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Sonar Technology and Shifts in Environmental Ethics

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Sonar Technology and Shifts in Environmental Ethics

For a philosopher, the history of sonar technology is fascinating. During the first and second World Wars, sonar technology was primarily associated with activity on the part of the sonar technicians and researchers. Usually this activity is concerned with creation of sound waves under water, as in the classic "ping and echo". The last fifteen years have seen a shift toward passive, ambient noise "acoustic daylight imaging" sonar. Along with this shift a new relationship has begun between sonar technicians and environmental ethics.

As I came to understand the sonar technology community, I was also inspired by the environmental ethics commentaries on J. Baird Callicott's work, especially those found in Wayne Ouderkirk and Jim Hill's collection from 2002, *Land, Value, Community: Callicott and Environmental Philosophy*. In Wayne Ouderkirk's introduction to that text, Wayne Ouderkirk gives a careful analysis of the foundations for an environmental ethic:

> "…the question then becomes whether and how to justify a moral concern for the environment, especially in light of the traditional Western restriction of morality to interhuman relations."[1]

Ouderkirk points out one of the central issues for philosophy of technology – the moral status of non-human beings that are participants in research, or that are affected by research. Callicott's own work sought to broaden the use of terms like community, to illustrate that even non-human entities (be they animals or ecosystems) are a part of a moral community with the researchers, and as such, they are entitled to moral consideration. This use of the term community has itself been deemed problematic. For example, Robert McIntosh, an ecologist, criticizes joining of "land ethic" with other specific key terms that guide scientific ecology.

> (McIntosh) moves the discussion to the land ethic's alleged foundation in scientific ecology. Searching a large sample of ecological literature for settled meanings of the ***key concepts of ecosystem, community, integrity, and stability,*** he finds little in that literature helpful to Callicott. All of those concepts, he claims, have diverse meanings in ecology; and that diversity raises difficulties for any philosophical appropriation of them.[2]

Similarly, Kristin Shrader-Frechette raises an important criticism of Callicott's use of the concept of scientific *community*. Shrader-Frechette notes that "there is no *scientifically/biologically* coherent notion of 'community' robust enough to ground either contemporary community ecology or environmental ethics."[3]

This question of terminology intrigued me as a philosopher of science, because very often philosophers of science try to understand key shifts in meanings of terms, status of theories, and construction of hypotheses in science. These shifts indicate deeper changes in ethical values, and in membership and consensus within communities. The case study from the history of sonar technology and the recent environmental impacts of underwater imaging stand as an example of such shifts in terminology and ethical values.

First of all, we should discuss whether the concepts and terms discussed by Callicott, McIntosh, and Shrader-Frechette on the right "level," or of the right "kind," for analysis? Philosophers of science look for key shifts in meanings of terms in a more localized level (for example, Philip Kitcher finds evidence of change in scientific communities, and unification of scientific theories, by looking at specific terms used by groups of scientists like "gene." "Gene" means something different to a molecular biologist than it does to a classical Morgan-style geneticist.) Can such changes in terminology also be coincidental with a new environmental ethos among researchers? Can technology used by researchers inspire them to adopt a new environmental ethics perspective, as well as a new appreciation for the environment in which they do their research and its inhabitants?

I have found a significant shift in the values, and the environmental ethics, of the underwater community by looking closely at the term "noise" as it has been conceptualized and reconceptualized in the history of sonar technology. To illustrate my view, I will include three specific sets of information:

> 1) a discussion of the 2003 debate regarding underwater active low- frequency sonar and its impact on marine life;
> 2) a review of the history of sonar technology in diagrams, abstracts, and artifacts;
> 3) the latest news from February 2004 on how the military and the acoustic daylight imaging passive sonar community has responded to the current debates.

In 2003, Greenpeace began a campaign to address low-frequency active sonar's effect on marine life. For a number of years, Greenpeace had raised concerns that various types of active sonar were increasing noise levels in the world's oceans to the point that caused physical damage to marine life.[4] Before Greenpeace's announcement, the United States military began use of low-frequency, long range active sonar in a special program to acoustically "light" oceans for advance warning of submarine and ship activity by other countries. In 2003 Greenpeace made a new suggestion, recommending acoustic daylight imaging as a more environmentally friendly type of sonar.

> The seas and their inhabitants are subjected to many stresses from man's activities. One which is little known but potentially destructive is noise pollution, which can disrupt the lives of or physically harm sea animals. The U.S. Navy, NATO, and other navies are blasting the oceans with enormous sound pressures as part of systems designed to detect enemy submarines. We're trying to end this assault, and recommending alternate approaches.[5]

Environmental activists concerned with ocean life received support from researchers in the mainstream scientific community, especially later in 2003 when an article appeared in Nature arguing that there was a link between low-frequency active sonar and a number of marine mammal deaths. The Nature article was eventually picked up by major news outlets, including CNN.[6]

Nature: Military sonar may give whales the bends

From Natalie Pawelski
CNN
Wednesday, October 8, 2003 Posted: 2:22 PM EDT (1822 GMT)

(CNN) -- Dozens of whales, dolphins and porpoises have washed up dead on shores around the world after exposure to military sonar. Researchers writing in the journal Nature say they may have found a link.

Scientists examined the bodies of ten beaked whales that died on two beaches in the Canary Islands in September.

Cut surface of the liver shows that cavitary lesions have extensively replaced normal tissue.

A number of blogs on the internet also followed the story, including this one celebrating a decision against low-frequency sonar:[7]

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September 01, 2003

Good News for the Whales!

The Washington *Post* reports some good news for whales and for those who respect those noble creatures. (And it's a partial defeat for the Bushites and the US military too, woo hoo!)

> *While Magistrate Judge Elizabeth Laporte stopped the Navy from going ahead with its global deployment of the system, she also denied a request from environmental groups for a complete peacetime ban on the low-frequency sonar. She ordered the Navy and environmental groups to negotiate a permanent plan to allow limited use of the technology, which is designed to track certain kinds of diesel submarines that can be undetectable by standard sonar.*

Greenpeace and the environmental activists did suggest an alternative type of sonar to replace the problematic low-frequency sonar:

> Greenpeace Foundation has, with other organizations, sued to try forcing environmental impact studies and to draw attention to the problem. We strongly recommend that alternate systems be developed which utilize greater computer processing power to

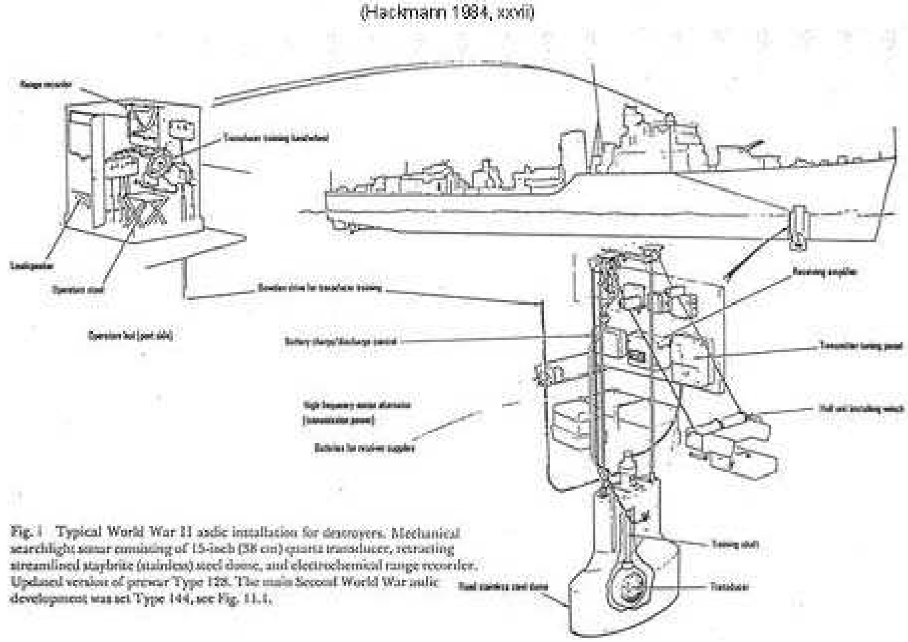
drastically lower the sound levels necessary for imaging; and ***request a move to "acoustic daylight" technology*** which analyzes perturbations in the ocean's naturally occurring noises to provide passive underwater imaging.[8]

What is acoustic daylight imaging, and how does it compare to other types of sonar? Why would the environmental activists recommend it? At this point a brief summary of the history of sonar technology will be helpful.

