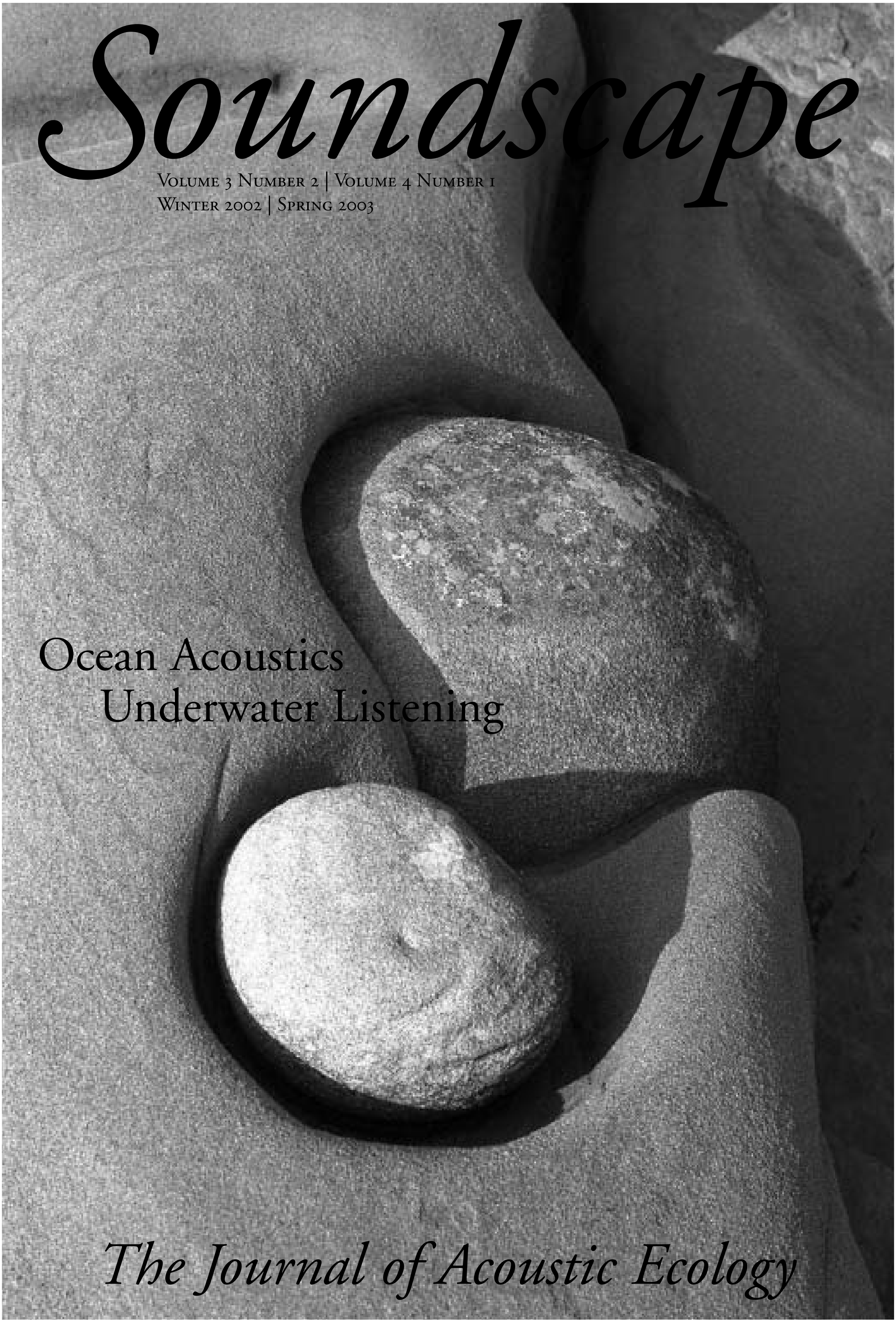


Soundscape

Volume 3 Number 2 | Volume 4 Number 1
Winter 2002 | Spring 2003

Ocean Acoustics
Underwater Listening

The Journal of Acoustic Ecology

Soundscape
The Journal of Acoustic Ecology
Volume 3 Number 2 | Volume 4 Number 1
Winter 2002 | Spring 2003
issn 1607-3304

Soundscape is a biannual English language publication of the World Forum for Acoustic Ecology (WFAE). It is conceived as a place of communication and discussion about interdisciplinary research and practice in the field of Acoustic Ecology, focussing on the inter-relationship between sound, nature, and society. The publication seeks to balance its content between scholarly writings, research, and an active engagement in current soundscape issues.

