines the legal issues associated with dam removal and examines how environmental restoration activities such as dam removal fit into the existing US legal system. *BioScience 52*(8): 739-747.

Braun, Y.A. 2011. The reproduction of inequality: Race, class, gender, and the social organization of work at sites of large-scale development projects. *Social Problems* 58(2): 281-303.

Callon, M. 1986. Some elements of a sociology of translation: Domestication of the scallops and the fishermen of St Brieuc Bay. *The Sociological Review* 32(S1): 196-233.

Carruthers, D. and Rodriguez, P. 2009. Mapuche protest, environmental conflict and social movement linkage in Chile. *Third World Quarterly* 30(4): 743-760.

Custodio, M.; O'Conner, B.; Pezza, P.; Strom, B. (n.d.). Let's protect Rhode Island Wild Brook Trout now! A proposal. *Protect Rhode Island Brook Trout.* http://protectribrooktrout.org/wp-content/uploads/2014/04/brook-trout-proposal.pdf

de Loë, R.C. 1999. Dam the news: Newspapers and the Oldman River Dam project in Alberta. *Journal of Environmental Management* 55(4): 219-237.

Druschke, C.G. 2013. Watershed as common-place: Communicating for conservation at the watershed scale. *Environmental Communication: A Journal of Nature and Culture* 7(1): 80-96.

Druschke, C.G. and Hychka, K.C. 2015. Manager perspectives on communication and public engagement in ecological restoration project success. *Ecology and Society* 20(1): 58.

Druschke, C.G. and Rai, C. (In Press). Making worlds with cyborg fish. In McGreavy, B.; McHendry, G.; Senda-Cook, S. and Wells, J. (Eds). *Tracing rhetoric and material life: Ecological approaches.* London: Palgrave Macmillan.

Einum, S. and Fleming, I.A. 2001. Implications of stocking: Ecological interactions between wild and released salmonids. *Nordic Journal of Freshwater Research* 75: 56-70.

Erkan, D. E. 2002. Strategic Plan for the Restoration of Anadromous Fishes to Rhode Island Coastal Streams. Completion Report in Fulfillment of Federal Aid in Sportfish Restoration Project.

www.dem.ri.gov/programs/bnatres/fishwild/pdf/riap2002.pdf

Fausch, K.D. and White, R.J. 1981. Competition between brook trout (Salvelinus fontinalis) and brown trout (Salmo trutta) for positions in a Michigan stream. *Canadian Journal of Fisheries and Aquatic Sciences* 38(10): 1220-1227.

Fox, C.A.; Magilligan, F.J. and Sneddon, C.S. 2016. You kill the dam, you are killing a part of me: Dam removal and the environmental politics of river restoration. *Geoforum* 70: 93-104.

Gartner, J.D.; Magilligan, F.J. and Renshaw, C.E. 2015. Predicting the type, location and magnitude of geomorphic responses to dam removal: Role of hydrologic and geomorphic constraints.

Germaine, M.-A. and Barraud, R. 2013. Restauration écologique et processus de patrimonialisation des rivières dans l'Ouest de la France. *VertigO – la revue électronique en sciences de l'environnement*, Hors-série 16. http://vertigo.revues.org/13583

Germaine, M.-A. and Lespez, L. 2014. Le démantèlement des barrages de la Sélune (Manche). Des réseaux d'acteurs au projet de territoire? *Développement durable et territoires* 5(3). http://developpementdurable.revues.org/10525

Germaine, M.-A.; Viry, M. and Menozzi, M.-J. 2016. Construction des lieux et rapports à la nature. Cabanons et pêcheurs des lacs du Sud Manche. *Norois* 240: 77-100.

Goedeke, T.L. and Rikoon, S. 2008. Otters as actors scientific controversy, dynamism of networks, and the implications of power in ecological restoration. *Social Studies of Science* 38(1): 111-132.

Gosnell, H. and Kelly, E.C. 2010. Peace on the river? Social-ecological restoration and large dam removal in the Klamath basin, USA. *Water Alternatives* 3(2): 362.

Grumbine, R.E. and Xu, J. 2011. Mekong hydropower development. *Science* 332(6026): 178-179.

Guerrier, G.; Paul, R.; Sananikhom, P.; Kaul, S.; Luthi, R.; Katz, J.P.; Robino, M.;, Khammanithong, P.; Brey, P.T. 2011. Strategic success for hydropower in Laos. *Science* 334 (6052): 38-38.

Haraway, D.J. 2008. *When species meet*. Minneapolis: University of Minnesota Press.

Hart, D.D. and Poff, N.L. 2002. A special section on dam removal and river restoration. *BioScience* 52(8): 653-655.

Hilbert, M.; Vásquez, J.; Halpern, D.; Valenzuela, S.; Arriagada, E. 2016. One step, two step, network step? Complementary perspectives on communication flows in twittered citizen protests. *Social Science Computer Review* 35(4): 444-461.