The history of sonar technology can best be illustrated in the diagrams and graphics used by sonar technicians. These diagrams depict the relationship between the sonar technician and their location on board a research vessel. The diagrams also show how the earlier forms of sonar before “acoustic daylight imaging” had conceptualized the environment and context within which the sonar works: the environment and context is represented by vacant white space, with little or no significance. Sources of “noise” underwater were understood to be an annoyance, a variance to be corrected and “whitened”. Later diagrams created by the acoustic daylight imaging community depict the environment and marine life as active and necessary for the sonar technicians’ work, the creators of underwater “noise” are shown as active participants in the process of research and imaging.

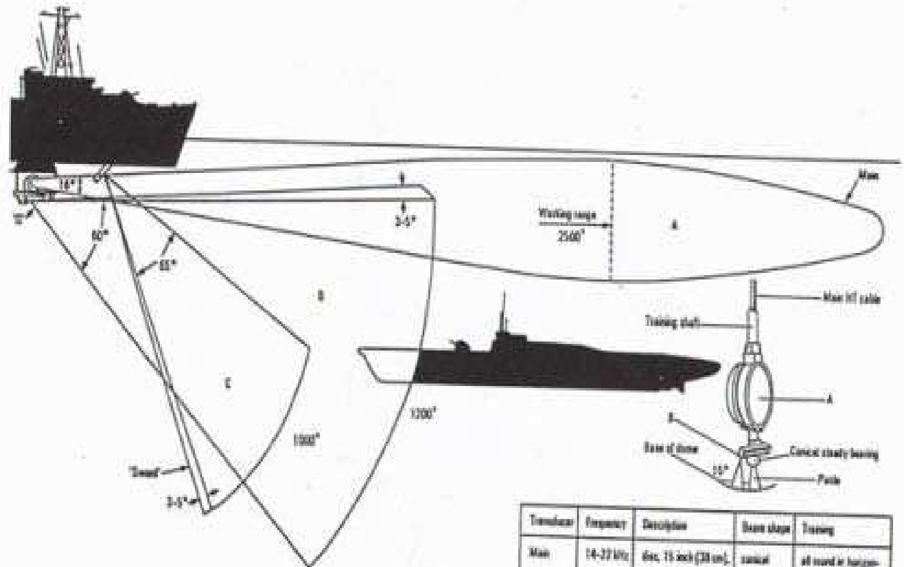
Active Sonar range finder apparatus on ship, 1940-1945

(Hackmann 1984, xxvii)



Refinements in sonar ranges, World War II

(Hackmann 1984, xxxi)



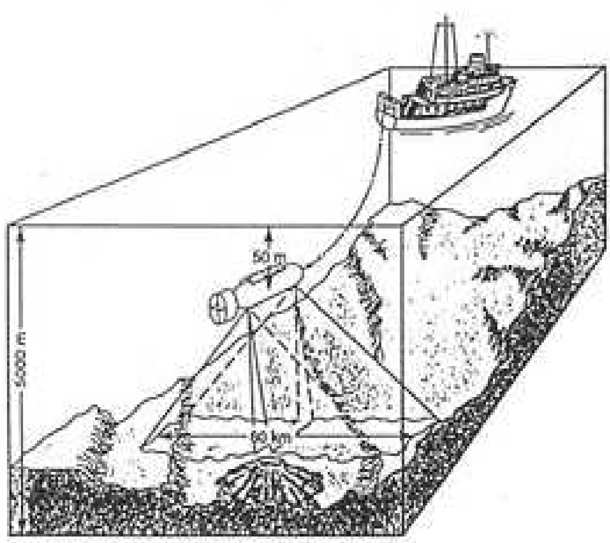
Transducer	Frequency	Description	Beam shape	Training
Main	14-22 kHz	disc, 15 inch (38 cm), held in vertical plane	conical	all round in horizontal plane
'Q'	38½ kHz	strip, 12x1 ¾ inch (30½x4.5 cm)*	wedge in horizontal plane	same; attached beneath main transducer
'sword' Type 147	50 kHz	strip, 18x1¾ inch (45 x 4.3 cm)*	fan in horizontal plane	tilts 45° backwards in vertical plane

*Dimensions changed slightly with later sets.

Fig. ii The three asdic beams developed during the period covered by this history.
A. Main 'searchlight' beam for long-range detection developed at end of World War I.
B and C. Secondary sets for maintaining contact with deep diving submarines developed in World War II.

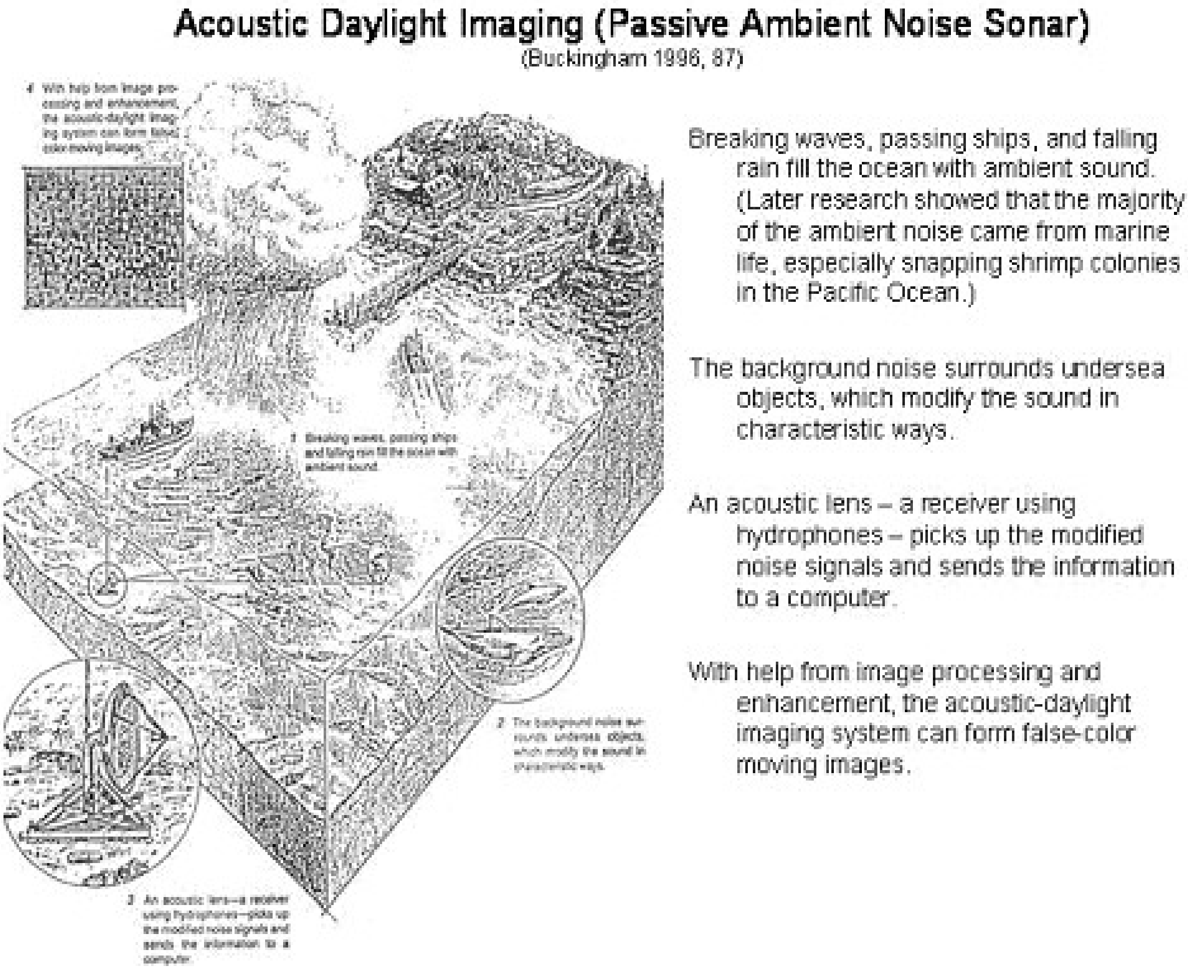
Swath bathymetry, multi-beam side-scan sonar, post 1950s

