Sea Around Us

Building bridges and making maps at AAAS

by Jennifer Jacquet

So much of what the scientists do is less relevant than it could be. This was the motivation behind the theme at the 2010 AAAS annual meeting, Bridging Science and Society, and *Sea Around Us* members delivered on this theme in three different sessions.

Daniel Pauly presented on a panel that showed the growing consensus among fisheries scientists. Although global overfishing is becoming an accepted premise, questions inevitably arose on the future of aquaculture. Pauly explained that it would be wrong to look at gladiator tournaments and vilify sports, when there is curling; similarly, it would be wrong to look at salmon farming and vilify aquaculture, when there are oyster farms.

Metaphors are powerful communication tools. So are 3-D visualizations, especially in a world that is already too big and too fast-paced to keep track of information. Can we help manage the future by allowing people to see it? To address this question, Villy Christensen co-organized a panel on the use of visualizations to bridge science and society for sustainability.

The *Sea Around Us* Project's Sherman Lai showed the game-like tool he and Christensen developed to allow users to visualize the real-time effects of their fishing decisions. Multiple players can watch how their choices would play out in the underwater world using a video game interface that can also display the embedded EcoSim models. George Basil from Arizona State University showed models of local water consumption to stakeholders in Phoenix and emphasized the need to become aware of water usage at the regional scale rather than a city block.

Sherman Lai and Villy Christensen present fisheries visualizations at the 2010 Annual Meeting of AAAS held in February in San Diego, CA. *Photo by Jennifer Jacquet.*

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Rather than simply talking about various climate change predictions, UBC's Steven Sheppard presented a visualization of Richmond, B.C. under several feet of water. These tools, currently used in immersion labs like our own in the Fisheries Centre, are designed to allow managers to experience the results of potential policies. The panel also discussed the potential for these tools online.

The AAAS theme of bridging science and society was commendable, but there is still hesitation from scientists who try to avoid being perceived as advocates.

A panel I organized showed the importance of keeping track of information so that we can gauge cooperative use of common goods like freshwater, greenhouse gases, and fisheries. We discussed non-regulatory means of enhancing cooperation – namely through reputation and shame. Ralf Sommerfeld, a recent graduate who worked with the Max Planck Institute, presented several of his new game-theoretical studies showing that gossip and reputation can lead to increases in overall cooperation (Sommerfeld *et al.* 2007, 2008). This theory underpinned my presentation proposing that we migrate away from guilt-based efforts in conservation (e.g. eco-labels) toward shame-based strategies, which we can use to motivate large-scale resource users — a more effective conservation strategy. To show evidence of this in the real world, John Hocevar, head of oceans campaigns for Greenpeace USA, presented how they affect retailer reputation to encourage greater cooperation. In particular, he focused on the seafood scorecard, which has been released in 15 countries around the world and ranks major supermarkets according to their seafood procurement policies. As a result, many large retailers have stopped selling certain fish, like Orange roughy and sharks, and have engaged in discussions with the 'good cops' of conservation, like WWF.

The AAAS theme of bridging science and society was commendable, but there is still hesitation from scientists who try to avoid being perceived as advocates. For instance, Chris Clark, head of the Bioacoustics lab at Cornell University and an expert on sound in the ocean, showed that the oceans are three times louder than they were in the 1960s – much of it on account of shipping. For acoustic feeders like right whales, this means greater difficulty locating food and each other, as noise disturbance causes "frequent tears in their social fabric". The evening before, at the COMPASS marine mixer between scientists and journalists, Clark mentioned to me that a potential solution was to slow boat speeds, which was also more fuel efficient and cheaper for shipping. A Norwegian firm had, in fact, already committed to slowing their ship speeds. Clark has also made progress in installing 'smart buoys' that alert ship captains to the presence of right whales to help them avoid collisions (http://www.listenforwhales.org/) . The following day, Clark made a very compelling presentation of the problem of acoustic disturbances, but he did not mention any solutions in his presentation.

This is why scientists need to build bridges and they need to make maps. I am not necessarily referring to literal `map making', which is what a colleague dubbed the spatial planning session at AAAS. I refer to an action map to guide the audience where they might go if they want to know more or do something with the science they just learned.

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The *Sea Around Us* website may be found at www.seaaroundus.org and contains up-

The *Sea Around Us* project is a scientific collaboration between the University of British Columbia and the Pew Environmental Group. The Trusts support nonprofit activities in the areas of culture, education, the environment, health and human services, public policy and religion. Based in Philadelphia, the Trusts make strategic investments to help organizations and citizens develop practical solutions to difficult problems. In 2000, with approximately $4.8 billion in assets, the Trusts committed over $235 million to 302 nonprofit organizations.

