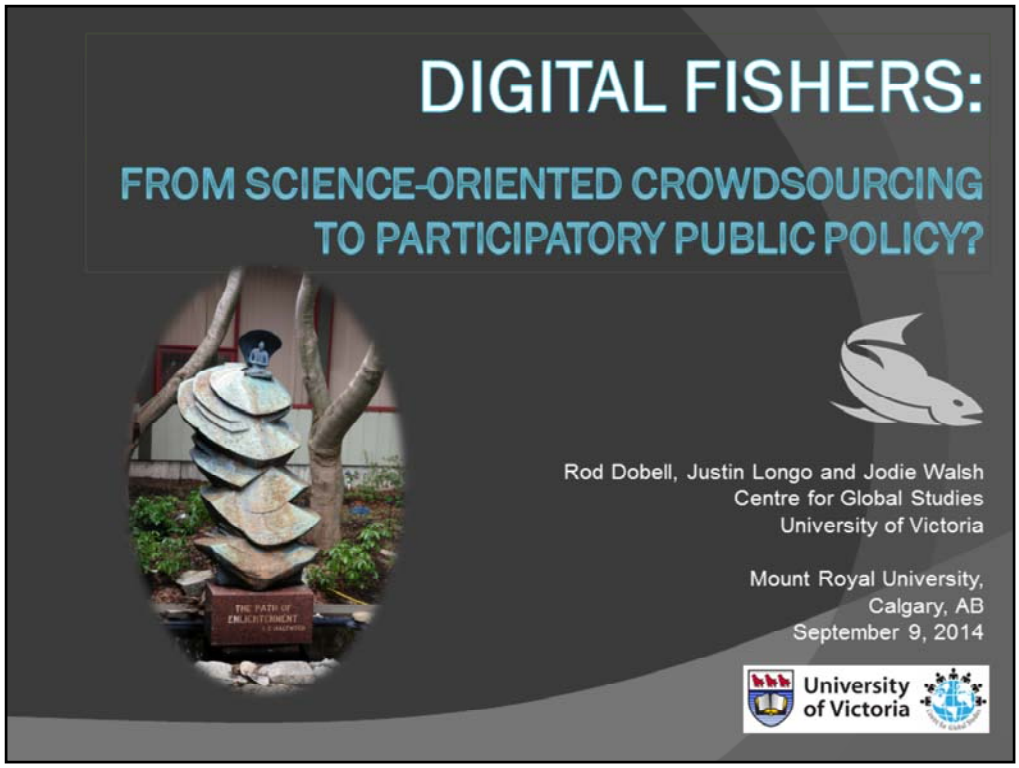
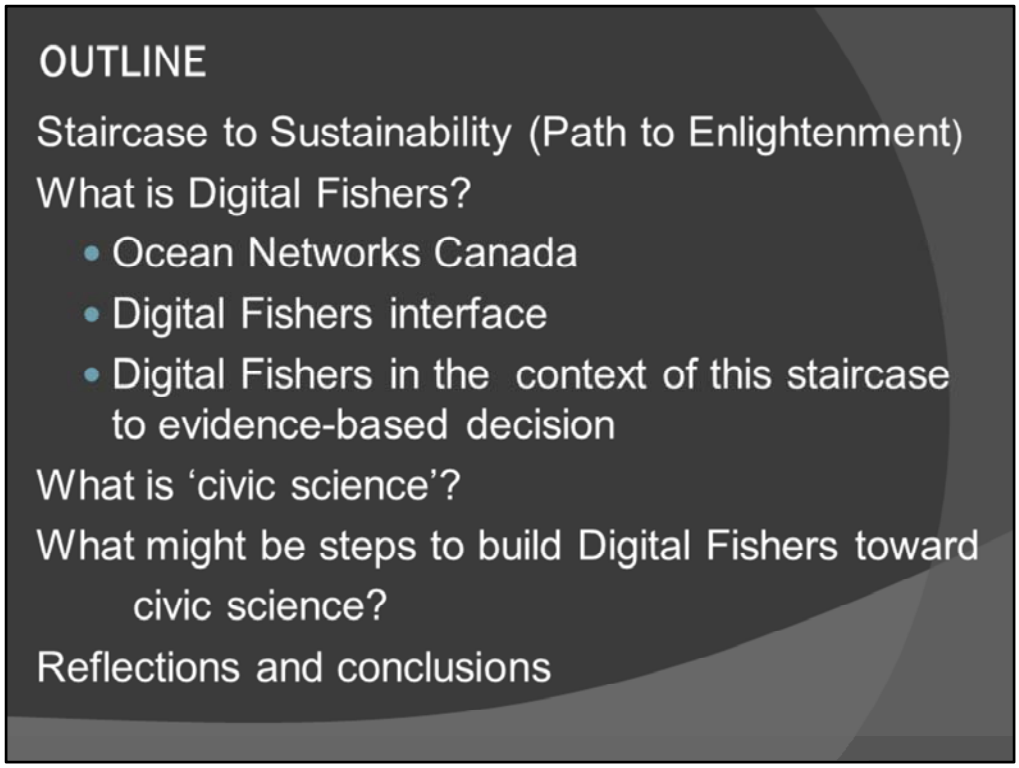


It is a great pleasure to be here at this conference, with this very vibrant group. Coming from BC, I do want to acknowledge the welcome to the traditional territories of the Blackfoot Confederacy and the Tsuu T'ina people. It's also a wonderful privilege to be here at the invitation of the Miistakis Institute, at the centre of the Y2Y initiative. As a coastal person, I have no real connection with the Yellowstone to Yukon corridor, but I see the strong resonances with what I can feel strongly about, namely B2B (Baja to Bering) or C2C (Chile to Chukchi). All of these campaigns recognize the need to look in a holistic way at integrated ecosystems, whether mountain or marine.

The Miistakis Institute itself, as a non-profit corporation within a post-secondary organization, represents innovative outreach toward realization of the new third mission of the university and the new social contract with the academy. That general challenge of integration and co-creation with academic expertise, professional social inquiry, local observation, experience within the particularities of place, traditional knowledge and First Nations culture is really the core theme underlying my comments today.