Editorial Committee
Gary Ferrington
Nigel Frayne
Hildegard Westerkamp
with assistance from Lisa Walker

Contributing Correspondents
Henrik Karlsson (Sweden)
Robert MacNevin(Canada)
Andra McCartney (Canada)
Veena Sharma (India)
Keiko Torigoe (Japan)

Layout Design and Prepress: Reanna Evoy
Original Design and Soundscape Logotype: Robert MacNevin

Printing: Kinko's, Melbourne
Front Cover Photo: © Robert MacNevin
Ear Graphic p. 8: Dirk Marwedel
Line drawings of sea creatures: Gary Ferrington
Rear Cover Photo: © Robert MacNevin

Membership Committee: John Campbell - chair (AFAE and WFAE); Lorenz Schwarz (FKL); Clarissa DeYoung (CASE); John Drever (UKISC); Outi Koivisto (FSAE); Nigel Frayne (WFAE board).

Mailing List and Distribution
Melbourne: John Campell and Nigel Frayne
The printing and distribution of this edition of the journal were made possible through membership contributions and donations. ***Special thanks*** to Hildegard Westerkamp.

World Forum for Acoustic Ecology (WFAE)

The World Forum for Acoustic Ecology, founded in 1993, is an international association of affiliated organizations and individuals, who share a common concern for the state of the world's soundscapes. Our members represent a multi-disciplinary spectrum of individuals engaged in the study of the social, cultural, and ecological aspects of the sonic environment.

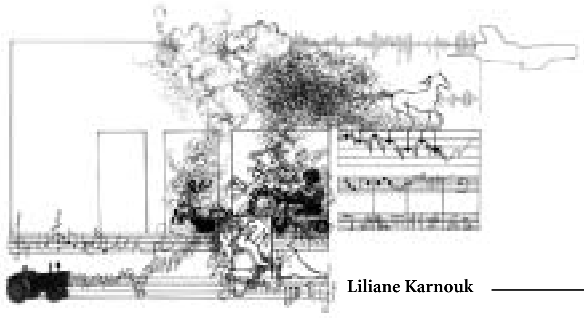
Contributions

Ideas for journal themes, proposals for new sections, as well as visual materials, are welcomed. You may submit either a proposal or a complete manuscript of a potential article to *Soundscape.* The Editorial Committee would generally prefer to communicate with you beforehand regarding your idea for an article, or receive a proposal, or an abstract (contact information below). Please also download our Guide to Contributors: Instructions for the Preparation of Materials for Submission to *Soundscape* (PDF) on the WFAE Website at: http://www.wfae.net

Future themes: Sound Design, Hearing Loss, Use of Music in the Soundscape, Sacred Soundcapes, Economics and Acoustic Ecology.

Submissions. Please send articles, letters, and materials for the following sections in this journal: Feature Articles; Current Research: a section devoted to a summary of current research within the field; Dialogue: an opportunity for editorial comment by the membership; Sound Bites: a summary of acoustic ecology issues found in the press; Sound Journals: personal reflections on listening to the soundscape; Soundwalks from around the world; Reviews: a section devoted to the review of books, CDs, videos, web sites, and other media addressing the theme of Acoustic Ecology (please send your CDs, tapes, books, etc.); Reports, articles, essays, letters from students and/or children; Announcements of acoustic ecology related events and opportunities; Quotes: sound and listening related quotations from literature, articles, correspondence, etc.; Random Noise: a section that explores creative solutions to noise problems.

Please send correspondence and submissions to: *Soundscape —The Journal of Acoustic Ecology* School of Communication, Simon Fraser University, Burnaby, B.C. V5A 1S6 Canada. E-mail: jwfae@sfu.ca. **Submission Deadline for next issue: June 1, 2003.**



Liliane Karnouk

Soundscape

The Journal of Acoustic Ecology

Volume 3 Number 2 | Volume 4 Number 1
Winter 2002 | Spring 2003

Contents

Contribution Guidelines 2

Editorial 3

Report from the Chair 4

Regional Activity Reports 5

- AFAE 5
- JASE 5
- FSAE 6
- FKL 6
- CASE/ACÉS 7
- UKISC 7

Dialogue 8

Quotes 9

Current Research 10

FEATURE ARTICLES

Ocean Bio-Acoustics
and Noise Pollution: 16

Antarctica:
Austral Soundscapes 30

Listening Underwater 35

Creatures of Culture? 37

Soundwalking the Internet 41

Reviews 43

Perspectives 46

Sound Bites 56

Sound Journals 58

Resources 59

Announcements 62

WFAE—Membership and
Subscription Information 63

Editorial

No matter where we live or what shore we visit the air and the ocean bring all of the problems that anyone has created elsewhere home to us, however far away those problems may have been at the start.