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Since the 1960s, studies have shown that behavior does not change merely as a result of information, even if it is fear inducing. Behavior can change if information is combined with an action plan. In a 1965 study on tetanus inoculation, researchers showed students the somewhat terrifying results of contracting tetanus, which resulted in 3 percent of the students getting a tetanus shot. Other subjects were given the same lecture but were also given a copy of a campus map with the location of the health center circled. They were then asked to make a plan for when they would get the shot and look at a map to decide what route they would take to get there. In this case, 28 percent of the students managed to show up and get their tetanus shot. The medical message seemed to influence attitudes but a specific plan influenced action (Leventhal et al. 1965).

In bridging science and society, scientists need to consider avenues to give their audience an action map. One obvious solution could be for scientists to incorporate policies and actions that would deal with the issues they study, like Chris Clark's recommendation to slow shipping speeds to reduce ocean noise. In some cases, scientists can *take* action, as happened in 1974 after two chemists at the University of California Irvine proposed a hypothesis that related CFC use to the depletion of the atmosphere. Sherwood Rowland and Mario Molina did not stop there but advocated for the ban of CFCs, which occurred regionally just three years later and, globally, with the 1987 Montreal Protocol (Haas 1990).

However, many scientists feel uncomfortable with action plans or, what many call 'advocacy'. In this case, scientists can team up with people who already have action plans, which is why AAAS supported a panel that included a main player at Greenpeace. It is why coral reef ecologist Terry Hughes, who presented about the fish biomass improvements within no-take zones, presented alongside Jay Nelson from Pew who is working to establish large marine reserves in an ocean where less than 0.08 percent of the area is no-take. Hughes also nicely exhibits the benefit of having scientists to examine the effects of action plans themselves. Like the scientists who examined the effects of a map on tetanus shots, Hughes has studied the biomass improvements in certain fish, like the coral trout, afforded by society's decision to re-zone and protect a greater area of the Great Barrier Reef (McCook et al. 2010). His research was a nice reminder that the bridge between science and society is a two-way street.

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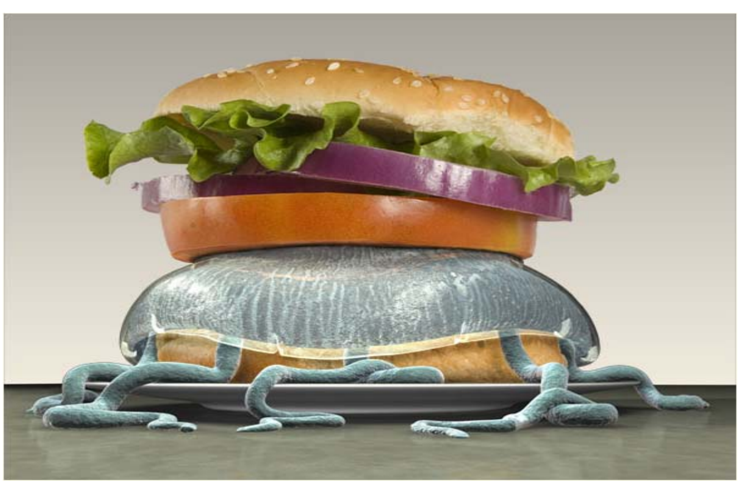

'Jellyfish Burger' by Jennifer Jacquet and David Beck received Honorable Mention in the 2009 International Science and Engineering Visualization Challenge. See the next article to learn more about the potential of jellyfish burgers landing on the menu.

What's for dinner?

by Lucas Brotz

If the thought of eating a jellyfish burger leaves a bad taste in your mouth, you might just have to get used to it. While they aren't available at drive-through windows quite yet, we may discover that our future seafood options are more jelly than fish, especially if we can't break our bad habits.

Over the last two decades, jellyfish have increased in a number of locations around the world including Asia, Europe, and the eastern United States. Unfortunately, knowledge of jellyfish from most marine environments is limited, making it difficult to understand how jellyfish and ecosystems are responding to changes at regional and global scales (Mills 2001).

Unless we change how we treat our oceans, a more gelatinous future may be inevitable.

In an attempt to see the bigger picture, jellyfish scientists from around the world are starting to pool their data, and I am privileged to be collaborating on the project. The first in a series of meetings was recently held at the National Center for Ecological Analysis and Synthesis (NCEAS) in Santa Barbara, California. NCEAS is an ideal host for the Jellyfish Working Group, as it facilitates the synthesis of existing data in order to advance ecological understanding. Over the next two years, the project will strive to develop a composite picture of jellyfish populations and their associated effects around the globe.