But, referring to the Katherine Maltwood image on the left of the slide, I have to note that this general theme has been approached in many ways in many cultural traditions.

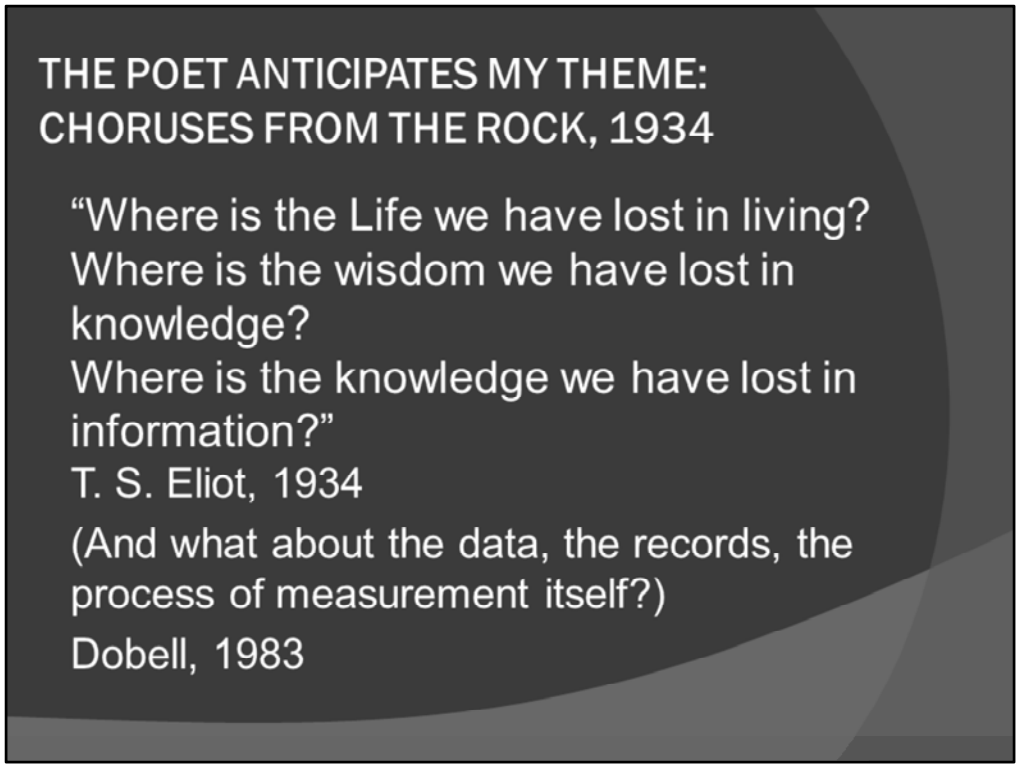


Just to set a bit of a framework, I'm going to begin by suggesting a very general context, mostly to help in clarifying concepts or illustrating the way I'll be using the language. I've labelled this conceptual framework the staircase to sustainability, but, as I just noted, more artistically one might refer to the path to enlightenment, as in the image on the previous slide, drawn from the Maltwood Collection at UVIC.

Then will move on concretely to describe Ocean Networks Canada very briefly, and within that to outline the instrument we call Digital Fishers. I'll try to suggest ways to set the Digital Fishers (DF) work in the context of my little staircase.

That context suggests the need to consider what some people might mean by 'civic science', and then to ask how one might consider trying to build DF toward that sort of 'civic science' and ultimately some form of web-enabled dialogic democracy.

Finally, if there is time to reflect on some of the more general questions arising from this discussion, we might be able to suggest some conclusions.



Opening Stanza from Choruses from "The Rock"

The Eagle soars in the summit of Heaven,
The Hunter with his dogs pursues his circuit.

O perpetual revolution of configured stars,

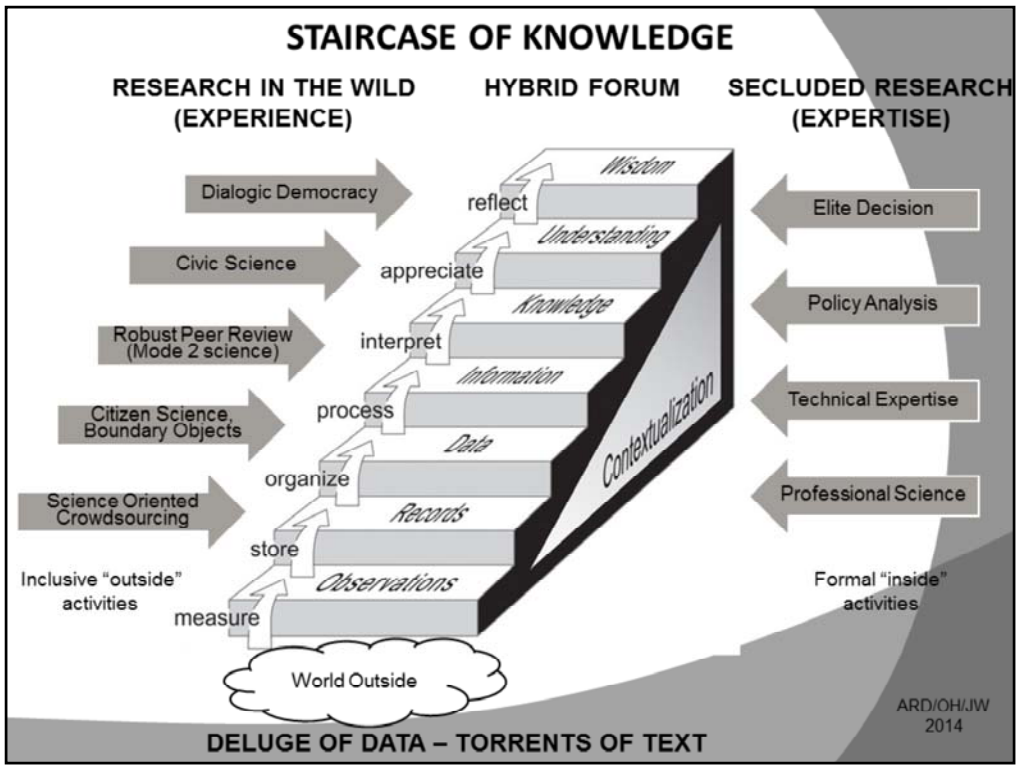
O perpetual recurrence of determined seasons,

O world of spring and autumn, birth and dying

The endless cycle of idea and action,
Endless invention, endless experiment,
Brings knowledge of motion, but not of stillness;
Knowledge of speech, but not of silence;
Knowledge of words, and ignorance of the Word.
All our knowledge brings us nearer to our ignorance,
All our ignorance brings us nearer to death,
But nearness to death no nearer to GOD.
Where is the Life we have lost in living?
Where is the wisdom we have lost in knowledge?
Where is the knowledge we have lost in information?
The cycles of Heaven in twenty centuries
Bring us farther from GOD and nearer to the Dust.