Roger Payne in
http://www.pbs.org/odyssey/voice/oneocean.html

For most of us the underwater soundscape of oceans is still a mysterious place. But thanks to the hydrophone—the underwater microphone—we can now listen into any underwater environment. In the late 1960's Roger Payne and Scott McVay were among the first to use hydrophones to explore the oceans' soundscape. What they heard surprised and excited their ears. The research recordings they made were eventually released in 1970 as *Songs of the Humpback Whale*. Not only was it the best-selling natural history recording ever released, it also served as a strong stimulus for further study of marine life environments. But already then—over 30 years ago—Roger Payne pointed out that the oceans' soundscapes had become polluted by noise:

> The sea in most places is alive with sound. The quietest parts of the sea are beneath the polar ice caps, far from industrialized man. The noises that most interfere with the Humpback whale song are the low-pitched ones, and in recent years ship traffic noise has become a constant roar of low-pitched noise in the ocean, even far from shipping lanes.... (Liner notes to *Songs of the Humpback Whale*)

Since then recordings and research have expanded our knowledge about underwater animal communication much beyond the sounds of whales and dolphins and a lot more is known about the types of noises human beings have introduced into the underwater environment. At the same time, the more we researched this topic in preparation for this issue of *Soundscape* the more it became apparent how little the underwater soundsape is really understood and how little is known about the effects of anthropogenic (human-made) noise on animal health and communication.

We are presenting four very different feature articles here. Together—so we hope—they will give you a good introductory sense of the various perspectives that exist in the field of ocean acoustics, as well as an idea of what the underwater environment actually sounds like. Michael Stocker has provided us with an extensive overview over the types of sounds that exist in the oceans' underwater soundscapes, how they have been studied and explored, what we know and do not know about them, and what we have done to disturb the original underwater soundscapes. Doug Quin's article about his recording experiences in Antarctica takes us into an unimaginably foreign place. His writing brings close to us how he experienced this environment and how he listened and recorded in this altogether unfamiliar and exotic soundscape. Lisa Walker gives us a personal and insightful account of how her ears—those of a musician and composer—have influenced and marked her scientific research into whale vocalization and her analysis of its rhythms, melodic shapes and contours. Scott Norris takes us into one of the most researched areas in underwater bioacoustics—the sounds of whales and dolphins—to find out whether cetaceans' communication can be understood as an expression of culture. He quotes Rendell in his article as saying, "An exciting aspect of this is that we might be better able to understand how we came to have the kinds of culture that we do, by understanding the evolution of culture in environments radically different from our own."

For those of you who have access to the internet, Gary Ferrington points the reader to websites that provide an opportunity to listen in on recordings of underwater soundscapes (see p. 41). In case you want to explore the areas of ocean acoustics and underwater listening further you will find resource and access information about this theme in other parts of the journal.

Many thanks to Lisa Walker who opened up the world of underwater sounds to us with much enthusiasm and competence and helped us in getting a handle on how to approach this vast area of research and study. In fact, the vastness of the field inspired us to expand this issue of *Soundscape* into a larger publication, making it a double issue. The next issue, Volume 4 Number 2, will come out in the summer of 2003.

Hildegard Westerkamp
for the Editorial Committee

?... acoustic ecology ...?
an International Symposium

Melbourne, Australia, March 19—23, 2003

Presented by the World Forum for Acoustic Ecology. Hosted by the Australian Forum for Acoustic Ecology (AFAE) the Victorian College of the Arts (VCA) and partners.

The First International Conference on Acoustic Ecology was held in Banff, Canada in 1993 and was attended by over 250 people from around the world. Since then a number of events and conferences have been held, Paris 1997, Stockholm 1998, Amsterdam 1999, Peterborough 2000 and Devon 2001. The most recent of these events have attracted more than 100 attendees each.

Acoustic ecology covers a wide and multi-disciplinary field of study and activity. For the most part the previous events have emphasised the field of soundscape studies and soundscape art. The Symposium in Australia is structured deliberately to include the broader spectrum of interests and the relationships between them.

The 2003 Melbourne Symposium brings together the existing community and introduces interested people to the broader concepts of acoustic ecology creating a groundswell of awareness and activity in this part of the world.

Contact:
symposium2003@wfae.net
http://www.afae.org.au
http://www.wfae.net

GOETHE INSTITUT
INTER NATIONES

In co-operation with the Goethe-Institut Inter Nationes

Report from the Chair

Once again the reports from the WFAE affiliates indicate a broad range of interesting and some important activities in acoustic ecology around the world. The collective whole of the organisations can provide both inspiration and focus to each individual group. Some activities previously undertaken in one country can be reinvented in others, further tailored to each setting.