The population dynamics of jellyfish can impact more than just your day at the beach. Jellies are important members of ecosystems, and their exceptional ability to form massive blooms can have dramatic consequences for food webs and carbon cycling. Large `smacks' of jellyfish are also directly interfering with human activities, resulting in significant economic losses and even putting human lives at risk. In several locations, nets that normally catch shrimp and fish are coming up full of jellyfish. If the massive weight of the jellies doesn't split the net or break hauling equipment, any useful catch is spoiled. Last year, one such haul even caused a Japanese trawler to capsize, tossing the three crewmen into icy waters. Thankfully, they were all rescued, but the event is a sobering reminder that we truly are "fishing down the food web" (Pauly *et al.* 1998). And major socioeconomic impacts of jellyfish are not limited to fisheries. Shipping, mining, aquaculture, power generation, and tourism have all been negatively affected by jellyfish blooms, and the list of incidents continues to grow.

Ironically, we may have only ourselves to blame for certain increases in jellyfish populations. Effects from overfishing, climate change, pollution, aquaculture and coastal development have all been linked to increases in jellyfish (Purcell *et al.* 2007). While such cause and effect relationships are still being investigated, it is clear that humanity is not on a sustainable path. Unless we change how we treat our oceans, a more gelatinous future may be inevitable.

If the idea of a jellyfish burger seems outlandish, you may be surprised to know that vast amounts of jellyfish are consumed by humans everyday, mostly in Asia. Over the last ten years, annual jellyfish production has averaged over 350,000 tonnes, exceeding the global catch of many other fisheries, such as lobster. Jellyfish salad is celebrated as a delicacy, and there's evidence to suggest that eating it may even be good for you. For those with a sweet tooth, a company in Japan adds jellyfish to candy, cookies, and even ice cream. But simply shifting our diets won't solve the world's jellyfish problems. While there are thousands of gelatinous species around the globe, only a handful are sought after for human consumption. Even an expansion of the fishery is unlikely to result in fewer jellyfish, as some edible stocks are now being enhanced. One such example comes from China's Liaodong Bay, where a hatchery

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Participants at the first meeting of the NCEAS Jellyfish Working Group. Back row (L-R): Craig Carlson, Carlos Duarte, Lucas Brotz, Hermes Mianzan, Steve Haddock, Rob Condon; Middle row (L-R): Kelly Robinson, Alenka Malej, Jennifer Purcell, Cathy Lucas; Front row (L-R) Monty Graham, Mary Beth Decker, Kylie Pitt; Absent: Mike Dawson, Shin-ichi Uye, Kelly Rakow Sutherland, Ric Brodeur, Mark Gibbons.

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program releases hundreds of millions of juvenile jellies every spring in the hopes of harvesting them in the fall (Dong *et al.* 2009).

Given the current state of world fisheries and the global need for protein, our oceans are in a crisis of supply and demand. Jellyfish cannot fill the gap, but if we don't change our behavior they will be one of the few items on the seafood menus of tomorrow. While we may have to get used to telling our kids to eat their jellyfish, let's hope they have another choice.

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Latest version of the *Sea Around Us* Catch Database casts a wider net

by Wilf Swartz and Reg Watson

One of the key objectives of the *Sea Around Us* Project is to provide spatially referenced estimates of global marine fisheries landings (Watson *et al.* 2004, Pauly 2007), allowing us to determine who caught what where. This involves assigning the over 3 billion tonnes of catch landed since 1950 into 180,000 half degree 'cells' that make up our global ocean grid system using a series of constraints, including the statistical areas used in the source dataset (e.g. the 18 FAO major statistical areas), the known distribution of nearly 1500 exploited taxa and a database of fishing access agreements that, taken together, provide information on the likely distribution of fishing fleets.

Such a task requires an immense amount of work by humans and machines, with countless challenges as we continuously test and refine our methodology. The previous version of the catch database was released in late 2007. Now, after two years of intense work led by Reg Watson and assisted by a skilled team including National Geographic-funded scientist Sean Tracey on loan from the Tasmanian Aquaculture and Fisheries Institute, and Grace Pablico, we are proud to announce that the new and improved version of the database is available online at www.seaaroundus.org (Figure 1).

Our methodology for spatial disaggregation of fisheries catch has evolved since it was first described in Watson *et al.* (2004). Some of the most noteworthy changes are documented below.