T. S. Eliot (1888-1965),

"What is this life if, full of care,
We have no time to stand and stare?"

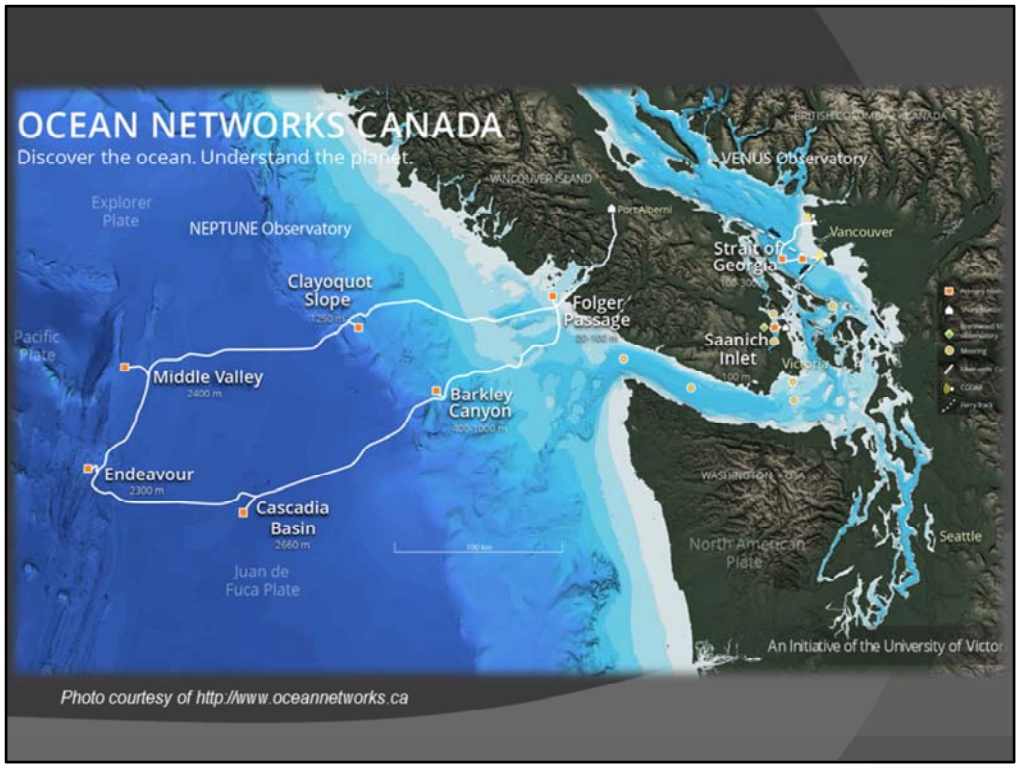


Beginning in the 1980s (though anticipated by the poet T. S. Eliot in the 1930s), and expanded a bit in the 1990's, there has been discussion of the so-called DIKW scheme in knowledge management—building from data and information through knowledge to wisdom. A staircase version was introduced by Fred Roots, a distinguished Canadian ecologist whom many of you will know. I've elaborated it substantially here.

A growing range of tools has been developing to carry out the transitions needed at each step of this staircase. In the Digital Fishers initiative I will sketch in a moment, we try to capture significant stages of the evolution in the slogan "Data from the Deep; Knowledge from the Crowd; Wisdom from the Process".

We can trace the steps up the staircase in a straightforward way, starting from the bottom, observing the increasing importance of context. (If we were thinking about the old policy cycle, we might think of the descent back down the back of the staircase, from new covenants back down to local action in particular places, but that's outside today's story.)

Many current topics and controversies are embedded in this diagram. Indeed there is a whole academic course of study, or several. Here I'd like just to emphasize the roles of science-oriented crowdsourcing or citizen science in the early steps, embracing participation in knowledge-building processes, as distinct from the role of civic science oriented to improved, more legitimate policy built on interpretation of that scientific evidence and knowledge at the later stages. (Of course, no such 'stages' images are ever accurate—all these processes are fuzzy, clumsy, iterated in a wide range of disorderly dynamics—but I hope the imagery is helpful for discussion purposes.)



Ocean Networks Canada (another non-profit corporation inside a university) operates the world-leading NEPTUNE and VENUS cabled ocean observatories for the advancement of science and the welfare of all the creatures of the Earth. These observatories consist of instrument clusters placed on the seafloor, connected by fibre optic cable. They collect data on physical, chemical, biological, and geological aspects of the ocean over long time periods, broadcasting continuously 365 days per year.