This is especially the case for the planning and implementation of Conferences and Symposia. The Australian Symposium in March 2003 (for further details see adjacent frame) is drawing on the resources of the WFAE through the membership of the paper reading committee, which includes representatives from the UKISC, FKL, AFAE and the WFAE (individual affiliate, USA). These 'behind the scenes' activities are an indication of the growing maturity and interconnectedness within the WFAE. It is hoped that the attendance of many international members at the Melbourne Symposium will provide us with the opportunity to ponder the current status of the WFAE through face to face discussions. While strengthening the bond between the existing membership it is also hoped that 'new blood' can be engaged to help power us further into the future. Any reader interested in becoming more actively involved in the WFAE is encouraged to make contact with us either directly or through the local affiliates (for contact information please see page 63 and/or pages 4-6 in Regional Activity Reports).

I would like to thank my fellow board members and the various committees and individuals who give us their time to keep the World Forum and this Journal alive and active. And thank you too for your support as members and subscribers. Here's to another engaging New Year in 2003!

Nigel Frayne
Chair of the Board, WFAE

WFAE—Electronic Contact Information

Website: http://www.wfae.net

Home to an extensive collection of Acoustic Ecology related materials—assembled and maintained by Gary Ferrington. (While you are at the WFAE Website—Join our Discussion List!)

WFAE Board: garywf@oregon.uoregon.edu
WFAE additional information: wfae@sfu.ca
Membership Secretary: wfm@sfu.ca

Regional Activity Reports

Australian Forum for Acoustic Ecology (AFAE)

by Nigel Frayne

Naturally enough the AFAE is concentrating all of its energies on the March 2003 Symposium in Melbourne (see page 4). Our members continue to be active in a variety of settings professionally, as well as in the arts and education. Some of us continue to be active on the board and committees of the WFAE.

Action around the Symposium is quickening in pace as the end of year approaches. The call for works and papers generated a huge response with 60 abstracts proposed from all over the world. The reading committee made up of mostly WFAE internationals has processed the abstracts and we look forward to receiving the print ready papers in early February and lively Paper Sessions on the first two days of the Symposium.

The Presentation programme is also coming together well. Thanks to the co-operation of the Goethe Institut we are very pleased to include a session on Soundscape and Digital Media by Sabine Breitsameter from Germany. She will join Hildegard Westerkamp and Murray Schafer and a number of other experts from across the field of acoustic ecology. AFAE member Ros Bandt through the Australian Sound Design Project is organising two associated events, an exhibition and audiotheque at the Symposium venue, and a sound sculpture exhibition *Hearing Place* at a local gallery. A concert series is also being planned to coincide with the Symposium. See the website for all details on the Symposium at http://www.afae.org.au

The AFAE continues to provide services to the running of the WFAE through the board and membership of the journal and membership committees. In particular we acknowledge the efforts of John Campbell and Helen Dilkes in managing incoming fees, the database and John's work in distributing the Soundscape journal.

Contact:
Nigel Frayne: nfrayne@netspace.net.au

Japanese Association for Sound Ecology (JASE)

by Keiko Torigoe

As the JASE is one of the operating divisions of the Soundscape Association of Japan (SAJ), our regional activity report of Japan brings you the activities of the SAJ.

The SAJ was established in 1993, and has flourished for the last 9 years thanks to the support of its circa 300 members. The main items of SAJ's activities are 1) the Annual General Meeting held around the end of May; 2) the Annual Symposium, which is open to the general public, held basically on the same day as the general meeting; 3) the Annual Academic Meeting held in the autumn; 4) the Japanese-language journal of the SAJ, called Soundscape, one issue per year (since 1999); 5) various other types of events, held about three times a year, such as lectures, concerts, workshops and tours, which are somehow related to the theme of "soundscape"; 6) the Japanese-language newsletter of the SAJ, several issues per year. Also, we run the SAJ listservs in the internet, enabling members to exchange information, as well as the SAJ Home Page, which is in the process of being revised.

During the year 2002, the SAJ held its Annual Meeting in Ohkurayama Memorial Building in Yokohama City, on May 25, where the establishment of the JASE was approved. After the Annual Meeting, on the same day in the hall of the same building, the SAJ held its Annual Symposium on the theme of *The Art of Remembering Sounds: Reading, Listening and Viewing Soundscapes*. As well, a special exhibition was held on the same theme in the round gallery of the same building from May 23 to 26, where various books, CDs, maps, videos and sound instruments were exhibited that, in their own way, capture a certain soundscape.