The first of the major updates to the database are its data sources. Previous versions of the database have relied almost exclusively on the official landings reported by international (e.g. NAFO, ICES) and by national (e.g. NMFS) agencies. However, we now realize that official catches, particularly from small island states and generally less-developed countries can severely underestimate actual catches. Hence, the project has developed and applied a methodology for 'reconstructing' the catches of such countries based on detailed analyses of secondary data (Zeller & Pauly 2007). Catch reconstructions have been completed or are underway for over 80 countries, and we considered such reconstructions for 12 countries in the present version, plus China, whose catch was, as in the previous version, adjusted downward (see Watson and Pauly 2001).

We are proud to announce that the new and improved version of the database is available online at www.seaaroundus.org.

We have also implemented some changes to the ancillary databases that serve as constraints in the spatial allocation of catch. The fishing agreement database, for example, has undergone a major overhaul, with records from the original, FAO-supplied, fisheries agreement database re-examined and, where possible, validated with alternative sources as to the nature of the recorded agreements and their durations. While the contents of many private fishing agreements, if not their existence, remain a mystery, we were encouraged to see that an increasing number of governments are making the contents of their fisheries agreements available online. This trend toward

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increased transparency will greatly improve our understanding of the nature of distant water fisheries.

The updated database also represents a major shift in our assumptions about distant water fishing activities in the years leading up to the United Nations Convention on the Laws of the Sea (UNCLOS) and to the Exclusive Economic Zones (EEZ) that it allowed for, i.e., the late 1970s-early 1980s. Previously, we operated under the assumption that distant water fleets did not operate in these 'undeclared' EEZs unless there were documented observations of fleets in such regions; such assumptions were deemed necessary in order to prevent catches from being 'smeared' across the world. However, with improvements in our knowledge of species distributions (which now use key ecological information such as depth and habitat preferences to derive predicted distribution: see Close *et al.* 2006) and reconstructed catch estimates, we can apply rules that allow the assignment of the catch of distant water fishing fleets to cells later assigned to host EEZ areas (provided they meet the constraints based on the species distribution and the source data reporting), up to the year of EEZ proclamation by coastal countries. We believe such assumptions better represent the 'Freedom of the Sea' principle that these fleets operated under during the pre-UNCLOS period, and better capture the offshore displacement of fishing that followed the UNCLOS.

We hope that our database will prove to be an even better tool for researchers and governments as they struggle to resolve the many issue that impact global fisheries sustainability.

We hope that as a result of these and other changes our database will prove to be an even better tool for researchers and governments as they struggle to resolve the many issue that impact global fisheries sustainability. We also acknowledge that this kind of database can only be useful through constant update and improvement, and are already at work on the next version. We are encouraged to find that our global methodology has yielded results that conform with local datasets, e.g. for Mauritania (Gascuel *et al.* 2007) and look forward to feedback and continued support from the fisheries research and NGO communities.

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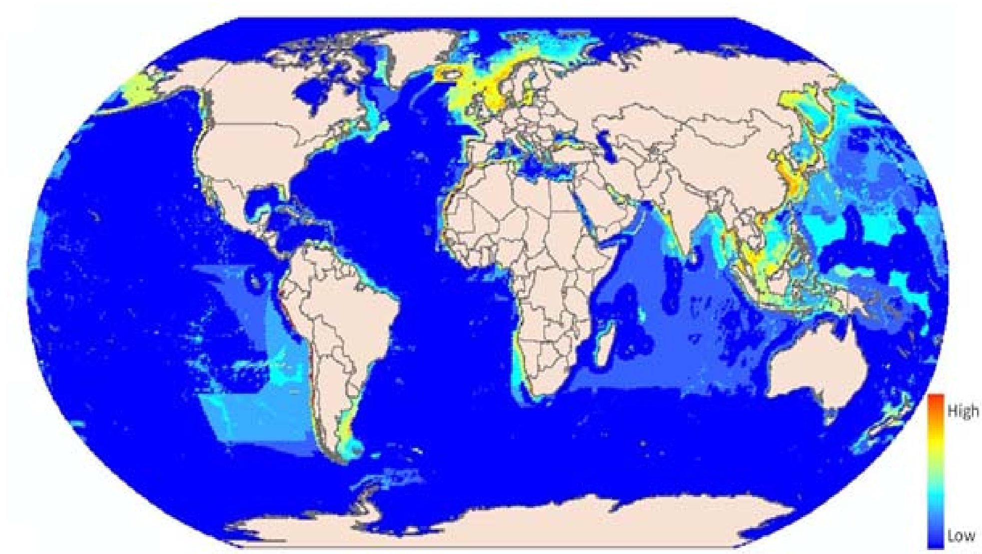

Figure 1. Map of world's marine fisheries catch (annual average 2000-2005).