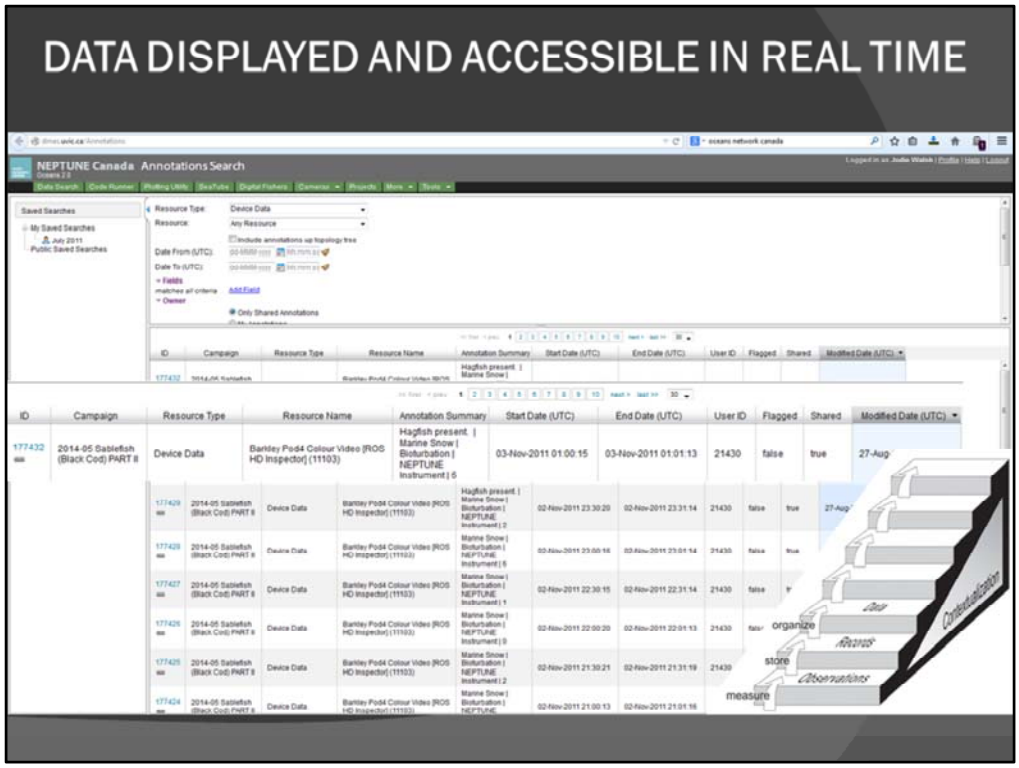
The NEPTUNE regional observatory and VENUS coastal observatory provide unique scientific and technical capabilities that permit researchers to operate instruments remotely and receive data at their home laboratories anywhere on the globe in real time. The 800-km NEPTUNE observatory off the West Coast of Vancouver Island and the nearly 50-km VENUS coastal observatory in the Salish Sea—which together make up the Ocean Networks Canada Observatory—stream live data from instruments at key sites off coastal BC via the Internet to scientists, policy-makers, educators and the public around the world. In addition to the instruments that capture quantified observations, these instrument clusters also include both hydrophones and video cameras.

Even though the cameras are operated only 5 minutes every hour—in order to avoid perturbing or contaminating the permanently dark seafloor environment—five Neptune Canada cameras operate every day through the years, and thus generate a veritable firehose of visual images. A rough estimate is that 5 minutes every hour accumulates to over 700 hours of video footage per camera per year. Five cameras generate 3500 hours, or 100 working weeks, or two full years of work just to view.

This massive body of video data is not currently amenable to machine processing, and in the absence of that alternative this volume of video data will eventually overwhelm the capacities of the global scientific community. Just as there are not enough scientists or students in the world to examine all the astronomical images flowing from growing arrays of marvelous new telescopes, there are not enough to handle the firehose of video imagery from ONC. And these are continuous video clips, not just single images—orders of magnitude more challenging. So the goal of the Digital Fishers project is to explore a crowdsourcing option that harnesses the Internet-based volunteer efforts of a large number of non-expert participants as a first-pass alternative to machine processing or analysis by experts.

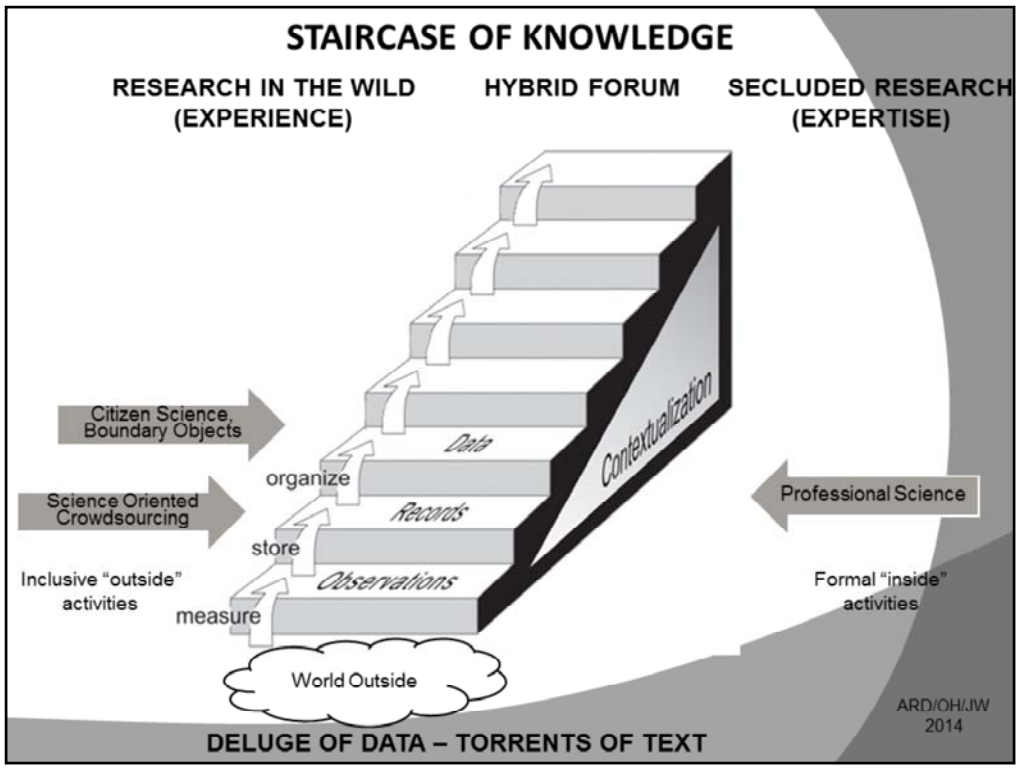
DF is a result of a joint project of NEPTUNE Canada (NC) and the University of Victoria Centre for Global Studies (CFGS). Digital Fishers attempts to draw in anonymous contributors to tag and enrich the databases storing ONC's flood of video data from under the sea, and thus improve the resulting foundation of scientific evidence to support decisions. These contributors may be motivated by nothing more than the entertainment value of the activity. The hope, however, is that they will get seriously drawn into the enterprise of improving the science itself, as is happening with the astonishingly successful Galaxy Zoo and other projects under the umbrella of the Zooniverse initiative founded by the Citizen Science Alliance.