Hindar, K.; Ryman, N. and Utter, F. 1991. Genetic effects of cultured fish on natural fish populations. *Canadian Journal of Fisheries and Aquatic Sciences* 48(5): 945-957.

Huber, A. and Joshi, D. 2015. Hydropower, anti-politics, and the opening of new political spaces in the Eastern Himalayas. *World Development* 76: 13-25.

Hustak, C. and Myers, N. 2012. Involutionary momentum: Affective ecologies and the sciences of plant/insect encounters. *Differences* 23(3): 74-118.

Hychka, K.C. and Druschke, C.G. 2017. Adaptive management of urban ecosystem restoration: Learning from restoration managers in Rhode Island, USA. *Society and Natural Resources* http://dx.doi.org/10.1080/08941920.2017.1315653

Jasanoff, S. (Ed). 2004. *States of knowledge: The co-production of science and the social order*. London: Routledge.

Jørgensen, D. and Renöfält, B.M.R. 2012. Damned if you do, dammed if you don't: Debates on dam removal in the Swedish media. *Ecology and Society* 18(1): 18.

Kondratieff, M.C. and Myrick, C.A. 2006. How high can brook trout jump? A laboratory evaluation of brook trout jumping performance. *Transactions of the American Fisheries Society* 135(2): 361-370.

Latour, B. 2004. *Politics of nature: How to bring the sciences into democracy*. Cambridge, MA: Harvard.

Latour, B. 1987. *Science in action: How to follow scientists and engineers through society*. Cambridge, MA: Harvard.

Law, J. and Lien, M. 2012. Slippery: Field notes on empirical ontology. *Social Studies of Science* 43(3): 363-378.

Lejon, A.G.C.; Renöfält, B.M. and Nilsson, C. 2009. Conflicts associated with dam removal in Sweden. *Ecology and Society* 14(2): 4.

Lewis, L.Y.; Bohlen, C. and Wilson, S. 2008. Dams, dam removal, and river restoration: A hedonic property value analysis. *Contemporary Economic Policy* 26(2): 175-186.

Lord, P. 2010. Pawcatuck stocked with tiny shad. *The Providence Journal*, 6 July 2010.

Lundberg, E.; Druschke, C.G.; McGreavy, B.; Randall, S.; Quiring, T.; Fisher, A.; Soluri, F.; Dallas, H.; Hart, D. and Gardner, K. In Press. Communicating about hydropower, dams, and climate change. *Oxford Climate Change Communication*.

Magilligan, F.J.; Graber, B.E.; Nislow, K.H.; Chipman, J.W.; Sneddon, C.S. and Fox, C.A. 2016a. River restoration by dam removal: Enhancing connectivity at watershed scales. *Elementa: Science of the Anthropocene* 4(1): 000108.

Magilligan, F.J.; Nislow, K.H.; Kynard, B.E. and Hackman, A.M. 2016b. Immediate changes in stream channel geomorphology, aquatic habitat, and fish assemblages following dam removal in a small upland catchment. *Geomorphology* 252: 158-170.

Mancilla-García, M. 2015. Does social media benefit dominant or alternative water discourses? *Water Alternatives* 8(2): 125-146.

Marie, A.D.; Bernatchez, L. and Garant, D. 2010. Loss of genetic integrity correlates with stocking intensity in brook charr (Salvelinus fontinalis). *Molecular Ecology* 19(10): 2025-2037.

Nepal, R. 2012. Roles and potentials of renewable energy in less-developed economies: The case of Nepal. *Renewable and Sustainable Energy Reviews* 16(4): 2200-2206.

O'Hanley, J.R. 2011. Open rivers: Barrier removal planning and the restoration of free-flowing rivers. *Journal of Environmental Management 92*(12): 3112-3120.

Öhman, M.B. 2016. Embodied vulnerability in large-scale technical systems: Vulnerable dam bodies, water bodies, and human bodies. In *Bodies, boundaries and vulnerabilities* 47-79. Cham: Springer International Publishing.

Öhman, M.B. and Thunqvist, E.L. 2016. Human bodies and the forces of nature: Technoscience perspectives on hydropower dams, safety, human security, emotions and embodied knowledges. *International Journal of Technoscience and Development* 1(1): 1-14.

On The Water Staff. (April 11, 2011). Rhode Island's Wood River. *On The Water* Magazine. www.onthewater.com/rhode-islands-wood-river/

Opperman, J.J.; Royte, J.; Banks, J.; Day, L.R. and Apse, C. 2011. The Penobscot River, Maine, USA: A basin-scale approach to balancing power generation and ecosystem restoration. *Ecology and Society* 16(3): 7.

Orr, C.H.; Roth, B.M.; Forshay, K.J.; Gonzales, J.D.; Papenfus, M.M. and Wassell, R.D. 2004. Examination of physical and regulatory variables leading to small dam removal in Wisconsin. *Environmental Management* 33(1): 99-109.

Ozen, H. 2014. Overcoming environmental challenges by antagonizing environmental protesters: The Turkish government discourse against anti-hydroelectric power plants movements. *Environmental Communication* 8(4): 433-451.