(Duxbury 1987, 98)



Box figure 3.1

A surface vessel tows a side-scan sonar system, or towfish, to acoustically map a swath of sea floor. The dark triangle shows the area covered by the sound beams. Vertical scale distorted for clarity.



The diagram depictions of the underwater context, marine life, and noise are also in concert with conference topics and abstracts from conferences and training manuals used throughout the history of sonar technology.

First, an example from a Naval text published in 1985, *An Introduction to the Theory and Design of Sonar Transducers*:

> The ultimate useful sensitivity of a hydrophone system is *limited by the noise* at its output. This noise will normally have both acoustic and electrical origins. The level of the acoustic noise depends on the nature and distribution of the sources, which may include *noises due to natural events, such as wind-induced wave splashing noise, biological noises*, or man-made noises of many types. Other noises may originate in turbulent boundary layer pressure fluctuations or mechanical vibrations coupled to the sensor from its mounting platform. In addition to these sources, noise exists due to thermal motions of the medium and to processes internal to the transducer itself and in the electrical amplifier. The hydrophone designer may have little or no control over the ambient acoustic *noise perceived* by the sensor...there is some *potential for reducing* the response to the ambient noise by limiting the hydrophone's frequency response or possibly using a directional sensor.[9]

Ten years later, a paper was given at a conference distinguishing self-noise created by the ship and instrumentation itself, from noise created by natural events and biologics (marine life):

> The performances of acoustic arrays for passive sonar systems are *limited by ambient noise* and by *self-noise phenomena*, such as turbulent flow induced noise, machinery noise propagating along the hull, or propeller noise. To predict the performances of the system and to improve the design of the arrays, it is important to determine which self-noise component is dominant on a given ship at different speeds.[10]

However, in 1993, there was also some disagreement and difference in perspective among members of the sonar community. In this paper presented at an international society conference, acoustic daylight imaging takes a place among the "hot topics" and future sonars that will respond to changing demands by "close coupling" with the ocean environment and its own processes:

> There have been two major changes that have modulated the temperature of topics in underwater, or ocean, acoustics since the last "hot topics" session. First, close coupling among the acoustics, *the ocean environment and its processes*, numerical models, and the signal processing continues to lead to new methods for learning about the ocean and to improved performance of acoustic systems. Second, *in response to changing demands upon future sonars*, there has been much more attention to both active systems and shallow water environments. Several "hot" (at least warm) topics will be discussed: adaptive focusing systems including phase conjugation, self-cohering arrays, and matched-field processing/tomography; global acoustics and ocean climate monitoring; high-resolution bathymetric mapping; reverberation; seismoacoustics of interface waves; shallow water acoustics; *ambient noise and acoustic daylight*; and high data rate acoustic telemetry. (The order is not an indication of relative temperature.)[11]

The instrumentation used by the acoustic daylight imaging community includes some of the same equipment used by the earlier active sonars. Earlier sonar relied on both active and passive hydrophones, phones that could both send out sound waves and receive and interpret the sound waves. Acoustic daylight imaging strengthens the passive "listening" hydrophone and combines many of them into a dish-shaped array. This array of hydrophones has greater ability to perceive changes in sound waves underwater than any earlier type of sonar:

> A multibeam "Acoustic Daylight" system is being developed that is capable of forming real time images at 30-Hz frame rate with 127 simultaneous beams. Objects at 10- to 200-m range will be imaged, primarily employing acoustic information over 8-70 kHz. The raw data rate of such a system is over 25 Mbytes per second, which poses serious beamforming, real-time imaging, and data storage problems. The solutions we have developed include: an acoustic lens in the form of a spherical reflector with multi-element sensor (which achieves beamforming geometrically rather than through phasing); frequency-estimator preprocessing; and an economic 40 MFlop DSP engine. The color and intensity of each pixel of the final image will be determined by the spectral shading and intensity of the received signal in each beam. The limitations of the design are explored in terms of their impact on expected performance. Image simulations have been computed based on a numerical sum of a closed-analytic expression for acoustic energy scattering from a submerged body. *The illuminating noise field is chosen for image*

> *synthesis, corresponding to obvious applications of interest*. Work supported by the Office of Naval Research.[12]

By 1994, the acoustic daylight imaging researchers had successfully used their passive hydrophone array to create reliable images:

> A broadband (8-80 kHz) multibeam (126) acoustic daylight system has been developed which forms real-time images at a 27-Hz frame rate *using only natural ambient noise in the ocean*. The color and intensity of each pixel of the final image is determined by the spectral shading and intensity of the received signal in each beam normalized to a running-average ambient noise spectrum. The first deployment of this system will be made from a floating research platform (ORB) during August in San Diego Bay. The high-frequency ambient noise at this site is dominated not by surface waves, but by colonies of snapping shrimp (Alpheus and Synalpheus) associated with nearby structures and other habitats. The preliminary results from this deployment will be presented, including a description of the data processing and color mapping algorithm, the ambient noise environment, and some preliminary image results from simple targets at close range. Work supported by ONR.[13]

In 1998, the acoustic daylight imaging community began to play close attention to the sources of the background noise that their hydrophone arrays relied on to make images. They discovered that a number of biological entities in the underwater environment, especially shrimp and dolphins, were creating the necessary noise:

> The data obtained from the Acoustic Daylight Ocean Noise Imaging System (ADONIS) in San Diego, California, is dominated by ambient noise from snapping shrimp. This is expected in all warm and shallow waters, except with very high winds or precipitation. It is shown that this data exhibits a log-normal intensity distribution. This exactly determines the number of independent statistical parameters that can be used to create images. Further, ambient noise data taken near Singapore is also shown to be log-normal in intensity. This distribution is common for unsaturated, multiply-scattered acoustic fields, but we show that it is a property of the sources and not the propagation. It is also demonstrated that *good ambient noise images can be created from cross-correlations of pixel intensities*, independently of mean or other statistical measures. Image examples will be presented and some implications for the next-generation ambient noise imaging system will be discussed. This work was funded by NUS and DSO, Singapore. ADONIS data provided by Scripps Institution of Oceanography.[14]

This shift in attention to the underwater marine life and the health of the ocean environment is also reflected in articles written by ambient noise / acoustic daylight researchers that reflect concern for the environmental impact of sonar. John Potter's "Ambient Noise Imaging Potential for Intelligent Terrestrial Animals"[15] addresses whether animals themselves might also be using a type of passive acoustic daylight sonar. An article co-written by John R. Potter and Eric Delory, "Noise Sources in the Sea and the Impact for Those Who Live There" [16] addressed how underwater noise, especially man-made underwater noise, could negatively affect the sonar ability and the health and well-being of underwater marine mammals. Specifically, dolphins and grey seals have been studied and appear to utilize the same underwater acoustic noise as a daylight “backdrop” against which objects can be “seen” through echolocation:

> Recent work has explored the possibility that marine mammals might also use this technique. One report recounts how investigators applied eye cups to a bottlenose dolphin (Tursiops truncatus) and then threw a live fish into the pool, this exercise being a casual and unplanned sequel to a more rigorous and traditional echolocation experiment. The dolphin followed and caught the fish 5 times in 5 sequential tests without any sound (of the dolphin’s echolocation) being recorded either by the monitoring hydrophones secured to the dolphin's melon or by others suspended at various locations in the pool. A similar report exists for the grey seal (Halichoerus) tested with an air-filled target.[17]

A wealth of papers on marine life and the underwater environment has been produced, including two sets of papers presented at the High-Frequency Ocean Acoustics Conference at the La Valencia Hotel, in La Jolla, California on March 1-5, 2004:

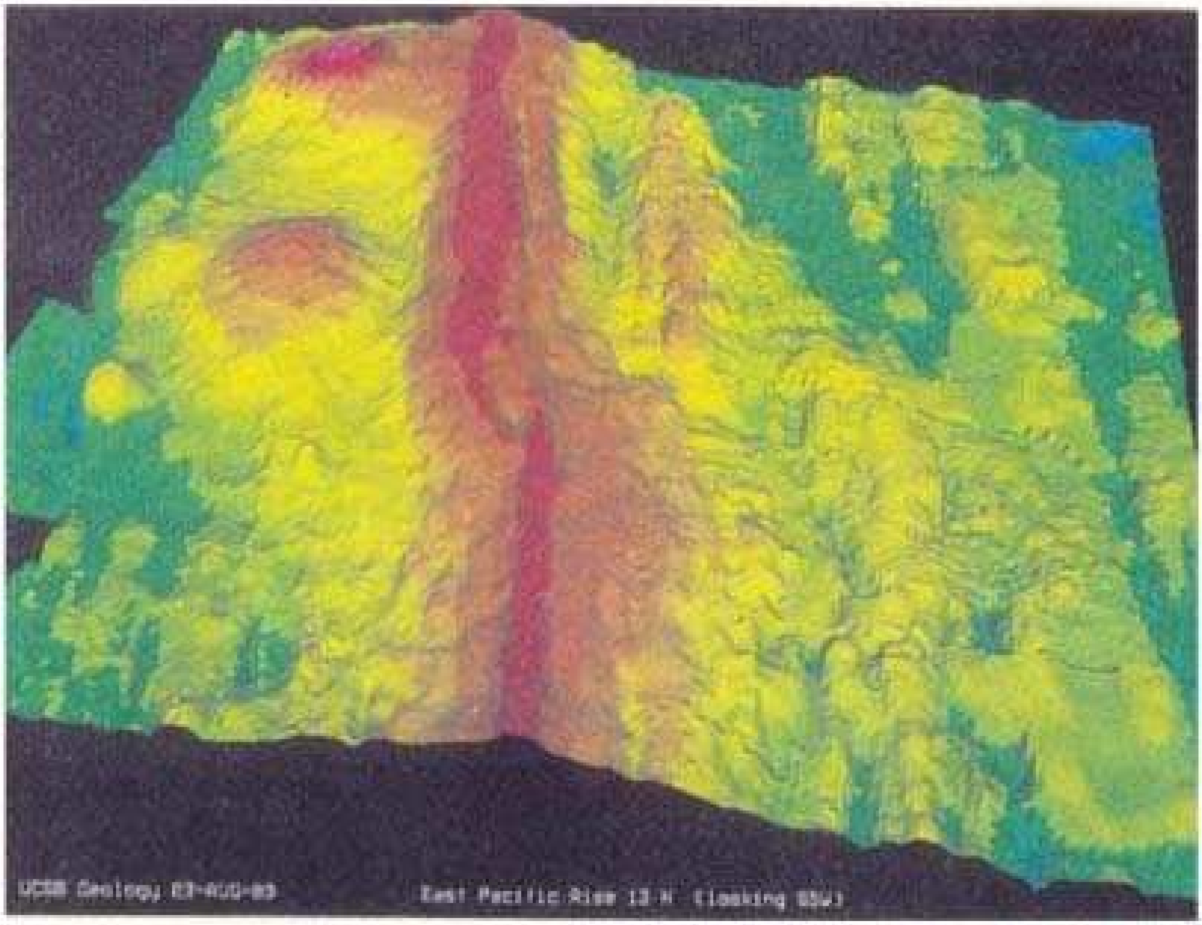
> **Tuesday March 2, 2004**
> ***Marine Mammals* - (4:15-5:20)**
> **Echolocation signals of wild dolphins (W. Au – invited speaker)**
> Active sonar and the marine environment (E. Sevaldsen) Acoustic propagation studies for sperm whale vocalization analysis during LADC experiments (N. Sidorovskaia, G. Ioup, J. Ioup, J. Caruthers)
> ***Marine Mammals II – (11:15-12:15)***
> Predicting the environmental impact of active sonar (*A. Duncan, R. McCauley, A. Maggi*)
> Biomimetic target classification (*A. Abawi, M. Porter, C. Tiemann, P. Hursky, S. Martin*)
> Underwater ambient noise and sperm whale click detection during extreme wind speed conditions (*J. Newcomb, A. Wright, S. Kuczaj, R. Thames, W. Hillstrom, R. Goodman*)[18]

The acoustic daylight imaging researchers have a new focus on creating research that admits, and invigorates concern for the environment and underwater life. This is reflected in the papers and presentations they have made in the last six years. We can also ask whether these concerns are reflected in the artifacts produced by the sonar technicians, and the images that stand as quintessential examples of what their equipment can do. These products tell us a number of interesting facts about how the researchers conceptualize their interactions with the environmental context:

Image from active, multi-beam side scan sonar (Duxbury 1987, 99)

This image was created using active sonar, sending out “pings” and recording echoes returned to the apparatus on board ship. The underwater context is primarily of interest as a point of comparison, note how the embedded rocks are used to present a sharp, organically shaped contrast to the manufactured, synthetic shape of the plane resting on the ocean floor. Any underwater noise, from biologic sources, marine life, or weather, would have to be ignored or “whitened” for the sonar apparatus to produce the image properly.

Image from active multi-beam swath bathymetry (Duxbury 1987, 98)



This image shows a section of ocean floor after "swath bathymetry", the systematic use of multiple active sonar passes along the ocean floor. Like the image of the plane resting on the ocean floor, in the use of swath bathymetry, any underwater noise would have to be ignored or "whitened" for the sonar apparatus to produce the image properly.

Images from passive acoustic daylight imaging, holey plus target,
http://extreme.ucsd.edu/adonis_media.html , Mandar Chitre, Acoustic Research Laboratory, Singapore (Target consisted of four 1mx1m square panels, at 38m range.)

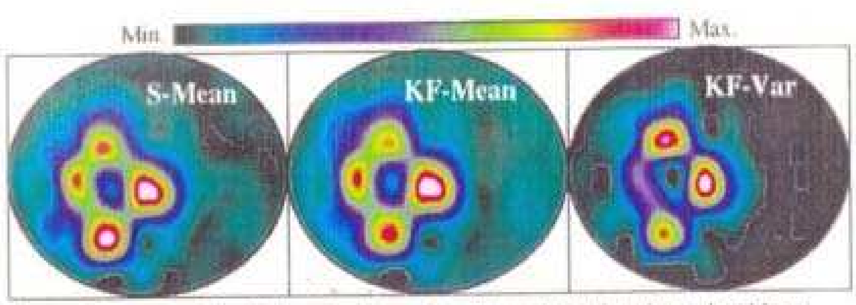


Figure 2. Images of the 'holey plus' target configuration using three algorithms

These two images are from the acoustic daylight imaging research program at Scripps Oceanographic Institution. The key difference between these two images and the ones above is the way that the image was made, and the noise conditions that had to obtain for the sonar gear to produce the image properly. Each of these sets of images was created by passing a "holey plus" sign shaped target in front of a passive hydrophone array. The hydrophones were able to pick up how the shape changed the patterns of ambient underwater noise, and created the image using the underwater noise context as a co-conspirator in the research progress. In the case of ambient noise imaging, the underwater noise context is needed, not "whitened" or ignored.