In addition to providing the basic functionality of easily viewing and annotating NC video data, the DF interface faces a second challenge - that of persuading volunteer participants to engage with the DF process across multiple iterations and long time periods. We do not yet have sufficient experience with DF or gamification to be confident that we can drive enough traffic to the site to assure statistically reliable annotations and enhancement of the database. But we are hopeful, based on the success of other such initiatives.



Along with other data collected by Ocean Networks Canada, the Digital Fisher annotations are recorded in their data management and archive facilities at the University of Victoria.

Once registered as a user, anyone can login anytime to observe/download the data in real time. All you need is an Internet connection.



Thus we can see DF as one example of science-oriented crowdsourcing, drawing in anonymous web-based participants to engage in pattern recognition tasks to annotate and enrich the database maintained by ONC as a fully accessible open resource for the benefit of scientists, professional or citizen, around the world. But we can go further in identifying DF as a boundary object (Leigh Starr), potentially serving as a link between citizen scientists engaged actively with professional scientists in the processing of the data to develop more usable information.

Muki Haklay describes this as a move toward 'extreme citizen science'. He also notes how crucial in all this is the migration and embedding of the human expertise represented on the right (left-brain) side to into the increasingly sophisticated (hand-held, often, maybe wearable) technologies increasingly accessible to the amateurs represented on the left (the right brain side). This development gives new meaning to Leigh Starr's notion of 'boundary objects'.

In this context, this diagram inspires many speculative questions. One is, what constitutes reliable evidence on which to base decisions?

It is often said by those promoting a hard-minded approach to science-based decision that "the plural of anecdote is not data". Actually data is the plural of datum, an observation drawn from some kind of experience, or isolated bit of a record.

Experience driven and disciplined by a need for survival generates a body of individual local observations, transmitted as oral history; professional social inquiry (Cohen and Lindblom) driven by curiosity generates notebooks of reportable results transmitted in journals or on-line portals. [Where is the incentive to accurate observation and faithful reporting likely to be strongest?]

As Mary Poovey teaches us, the rise of the modern fact stems from the building and gradual acceptance of measurement, recording, accounting and reporting conventions looking to standardization and authoritative disciplinary protocols. But now, does visualization from results of text analysis and Big Data not begin to look a bit like collections of anecdotes?

Here DF is being used more precisely as an instrument for individual initiatives in scientific research. Rather than simply being broadcast widely for pattern recognition purposes, the video clips are selected for a particular scientific campaign. This particular 'sablefish campaign' was developed as a foundation for particularly interesting research efforts to explore both question of the 'quality' of the crowdsourced contributions, and the comparative quality of human contributions organized in different ways as against those obtained from constructed software agents.

In this case, the goal is to compare the results from DF, university marine biology classes, individual subject matter experts, and an algorithm constructed by an undergraduate student at UVIC/ONC that seems to be promising unprecedented levels of accuracy in recognition of patterns in moving objects. This campaign is currently still in train—visit digitalfishers.net to climb on board if you're interested.

Digital Fishers is more than simply a way to collect contribute useful metadata. It also has the potential to engage the user in several other ways. The annotation process pursued by the "science-oriented crowd" is also an avenue to encourage this crowd to progress from data gathering to more active citizen science in the early steps of the staircase of knowledge through tutorials and advancement through levels that take the participant to later steps in discussion and interpretation of the accumulating evidence.

This image is the tutorial in level 1 and illustrates the variety of "objects" users may see as they annotate the video. Each level gets progressively more difficult and the range of annotations more diverse. Users become more familiar with marine terminology, get exposed to the underwater environment, and increasingly appreciate that they are doing real science for real researchers. It is like a virtual and participatory field trip, and there is tremendous educational potential to be developed with progress through the levels and graduation into collaborative platforms, perhaps ultimately to deliberative spaces such as the Collective Intelligence Lab or the Human Dynamics Lab at MIT.

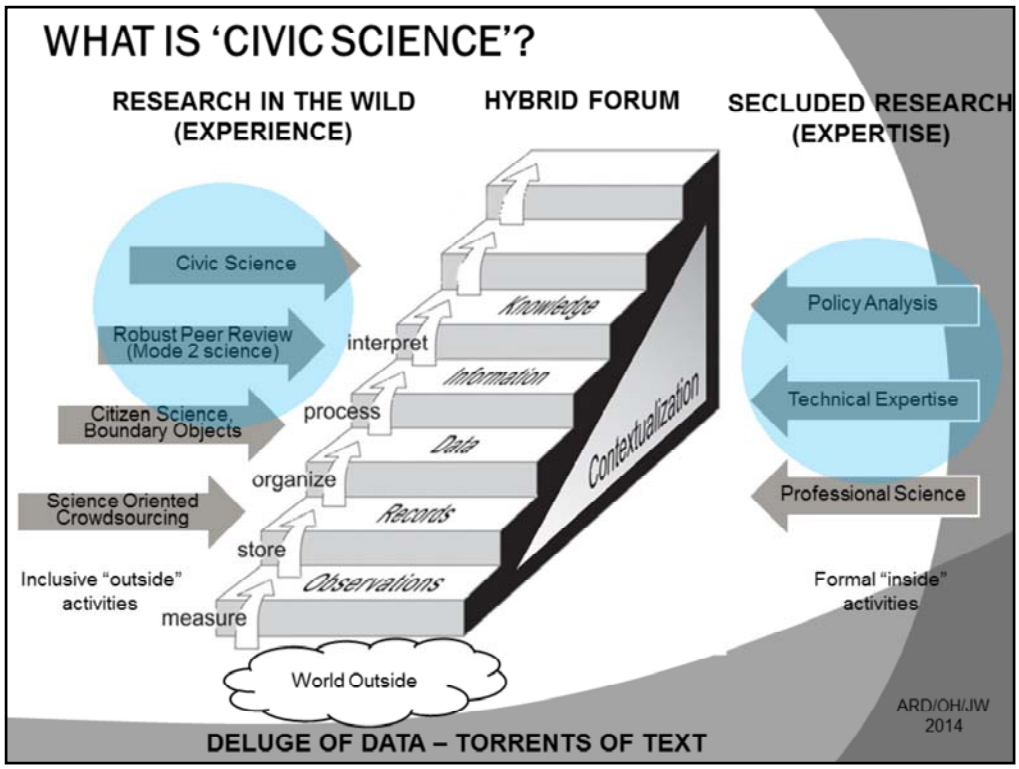
A number of fascinating issues of language and vocabulary central to the discussions of citizen science emerge starkly in this domain. We cannot pursue them here, but see Nephin, 2013.