Palmer, M.; Allan, J.D.; Meyer, J. and Bernhardt, E.S. 2007. River restoration in the twenty-first century: Data and experiential knowledge to inform future efforts. *Restoration Ecology* 15(3): 472-481.

Philo, C. and Wilbert, C. 2000. *Animal spaces, beastly places: New geographies of human-animal relations.* Chicago: Psychology Press.

Provencher, B.; Sarakinos, H. and Meyer, T. 2008. Does small dam removal affect local property values? An empirical analysis. *Contemporary Economic Policy* 26(2): 187-197.

Robinson, J.D. 2014. Local media coverage of environmental conflict: The Klamath River Basin. Masters thesis. Seattle: University of Washington.

Rogers, R.A. and Schutten, J.K. 2004. The gender of water and the pleasure of alienation: A critical analysis of visiting Hoover Dam. *The Communication Review* 7(3): 259-283.

Ross, D.G. 2008. Dam visuals: The changing visual argument for the Glen Canyon Dam. *Journal of Technical Writing and Communication* 38(1): 75-94.

Rozzi, R. and Jiménez, J.E. (Eds). 2014. *Magellanic sub-antarctic ornithology: First decade of long-term bird studies at the Omora Ethnobotanical Park, Cape Horn Biosphere Reserve, Chile*. Denton: University of North Texas Press.

Salit, Richard. Getting back in the swim. *The Providence Journal*, 30 January, 2014.

Scherman, A.; Arriagada, A. and Valenzuela, S. 2015. Student and environmental protests in Chile: The role of social media. *Politics* 35(2): 151-171.

Smith, M.G. 2009. Dam removal: A taxonomy with implications for economic analysis. *Journal of Contemporary Water Research & Education* 134(1): 34-38.

Steinberg, P. and Peters, K. 2015. Wet ontologies, fluid spaces: Giving depth to volume through oceanic thinking. *Environment and Planning D: Society and Space* 33(2): 247-264.

Sovacool, B.K.; Dhakal, S.; Gippner, O. and Bambawale, M.J. 2011. Halting hydro: A review of the socio-technical barriers to hydroelectric power plants in Nepal. *Energy* 36(5): 3468-3476.

TallBear, K. 2011. Why interspecies thinking needs indigenous standpoints. In *American Anthropological Association Meeting,* Montreal, CA.

Todd, Z. 2014. Fish pluralities: Human-animal relations and sites of engagement in Paulatuuq, Arctic Canada. *Études/Inuit/Studies* 38(1-2): 217-238.

Tong, J. 2014. Environmental risks in newspaper coverage: A framing analysis of investigative reports on environmental problems in 10 Chinese newspapers. *Environmental Communication* 8(3): 345-367.

Valenzuela, S. 2013. Unpacking the use of social media for protest behavior; the roles of information, opinion expression, and activism. *American Behavioral Scientist* 57(7): 920-942.

Valiquette, E.; Perrier, C.; Thibault, I. and Bernatchez, L. 2014. Loss of genetic integrity in wild lake trout populations following stocking: Insights from an exhaustive study of 72 lakes from Quebec, Canada. *Evolutionary Applications* 7(6): 625-644.

Walter, R.C. and Merritts, D.J. 2008. Natural streams and the legacy of water-powered mills. *Science* 319(5861): 299-304.

White, S.L. and Gowan, C. 2013. Brook trout use individual recognition and transitive inference to determine social rank. *Behavioral Ecology* 24(1): 63-69.

White, S.L. and Gowan, C. 2014. Social learning enhances search image acquisition in foraging brook trout. *Environmental Biology of Fishes* 97(5): 523-528.

White, S.L.; Wagner, T.; Gowan, C. and Braithwaite, V.A. 2017. Can personality predict individual differences in brook trout spatial learning ability? *Behavioural Processes* 141(2): 220-228.

Wild and Scenic Rivers Act § l(b), 16 U.S.C. § 1271 (Supp. IV, 1969).

Woelfle-Erskine, C. 2015. Thinking with salmon about rain tanks: Commons as intra-actions. *Local Environment* 20(5): 581-599.

Woelfle-Erskine, C. and Cole, J. 2015. Transfiguring the anthropocene stochastic reimaginings of human-beaver worlds. *TSQ: Transgender Studies Quarterly* 2(2): 297-316.

Wohl, E. and Merritts, D.J. 2007. What is a natural river? *Geography Compass* 1(4): 871-900.

Wood-Pawcatuck Watershed Association. www.wpwa.org

Wood-Pawcatuck Watershed Association. (n.d.). Upper Pawcatuck River Fish Passage Restoration Project. Informational flier. http://wpwa.org/documents/Upper%20Pawcatuck%20Informational%20Flyer.doc (accessed 17 January 2017)

Yang, G. and Calhoun, C. 2007. Media, civil society, and the rise of a green public sphere in China. *China Information* 21: 211-236.