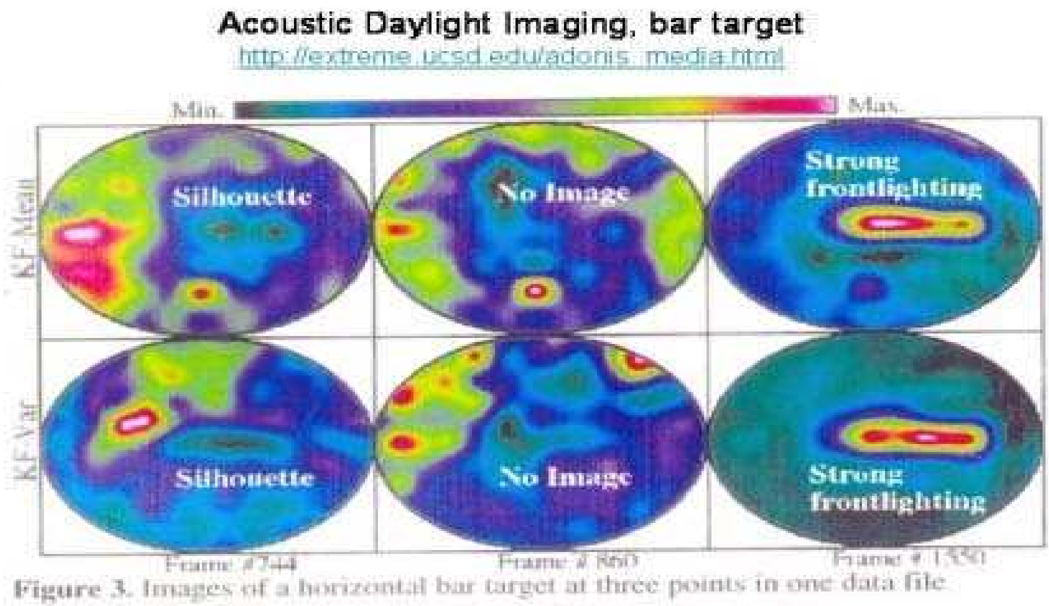
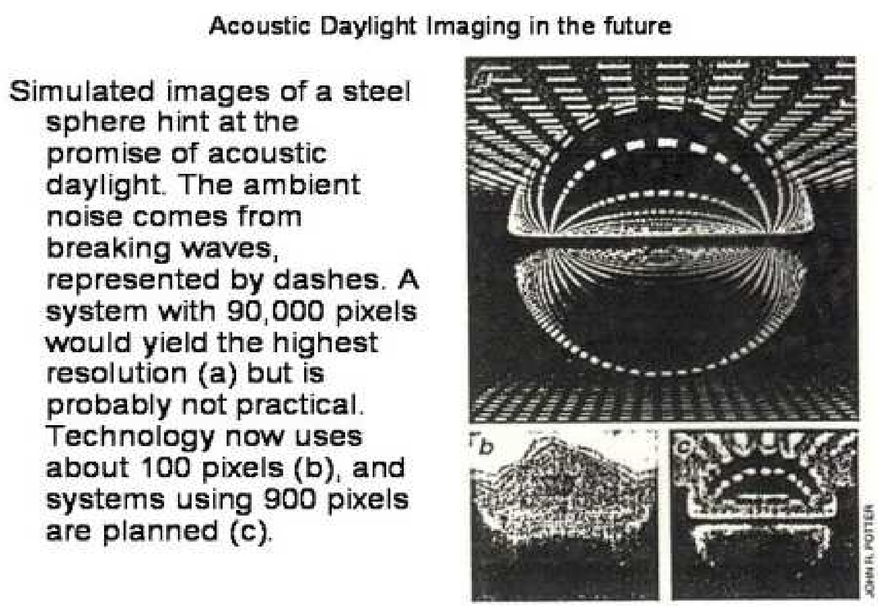


Figure 3. Images of a horizontal bar target at three points in one data file

Below, John Potter of the acoustic daylight imaging group gives simulated images of a steel sphere. The clearest image of the sphere, at the top, utilizes a greater number of hydrophones in the array, and a greater number of pixels in the resulting image.[19]



How does this information about the sonar technology community, and its shifting interest in ambient noise "acoustic daylight imaging" sonar, relate to the issues raised by Greenpeace? Greenpeace had recommended a shift to acoustic daylight imaging instead of the low-frequency, long range style sonar that had been used by the military. On October 14, 2003, the Navy promised to limit the use of low-frequency active sonar:[20]

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Navy to curb use of sonar system

By LISA STIFFLER
SEATTLE POST-INTELLIGENCER REPORTER

Oct. 14 - Environmental groups and the U.S. Navy have struck a deal to dramatically limit the peacetime use of a new kind of sonar in the world's oceans after scientists found the technology can harm marine life, including whales and dolphins.

Navy sonar is being investigated as a possible cause of the deaths of 13 harbor porpoises that washed ashore in the San Juan Islands in May. And researchers last week reported that the bends -- a condition suffered when human divers surface too quickly -- might be triggered in whales after sonar exposure.

Although the restrictions wouldn't apply to the type of sonar suspected in the deaths of San Juan Islands porpoises, the move is "a major step forward" in preventing expansion of sonar's use, said Joel Reynolds, director of the Marine Mammal Protection Project with the Natural Resources Defense Council.

This graphic from the October 14, 2003 Seattle Post-Intelligencer shows that one of the areas where marine life had been affected, and where low-frequency active sonar was in use, is an area of the Pacific that the acoustic daylight imaging researchers have relied on for snapping shrimp colony "noise."

A new monograph has also been published, addressing the issue:

> Public awareness of the issue escalated in 1990s when researchers began using high-intensity sound to measure ocean climate changes. More recently, the stranding of beaked whales in proximity to Navy sonar use has again put the issue in the spotlight.[21]

Even with the spotlight on the issue, in the last seven months, the Navy has begun to cast doubt on low-frequency sonar as the cause of marine mammal deaths. In February of 2004,

> Rear Admiral Len Hering, commander of the U.S. Navy's Northwest operations, (reported that) experts who examined 11 harbor porpoises that died last spring -- around the time a Navy ship conducted sonar tests in the area -- found no evidence that the sound waves were a factor, but the report added that so-called acoustic trauma cannot be ruled out since the porpoise remains examined by experts were decomposed. (AP Photo/Ted S. Warren)

Articles appeared in a number of news sources making the same point, that the low-frequency sonar could not be proven as the cause of the porpoises' trauma.[22] What the speech by Rear Admiral Hering did not address was the open-ended nature of the National Marine Fisheries report, which actually neither ruled out nor endorsed the claim that acoustic trauma from low-frequency sonar was to blame:

> But so-called acoustic trauma cannot be ruled out since porpoise remains examined by experts were decomposed, the experts wrote in a report for the National Marine Fisheries Service, a monitoring agency. "No matter which side you're on, you can interpret the report as supporting your claims," Fisheries Service spokesman Brian Gorman said. Decomposition of the remains made it "very difficult if not impossible ... to determine a cause of death linked to soft tissue," such as the animal's hearing organs, he said…no cause of death could be determined for the six other animals.[23]

In the context of the dispute about sonar's potential effects on marine life, the interests of national security trumped the concerns of environmentalists. A tenuous compromise solution was arrived at:

> …Hering said the system on the Shoup, the only vessel stationed in the region with mid-range sonar, must still be used occasionally in the interest of national security. Because of concerns about porpoises, however, the vessel now will get clearance from Pacific Fleet Command and Hering before the system is used. The effects of sonar on marine life have been debated for years. Federal researchers linked sonar systems to whale deaths in the Bahamas in 2000.[24]

The need for national security is acknowledged by the acoustic daylight imaging researchers, and their attempts to respect both the marine life and human concerns may be a part of the reason that Greenpeace has given tacit endorsement to their research efforts. The acoustic daylight imaging researchers have given detailed explanations of the benefits of their type of sonar, including the benefits for military applications:

> The ADONIS technology, once perfected, could serve a myriad of uses. The U.S. Navy, for example, could potentially use acoustic daylight imaging to detect the presence of mines in the ocean -- some of which can be triggered by sonar -- without causing them to explode. In addition, project scientists envision acoustic daylight technology being someday used to secure harbors from underwater attack, to monitor oil rigs and to perform counts of underwater marine-mammal populations. Acoustic daylight imaging could also be used be unmanned, underwater vehicles. A navigation system equipped with ambient noise imaging would allow these vehicles to steer themselves around underwater objects without human intervention.[25]

At this point, it is helpful to discuss the case of acoustic daylight imaging in light of philosophers' works in environmental ethics. For example, in Jim Cheney and Anthony Weston's 1999 article "Environmental Ethics as Environmental Etiquette: Toward an Ethics Based Epistemology," it is argued that a robust environmental ethic emerges not from disengaged epistemological contemplation, but from a deep revisioning of what it is to interact with the world: "Our task is *not to 'observe' at all* -- that again is a legacy of the vision of ethics as belief centered--but rather to *participate*".[26]

The researchers in acoustic daylight imaging see themselves, as well as the marine life, as co-participants in their research. When I began to think seriously about acoustic daylight imaging as a philosophy of technology case, I was struck by its apparent harmony with the environmental context, but it was not my main area of interest. As the issue of the military using low-frequency active sonar came to a head in 2003, I realized that the dialectical objectivity/acoustic daylight example also provides inspiration in the area of environmental ethics.

However, my interpretation of the acoustic daylight imaging technology and its relationship to the environment still calls to mind the problematic terminology that Shrader-Frechette and other environmental ethicists have problematized. It is important to remember why the specific terms, like *community*, first held significance for an environmental ethicist. If we can prove our membership in a community, then we can show grounds for moral sentiment, and moral value for all the participants in that community. As Callicott says in describing the land ethic …

> we ought to value nonhuman nature for itself…because it constitutes a community to

> which we belong, as ecology demonstrates, and because we experience positive feelings toward our acknowledged communities, as the Humean theory of moral sentiments shows… once acknowledged, (this) shifts 'the burden of proof from those who would protect nature to those who would exploit it only as a means.' In this vision, constraints on the treatment of intrinsically valuable nonhuman nature would develop analogous to constraints on the treatment of human workers that protect them from abuses.[27]

Many might argue that the acoustic daylight imaging technology and its researchers are only using the underwater marine life as a means to their own research. But I would submit that the fact that the researchers have gone out of their way to produce controversially environmentally interested papers, to make connections with both the environmental activist community and the military community, means that they are attempting to advocate on behalf of the marine life in a new and deeper way. They have found an intriguing colleague in the underwater context, and they have attempted to give back some of the safety and security that has been disappearing in the oceans since the increased use of low-frequency sonar.

It is right that environmental ethicists are concerned with how we define the members of these communities, especially in regard to "nonhuman nature." Many believe that when we have no distinction between the natural and the non-natural, we disrupt our ability to evaluate human actions as destructive or detrimental to specific members of the natural community. One of these environmental ethicists is Holmes Ralston III, who motivates the discussion of "intrinsic value" of nature. Rolston holds that intrinsic value is not subjective in any way, but is fully objective. Callicott prefers an antidualistic naturalism, and Rolston criticizes him for this view. Rolston is concerned that as we overcome dualistic thinking, we are forced to naturalize everything and "Naturalizing everything naturalizes too much."

> Robbed from the nonnatural, we no longer can sort the natural from the nonnatural, and we want to do so in guiding human behavior toward the environment. Otherwise, destructive human actions are as natural as benign ones. Rolston describes some of what he takes as clear differences between humans and nature, which we ignore at our peril. As for intrinsic value, Rolston finds serious problems with Callicott's theory. For one thing, Callicott seems to take back his antidualism with his value theory. In saying that only we (or conscious beings) can value, he distinguishes between us and nature.[28]

The distinctions of the natural and the nonnatural are also discussed by Rolston in his work from 1991, "The Wilderness Idea Reaffirmed" in The Environmental Professional. In that piece, Rolston finds numerous characteristics and values of wild nature that can be lost, or misunderstood, when the distinction between wild nature and human culture is blurred. He fears that the alternatives to these distinctions will allow for much greater human intervention in wild nature.

> Wilderness advocates …must … appreciate and criticize human affairs with insight into their radically different characters. Accordingly, they insist that there are intrinsic wild values that are not human values. These ought to be preserved for whatever they can contribute to human values, and also because they are valuable on their own, in and of themselves. Just because the human presence is so radically different, humans ought to draw back and let nature be.[29]

What is really being recommended might not necessarily be letting nature be, in the sense of doing nothing. Letting nature be might actually require a site of dialogue, or a site of interaction, that allows technology and researchers to actively fight for the rights of nature. This dialogic or dialectical relationship serves a number of important philosophical and ethical tasks: it can help us to define key terms, preserve necessary distinctions between community members, show shifts in key term meanings, show criteria for membership in communities, and preserve our ability to make ethical evaluations. Indeed, following the work of philosophers of science who write on objectivity as a concept with its own genealogy, as a concept with a taxonomy of possible meanings, we may coherently speak of a more robustly "objective" dialectical objectivity.

I should note that talk of objectivity and subjectivity usually seems to disrupt discussion of ethics. If one locates ethics in the subjective, one risks bias and anthropocentrism. If one attempts to be objective in a more historical sense (as in a "moral" objectivity, where one simply has faith in the good ethics of researchers and the learned classes), then we assume far too much of the humans in the communities. For example, Rolston notes in his 1995 piece "Does Aesthetic Appreciation of Landscapes Need to be Science-Based?" from The British Journal of Aesthetics,

> …the eye of the beholder is notoriously subjective, hopelessly narrow in its capacities for vision. One has only to consult smell or taste, for example, to realize that much more is going on than the eye can see. Science, by extending so greatly human capacities for perception, and by integrating these into theory, teaches us ***what is objectively there***. We realize what is going on in the dark, underground, or over time… science cultivates the habit of looking closely, as well as looking for long periods of time.[30]

Let's unpack what Rolston meant by "what is objectively there". The way that researchers define what is objectively there, can potentially be theory-laden. Limitations of the powers of human senses mean that human beings alone cannot determine what is objectively there. It must be the case that the active participation of the object studied is necessary for us to "know" anything at all, whether it is the yeast proving itself that Latour wrote about, or the underwater marine life that creates noise – noise that was only recently regarded as so significant for "knowing" the underwater world.