August 23, 2014 – Cambridge Bay, Nunavut. On Aug. 23, Prime Minister Stephen Harper and Laureen Harper, with UVic President Jamie Cassels and Ocean Networks Canada's President Kate Moran.

Since the Digital Fishers interface was first designed and deployed with the NEPTUNE Canada observatory, Ocean Networks Canada has installed autonomous mini-observatories at Brentwood College in Mill Bay, BC (2011) and in Cambridge Bay (2012). One and half years in the making, the first mini-observation system went live in late December 2011, with this handover to the school providing the opportunity to test and develop the system with Brentwood College students and teachers.

Installed in 2012, ONC's community-based, cabled seafloor observatory in Cambridge Bay is the first location in Canada's Arctic for year-round, continuous undersea monitoring of the northern environment. Its instruments – including an underwater camera, ice profiler and sensors that measure temperature, depth and salinity – provide science-based support for greater understanding and protection of fragile arctic marine ecosystems. Data streaming from the instruments supports cutting-edge research and science-based decision making and enables local students, teachers and community members to steward their own environment.

With networks of such mini-observatories in the circumpolar region and elsewhere, and collaborative exchange supported by a Digital Fishers platform, one can envisage growing and more sustained community engagement, building a constituency to participate more directly in decision-making at local and eco-regional scale, perhaps around coastal and marine spatial planning as well as ocean zoning.



"How to make policy decisions in the face of uncertainty…Civic science reflects the complex input from individuals in society, with their professional and disciplinary orientations, often called informed public opinion….

If a scientific consensus cannot be achieved and a political decision must still be made, democratic tradition requires that a range of views be expressed by experts and the public so the decision to act may be based on societal values and ethics, rather than expert calculation….

The challenge of incorporating societal values within the two realms of uncertainty, scientific understanding and policy formulation, lies at the heart of the concept of civic science. This is the public domain where facts are interpreted, and societal questions emerge as part of a great iterative process systemized by governmental and educational institutions….

The strength of civic science occurs where there is doubt, since it derives from all of the sciences, including social sciences and ethics, the humanities and the varied experiences of members of the community…."

Conclusion: "The concept of civic science involves more than simply public participation and is essential to guide decision-making in a democratic society."

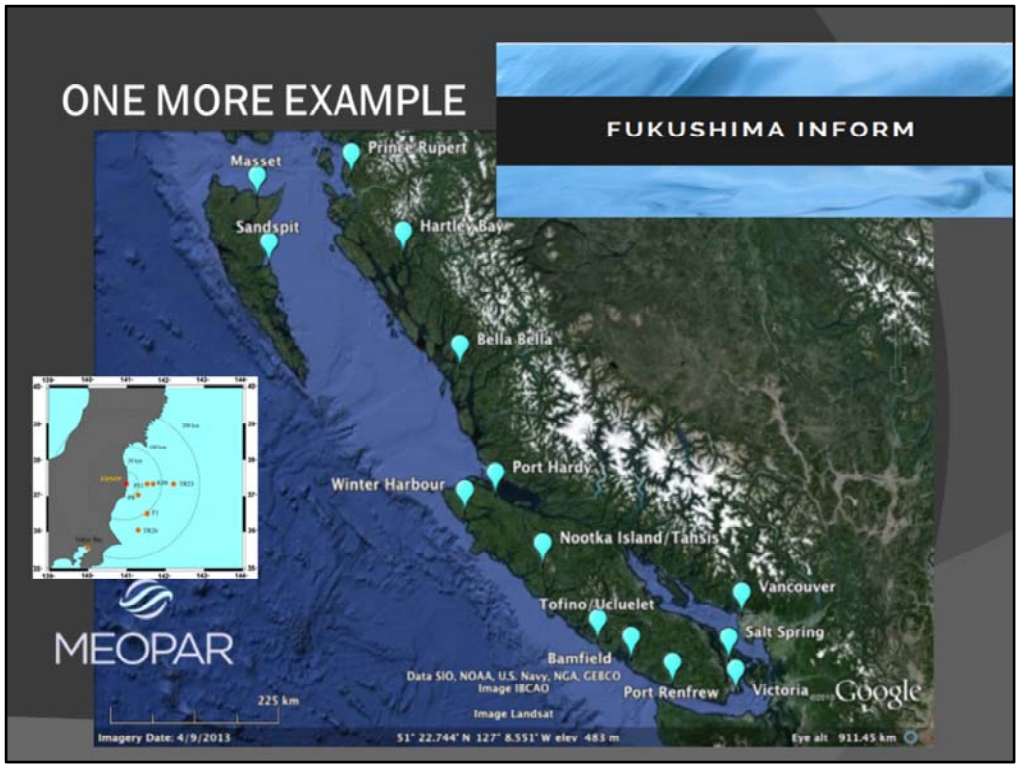
International Joint Commission. Great Lakes Science Advisory Board. Excerpts from 1993-95 Priorities and Progress under the Great Lakes Water Quality Agreement. Chapter Two.

Here is one example of citizen engagement in voluntary monitoring, again with Oceans Networks Canada.

"…keep our West Coast clean and safe by reporting marine debris via Coastbuster for Android. Use this app to report large, unusual and potentially hazardous marine debris– especially items that may have been swept into the sea by Japan's devastating March 2011 tsunami. Simply photograph the debris you find, enter some descriptions, and upload to Ocean Networks Canada. We will forward your reports to authorities. We'll also upload your photos to Flickr, where you can browse, share and comment on the full collection of marine debris snapshots. The information and photos you share may also help scientists better understand how winds and currents carry marine debris across the oceans.

http://www.oceannetworks.ca/learning/citizen-science/coastbuster"

With the increasing concern about the wilful blindness and deliberate decay in scientific capacity being pursued by the Harper Government (the muzzling of scientists), the possibility of appealing to highly engaged web-based citizens for ongoing monitoring of environmental health as well as regulatory compliance opens interesting possibilities. The recent concerns about the decline in capacity for monitoring, inspection and enforcement of mining regulations in BC provide further illustration of the challenge. (See Auditor General, Chris Turner, August 2012 story on Arctic briefings…). Capacity not just for the monitoring, but for the filtering, aggregation and dissemination of info will be crucial.



Another example of what Haklay might call extreme citizen science is the new InFORM network.

http://fukushimainform.wordpress.com/about/

University of Victoria chemical oceanographer Jay Cullen is leading the formation of a new marine radioactivity monitoring network that will engage scientists in Canada and the US, health experts, non-governmental organizations and citizen scientists along the British Columbia coast.

The InFORM Network, which stands for Integrated Fukushima Ocean Radionuclide Monitoring, is being funded by $630,000 over three years by the Marine Environmental Observation Prediction and Response Network(MEOPAR).

Since the 2011 tsunami and Fukushima-Daiichi nuclear disaster in Japan there's been widespread concern along the coast of western North America about the potential danger posed by low-level radioactivity crossing the Pacific Ocean.

Research partners in the network include: Woods Hole Oceanographic Institution in Massachusetts; Health Canada; the University of Ottawa; the University of British Columbia; and Fisheries and Oceans Canada (DFO).

The network will involve NGOs such as the Clayoquot Biosphere Trust, the Georgia Strait Alliance, the Raincoast Education Society, the Living Oceans Society and the David Suzuki Foundation, which will help with public outreach, information transfer, and recruitment and training of citizen scientists.

The plan is to set up 10 to 15 community sites along the BC coast where volunteer citizen scientists will collect water and seafood samples monthly or bimonthly for analysis.

Those samples will supplement measurements already being taken offshore by DFO and an existing citizen scientist network coordinated by Woods Hole that extends from the Bering Strait to San Diego.

The Center for Policy Informatics at Arizona State University has also announced the launch of their 2014/2015 project: "Crowdsourcing the Next Great Citizen Science Project". Your chance to blow the system wide open. http://10000solutions.org/citizen-science

Students teams (high school and college level) from around the world are invited to imagine an idea for an innovative citizen science project that can be implemented in collaboration with Arizona State researchers. The winning team will have access to ASU faculty, grad students and affiliated professionals and a project budget of $10,000 to bring their idea to a working prototype stage.

This project is premised on the idea that truly novel innovations are more likely to result from distributed approaches, because diverse participants bring unique perspectives to the problem. Rather than university researchers propose what they think is the best citizen science project, they are using a challenge platform to crowdsource new ideas for citizen science projects.

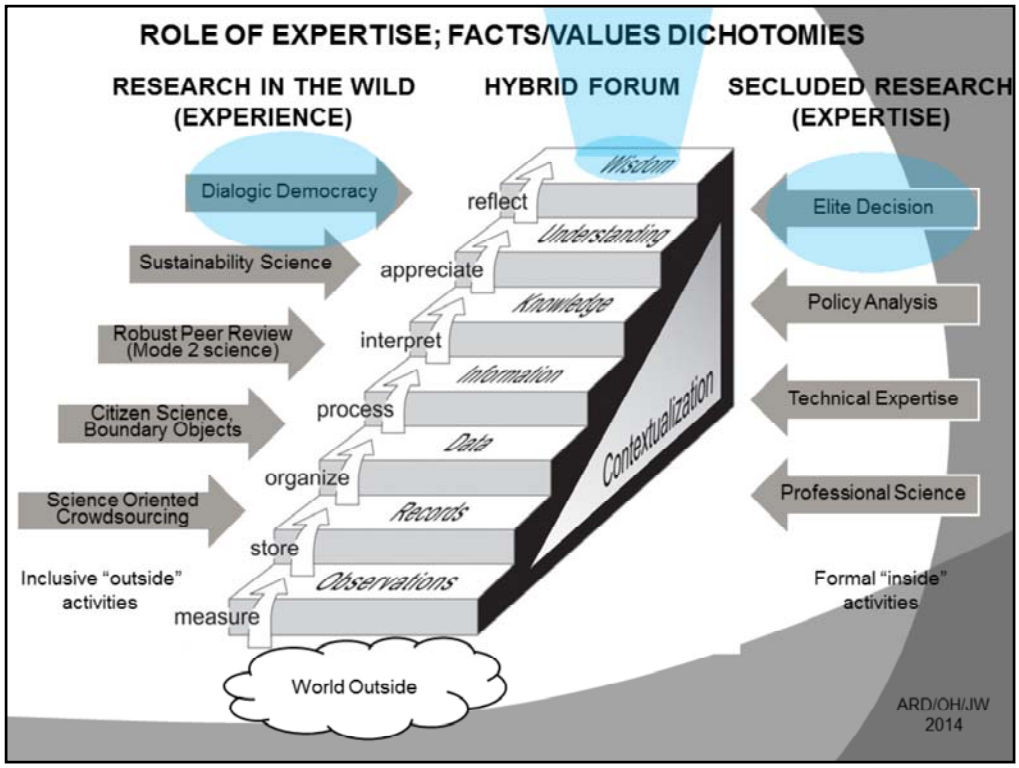
This project also modifies the traditional challenge framework. Rather than provide funds directly to the winning proponents, the value of the prize is in working with university and industry experts, having a budget to support implementation, and receiving the cv-building accolades that accompany success. As with most citizen science projects (as opposed to say, Amazon Mechanical Turk), the incentive to participate is deeper than any monetary compensation.

Really no time to go into this slide. Just a couple of quick comments.

First, it seems clear that the technical capacity for monitoring and analysis of ecosystem state and function is increasing substantially. But it seems also that the outlook for many of the ecosystems being monitored is bleak, dismal and deteriorating—unless perhaps we can conclude—optimistically—that our models and scenarios are quite wrong.