I hold that value need not be projected artificially, or human-subjectively, onto natural objects or events by the subjective feelings of observers. Dialectical relationships, and their role in producing new knowledge and new self-definitions for all members of the sonar technology community (human and nonhuman), provide a new example of valuing that is not entirely subjectively or objectively biased. Indeed, this conceptualization of dialectical relationships between technician and nature, researcher and object, allows for a wide range of heroes, and heroic narratives, that tell the story of how environmentally concerned scientists can save and be saved by their objects of study.[31]

Using these insights, we can focus our attention on heroic narratives (or potential narratives) of members of ecological communities, like the narrative that describes the underwater life and snapping shrimp colonies making noise, and the narrative that describes the other (human) members of the community's newfound appreciation for that noise. Who is an "actor" has to do with who has a potential "narrative," a potential heroic narrative…in Latour-inspired language, we should look to the community members that have a heroic story to tell, nonhuman and human. Heroic actors that are nonhuman, that is to say, "potential narratives of nonhumans" are perfectly acceptable, and absolutely necessary, for an accurate telling of the story.

When the actors and heroes have trouble, as in the case of the marine mammals affected by active, low-frequency sonar, we also have an example of a narrative that shows significant membership in the moral community and the environmental community. Rolston hinted at this when he described the way that "humans who find their environments congenial, or even beautiful, flourish, while those who find their environments stressful, or ugly, might do less well…"[32] We simply need to push that comment further and include the nonhumans whose environments are being stressed and manipulated by specific human and military interventions.

This interpretation, centered on non-human comfort, is also in concert with the types of activism, and actors, analyzed in current literature on political ecology. In *Third World Political Ecology*,[33] the relationships between different types of "actors" reiterates the point that the power relationships inherent in cases like those faced by environmental ethicists are usually fluid power relationships:

> …there are decided, if not always particularly clear, political implications associated with the specific organizational traits of the different actors involved in Third World environmental change and conflict…grassroots actors derive their power primarily from the combination of a detailed local social and environmental knowledge, and a willingness and determination to use such knowledge through covert and public means to promote their interests. These actors have a variety of means at their disposal to resist more powerful actors; this ensures that, however ostensibly weak they appear, they are nonetheless rarely, if ever completely, without power.[34]

The case from the history of sonar technology provides a clear example of non-human actors that are definitely in power, and their power results from their own active role in the underwater context. The facts are that the acoustic daylight imaging team has acknowledged the talents of the biologics underwater, studied their talents for sonar, for making beneficial noise, and taken inspiration from them. This illustrates the political ecologists' perspective, which notes that "there is often an inherent logic to the coalitions and alliances that develop between actors based on their contrasting traits and interests."[35]

A related point can be made about activism and active objects of study from the Ecofeminist perspective. Karen Warren discusses the epistemology of ecofeminism, and its acknowledgement of nature as an active subject:

> Ecofeminist epistemologies often critique Western notions of objectivity and conceptions of nature as a passive object of study – on this view, nature is an active subject – not a mere object or resource to be studied. Nature actively contributes to what humans know about nature. The job of the scientist, philosopher, and theorist is not to try to give accounts that "mirror nature," since mirroring assumes that nature is an unconstructed "given."[36]

In the case of sonar technology, and especially acoustic daylight imaging, the natural environment is definitely not an "unconstructed given." It is an active contributor to knowledge. The early forms of active and passive sonar conceptualized the ocean environment as noisy, turbulent and unpredictable; the noise had no value and needed to be controlled or ignored. The ocean was assumed to be simply a dense medium through which the pings and echoes of the earliest forms of sonar devices would travel, sometimes the silent, placid deep and at other times noisy and unpredictable. In so far as the early sonar researches saw the ocean in this way, they also saw their own agency as limited in specific ways: as long as the ocean's underwater noise was so challenging to control, there would be a limit to the kinds of imaging technology that the researchers could create, and a limit on what they could know about the ocean.

Fortunately, the acoustic daylight imaging program reconceptualized the underwater environment and its noises. The ambient noise of the ocean is now regarded as a reliable, helpful background for new kinds of sonar imaging technology, and by interacting with the underwater environment and respecting it in new ways, we also gain new abilities as knowers and as perceivers. Our ability to know, and to hear underwater, is augmented by our greater respect for the ambient noise context. In Latour's language, as the ocean acquires new "competences," the researchers gain new competences as well (Latour 1990, pp. 57-60). We know more about underwater sound, and we have more insight into our own senses (hearing with ambient noise, and seeing with ambient daylight). The ocean is helping the scientists in creating new images and representations of the underwater world: acoustic daylight imaging relies on changes in the ambient noise patterns underwater to locate objects and to gain new knowledge about the underwater world environment and its health. The ocean itself also achieves a new competence, a new level of self-knowledge and self-awareness, in so far as it has asserted itself, it has pushed its true nature forward and made itself known, as a vibrant, colorful and helpful community of sound. And in so far as the ocean has succeeded in pushing forward its truth, it also gains a new determination of value: people have yet another reason to value the ocean, because it is our cooperative partner, and it helps us to know ourselves better.

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References

Audoly, Pierre. 1995. "Hot Topics In Underwater Acoustics," a session at the Acoustical Society of America meeting.

Baggeroer, Arthur B. 1993. "Hot Topics In Underwater Acoustics," a session at the Acoustical Society of America meeting.

Bryant, Raymond M. and Sinéad Bailey. 1997, 2000. *Third World Political Ecology*. London and New York: Routledge.

Buckingham, Michael J. 1996. “Seeing Underwater with Background Noise”, *Scientific American*, vol. 274, February 1996, pp. 86-90.

---. 1994. "On surface-generated ambient noise in an upward refracting ocean", *Phil. Trans. Roy. Soc. Lond.* A 346, 321-352.

---. 1993. "Theory of acoustic imaging in the ocean with ambient noise", *Journal of Computational Acoustics* 1, 117-140.

---. 1992. “Imaging the Ocean with Ambient Noise”, *Nature*, vol. 356, March 26, 1992, pp. 327-9.

Cheney, Jim and Anthony Weston. 1999. “Environmental Ethics as Environmental Etiquette: Toward an Ethics Based Epistemology.” *Environmental Ethics*, vol. 21. pp. 115-134.

Devereux, Tony. 1990. *Messenger Gods of Battle: Radio, Radar, Sonar: the story of electronics in war*. London: Brassey’s.

Duxbury, Alyn C. and Alison B. Duxbury. 1997. *An Introduction to the World’s Oceans*, 5th ed. Chicago: Wm. C. Brown.

Hackmann, Willem. 1984. *Seek & Strike: sonar, anti-submarine warfare and the Royal Navy*. London: Her Majesty’s Stationery Office.

Kitcher, Philip. 1995. “Author’s Response” to a series of articles in response to The Advancement of Science, *Philosophy and Phenomenological Research*, vol LV, n 3, September 1995, pp 653-673.

---. 1994. “Contrasting Conceptions of Social Epistemology” in F. Schmitt (ed.) *Socializing Epistemology*. Rowman and Littlefield, 1994, pp. 155-177.

---. 1993. *The Advancement of Science*. Oxford: Oxford University Press, 1993.

---. 1993a. “Knowledge, Society and History”. *Canadian Journal of Philosophy*, vol. 23, n. 2, June 1993, pp. 111-134.

---. 1992b. “The Naturalists Return”. *Philosophical Review*, vol. 101, no. 1, January 1992, pp. 53-114.

---. 1990. “The Division of Cognitive Labor”. *Journal of Philosophy*, vol. 87, no.1, January 1990, pp. 5-22.

---. 1984a. *The Nature of Mathematical Knowledge*. New York: Oxford University Press, 1984.

---. 1984b. “Species”. *Philosophy of Science*, vol. 51, 1984, pp. 308-333.

---. 1982a. *Abusing Science: the Case Against Creationism*, Cambridge, MA: MIT Press, 1982.

---. 1982b. “Genes”. *British Journal for the Philosophy of Science*, vol. 33, 1982, pp. 337-359.

---. 1982c. “Implications of Incommensurability”. *Philosophy of Science Association Proceedings*

1982, vol. 2, pp. 689-703.

---. 1981. “Explanatory Unification”. *Philosophy of Science*, vol. 48, December 1981, pp. 507-531.