Second, everybody recognizes the need for greater social or political will, which can only flow from greater public awareness of the issues and greater public pressures for action, which in turn can only flow from greater public acceptance of the legitimacy of agreed social action. So we move quickly from the world of science—the academic tower--to the public arena and the battlefields of politics.

The fundamental conclusion to which this brief sketch leads is the crucial importance of finding processes that create 'safe places' for continuing conversations around the adaptation of claims of access, limits on harvest and intervention, and concepts of 'property'.

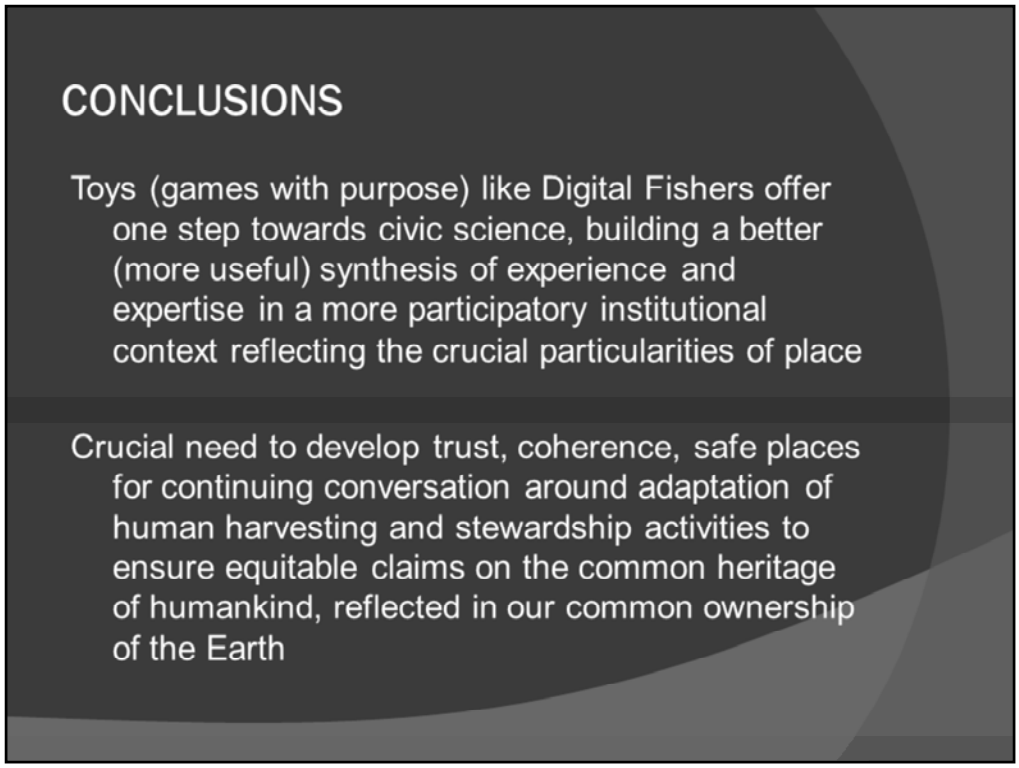


Citizen science can provide a foundation for formal evidence-informed, science-based decisions (of the sort Stephen Harper insists he wants).

But it is important to note that we can look to other options, namely the idea of interactive sustainability science and dialogic democracy depicted at the top of the left side of our little ladder.

Come back to the quality issue, which arises in different ways in the two categories of citizen science. We've already mentioned the question whether the science-oriented citizen science contributions can be trusted as science. This quality assurance question is usually resolved by appeal to authoritative psi.

But when views/opinions/perspectives clash, especially as between citizens and scientists, how can that conflict be resolved? Whose views are to prevail in policy-oriented citizen science (civic science). Can it be argued that 'science offers the best advice' ? [Note that in this case we face the fundamental dilemma of the conflict between the system and the case worker (consequential versus deontological—cf Joshua Greene argument.]



So, I've talked about techniques, as social processes, for collaboration and deliberation in the 21st century. I've mentioned ocean observatories like NEPTUNE Canada, and new web-enabled platforms as tools to support such collaboration and deliberation, along with the fundamental science on which they are based. And I've described very briefly one example of the toys, or games with purpose, that promote public engagement in improving the science as well as increasing the quality of decisions based on the evidence flowing from that science.

Context: Need for public participation in building understanding and forging consensus on human action in complex ecosystems, drawing on the diversity of democracy, a multiplicity of perspectives and principles, and the wisdom of crowds

Conclusion. Building global capacity to pursue consensus on resolution of conflicts in access to and use of oceans and marine space: Public participation to create a 'safe place' for adaptive management within democratic processes accepted as legitimate will be crucial.

I've also tried in passing to draw a link to the need to promote trust and confidence in the decision processes that guide human activities affecting ecosystem health. Maybe there is some room for optimism arising from the spread of the social processes I've mentioned briefly here.

But still I have to add one quick further general qualification: Though I am sketching a range of ideas for new tools and toys to support participatory decision-making in a diverse and changing democracy, I am also assuming that we cannot here think outside the box of the representative democracy that situates ultimate decision-making authority with elected representatives acting on the basis of their interpretations and contextualizations of the relevant evidence. [Leave aside any image of a 'representative democracy' in which only one voice speaks, where Parliament must pass omnibus bills without debate, and 'representatives are required to vote on secret texts they have never seen.]

Leaving that aside, we are looking really only at the question how much influence might community agreement or broad consensus have on the thinking of the decision-makers who carry authority to initiate possible actions. And in that respect, the fundamental dimensions of the box outside of which it is hard to venture are those associated with the actual distribution of power and influence as they are exercised in the continuing play of public interests against private, individually or collectively, in long term or short.

Ultimately we need to consider what Jim Tully calls civic society, and look toward possible civil disobedience, continued contestation, agonistic or dialogic or cooperative democracy. This obviously is a topic for another time, taking us way beyond citizen science.

Huy ch q'u

OCEAN NETWORKS CANADA http://www.oceannetworks.ca/

CANARIE http://www.canarie.ca/

For anyone who might wish to stay up to date with the project there is a Digital Fishers http://digitalfishers.net/ website and a Twitter account @digitalfishers

Related work on other Web 2 and Web3 aspects of the staircase of knowledge might be seen at http://cpi.asu.edu/project/opening-governance.