---. 1978. “Theories, Theorists and Theoretical Change”. *Philosophical Review*, October 1978, pp. 519-547.

Latour, Bruno. 1990. “The Force and Reason of Experiment,” in *Experimental Inquiries*, H. E. LeGrand, ed., the Netherlands: Kluwer Academic Publishers.

Potter, John R. 1998. “Ambient Noise Imaging Potential for Intelligent Terrestrial Animals.” Singapore Acoustical Society Annual Conference, 1998.

Potter et al., 1994. Acoustic Daylight: preliminary results from an ambient noise imaging system (1994 ASA meeting): sound.media.mit.edu/~dpwe/AUDITORY/asamtgs/asa94aus/2aAO/2aAO9.html

Potter, John R. and Mandar Chitre. 1997. ADONIS Imaging with a Kalman Filter and Higher-Order Statistics. http://arl.nus.edu.sg/pub/ecua3/index.shtml based on a presentation from the 3rd European Conference on Underwater Acoustics, Greece 1996.

Potter, John R. and Eric Delory. 1998. “Noise Sources in the Sea and the Impact for Those Who Live There.” Acoustics and Vibration Asia 1998 (conference), Singapore 1998.

Ouderkirk, Wayne and Jim Hill. 2002. *Land, Value, Community: Callicott and Environmental Philosophy*. Albany: State University of New York Press.

Rolston III, Holmes. 1995. “Does Aesthetic Appreciation of Landscapes Need to be Science-Based? ” *The British Journal of Aesthetics*, vol. 35, no. 4, October 1995, pp. 374-385.

Rolston III, Holmes. 1991. “The Wilderness Idea Reaffirmed” from The Environmental Professional 13, (4) 1991, National Association of Environmental Professionals.

Warren, Karen J. 1990. “The Power and the Promise of Ecological Feminism,” in *Environmental Ethics* 12, 3 (Summer 1990): 125-46.

Wilson, Oscar Bryan. 1985. *An Introduction to the theory and design of sonar transducers*. Document of the United States Department of the Navy. June 1985.

Zimmerman, Michael E. et al. 2001, 3rd edition. *Environmental Philosophy: From Animal Rights to Radical Ecology*. New Jersey: Prentice Hall.

Notes

1. Ouderkirk 2002, 3.

2. Ibid, 5, my emphasis.

3. Ibid, 5, my underline.

4. http://www.greenpeacefoundation.com/action/campInfo.cfm?campID=18.

5. Greenpeace LFA/Ocean Environment Campaign, 2003.

6. http://www.cnn.com/2003/TECH/science/10/08/whale.sonar/

7. http://fando.blogs.com/fando/2003/09/good_news_for_t.html

8. Greenpeace LFA/Ocean Environment Campaign, 2003.

9. Wilson 1985, p. 149; emphasis added.

10. Audoly, 1995, italics added.

11. Baggeroer, 1993, italics added.

12. Potter and Buckingham, 1993, italics added.

13. Potter et al., 1994, original emphasis.

14. Potter and Chitre, 1998, original emphasis.

15. Singapore Acoustical Society Annual Conference, 1998.

16. Acoustics and Vibration Asia 1998 (conference), Singapore 1998.

17. Potter 1998.

18. http://ososd.saic.com/High_Frequency_Conf/Conference%20agenda-draft.doc.

19. Buckingham, Michael J. 1992. "Imaging the Ocean with Ambient Noise", *Nature*, vol. 356, March 26, 1992, pp. 327-9.

20. http://stacks.msnbc.com/local/PISEA/143752.asp?0LA=akc9n.

21. *Ocean Noise and Marine Mammals*, Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals, National Research Council, 204 pages, 6x9, 2003. For the 119 species of marine mammals, as well as for some other aquatic animals, sound is the primary means of learning about the environment and of communicating, navigating, and foraging. The possibility that human-generated noise could harm marine mammals or significantly interfere with their normal activities is an issue of increasing concern. Noise and its potential impacts have been regulated since the passage of the Marine Mammal Protection Act of 1972. Public awareness of the issue escalated in 1990s when researchers began using high-intensity sound to measure ocean climate changes. More recently, the stranding of beaked whales in proximity to Navy sonar use has again put the issue in the spotlight. *Ocean Noise and Marine Mammals* reviews sources of noise in the ocean environment, what is known of the responses of marine mammals to acoustic disturbance, and what models exist for describing ocean noise and marine mammal responses. Recommendations

are made for future data gathering efforts, studies of marine mammal behavior and physiology, and modeling efforts necessary to determine what the long- and short-term impacts of ocean noise on marine mammals.

22. http://story.news.yahoo.com/news?tmpl=story&u=/ap/20040210/ap_on_sc/porpoise_deaths_3.
No Evidence Sonar Caused Porpoise Deaths.
Tue Feb 10, 8:27 AM ET By PEGGY ANDERSEN, Associated Press Writer
SEATTLE - Experts who examined 11 harbor porpoises that died last spring — around the time a Navy ship conducted sonar tests in the area — found no evidence that the sound waves were a factor. But so-called acoustic trauma cannot be ruled out since porpoise remains examined by experts were decomposed, the experts wrote in a report for the National Marine Fisheries Service, a monitoring agency. "No matter which side you're on, you can interpret the report as supporting your claims," Fisheries Service spokesman Brian Gorman said. Decomposition of the remains made it "very difficult if not impossible ... to determine a cause of death linked to soft tissue," such as the animal's hearing organs, he said. The experts found that two of the porpoises died of blunt-force trauma, possibly caused by hitting ships or colliding with other animals. Illness — such as pneumonia and peritonitis — was implicated in the deaths of three porpoises. No cause of death could be determined for the six other animals. The investigation followed reports on May 5 of killer whales, porpoises and minke whales suddenly trying to flee waters around Haro Strait, just north of Puget Sound. The Navy later confirmed that the guided-missile destroyer USS Shoup had been training with mid-range sonar in the area briefly that day. "We believe this report proves ... what we've said from the beginning," said Rear Adm. Len Hering, commander of the Navy's Northwest operations. "The Shoup did not kill or cause the deaths of those animals." He said the findings are consistent with the Navy's own report, also released Monday, Fred Felleman, a spokesman the Orca Conservancy, a private protection group, said agitation displayed by marine mammals on May 5 provided "indisputable behavioral evidence ... of stress. Whether or not this resulted in their death or substantial impact on their hearing or decreased their immunological capacity is difficult to determine." He called for a halt to use of mid-range sonar in inland waters. But Herring said the system on the Shoup, the only vessel stationed in the region with mid-range sonar, must still be used occasionally in the interest of national security. Because of concerns about porpoises, however, the vessel now will get clearance from Pacific Fleet Command and Hering before the system is used. The effects of sonar on marine life have been debated for years. Federal researchers linked sonar systems to whale deaths in the Bahamas in 2000.

23. Ibid.

24. Ibid.

25. http://extreme.ucsd.edu/adonis.html.

26. Cheney 1999, 128, my emphasis.

27. Ouderkirk 2002, 7.

28. Ibid, 9.

29. Rolston 1991, 383.

30. Rolston 1995, 375.

31. If the philosophy of science – objectivity view doesn't appeal to you, perhaps medical ethics discussions might. Consider recent medical ethics and nursing theory literature that is in concert with continental philosophy: a new re-valuing of patient emotions through hermeneutic research on patient narratives.

32. Rolston, 1995, 378.

33. Bryant, Raymond M. and Sinéad Bailey. 1997, 2000. *Third World Political Ecology*. London and New York: Routledge.

34. Ibid, 189.

35. Ibid, 190.

36. Karen Warren in Zimmerman, Michael E. et al. 2001, 3rd edition. *Environmental Philosophy: From Animal Rights to Radical Ecology*. New Jersey: Prentice Hall, pp. 262.