The Annual Academic Meeting was held in Xebec Hall in Kobe, on October 12, where five papers were presented. Also, the same exhibition mentioned above, was held on a smaller scale in the lounge of Xebec Hall for several days including October 12. Among the other activities was a soundscape tour which was held in Mie Prefecture visiting Yokkaichi and Matsuzaka City on both November 9 and 10. Participants visited an old temple to listen to its traditional Japanese sound installation, the Suikinkutsu (Japanese Water Harp Jar). They also attended a meeting held in a junior high school where the students are engaged in a program of searching for their local sound resources.

Currently, the SAJ is preparing a series of special events for next year to celebrate its 10th anniversary. One of these will be the Annual Symposium, to be held in Hirano Osaka, on May 24, 2003. The theme of the symposium is *Soundscape Design as a Grass-roots Movement.* You can find more details about this event on page 62, reported by the organizer, Atsushi Nishimura.

Contact:
Japanese Association for Sound Ecology (JASE)
c/o Keiko Torigoe
University of the Sacred Heart
4-3-1, Hiro-o, Shibuyaku, Tokyo,
150-8938, Japan

Finnish Society for Acoustic Ecology (FSAE)

by Simo Alitalo

The FSAE will launch its project *100 Finnish Soundscapes* during the first part of the year 2003. This autumn the FSAE board has been busy drafting up the proposal and applying for funds to finance the project. *100 Finnish Soundscapes* will be a 3-year project that aims to increase public awareness of the different social and cultural meanings of our acoustic environment.

The project will be carried out as a kind of 'heritage collection rally.' Members of the public are encouraged to send written essays, recollections or memories about acoustic environments that are or have been somehow significant in their lives. People can also send recordings of their favourite soundscapes and make recommendations of soundscapes that they think should be preserved for future generations.

In Finland these types of heritage collection rallies have been quite successful in collecting materials about the history of everyday life. And of course—this being Finland—prizes of some kind will be given out for the "best" contributions.

The collected materials will provide a basis for the list of *100 Finnish Soundscapes*, a documentation of which will be published as an audio CD/CD ROM/website. It will also be possible to broadcast the materials on radio as a "Soundscape of the Week."

The Finnish Ministry of the Environment is sponsoring a pilot study that will chart the relatively quiet areas in the counties of Western Finland. The FSAE, among other non-governmental and governmental organizations, was invited into the National Advisory Council of this pilot project. The first meeting of the NAC was held on October 29, 2002. There was a lot of discussion about the meaning of words like "quiet" and "relatively" and of course about the decibel. But it was interesting to notice that many participants seemed to have acquired a basic understanding of acoustic ecology terminology like the concept of a soundscape. So it seems that the work of the FSAE has raised awareness at least on some level.

It seems that more things are brewing on the acoustic ecology front in Finland. The Finnish Ministry of the Environment is putting together a national committee with the task of outlining a National Strategy for Environmental Noise. It will be interesting to see who gets invited into this committee.

Contact:
Simo Alitalo: simo@alitalo.pp.fi

BACK ISSUES OF *SOUNDSCAPE* NOW AVAILABLE ON LINE

Adobe Acrobat PDF versions of *Soundscape* are now available for download at the URL below:

http://www.wfae.net

Forum Klanglandschaft (FKL)

by Albert Mayr

The FKL has made an important step towards acceptance into the official world of music, at least in Austria: our president, Gabriele Proy, is now representing us in the Austrian Conference of Presidents/Music Section, which offers the opportunity of interacting with all the other music associations in the country.

Considerable effort has been and continues to be devoted to the organization of our one-day, bi-lingual, public conference *Klangumwelt: schon gehört?—Chi ha suonato? L'ambiente!* It will take place in Meran (South Tyrol) on March 15, 2003. The preparations have, among other things, offered the opportunity of getting in contact with the environmental agency of the region and with teachers who have been doing interesting educational work on soundscape (and who, hopefully, will join the association). The composers' association of South Tyrol has kindly agreed to assist us with the application for public funding. Unfortunately their interest in the theme of the conference has, so far, been quite modest. Meran is a very attractive town with beautiful surroundings, thus all WFAEers who happen to be nearby in March 2003—perhaps on their way to Australia—are cordially invited to come by.

Recent publications by FKL-members:

Werner, Hans U. 2002. "MetaSon #5 Skruv Stockholm: Turning Schizophonic Sound into Audiovirtual Image." *Organised Sound—An International Journal of Music Technology*, 7(1): 73-78. Cambridge: Cambridge University Press.

Proy, Gabriele 2002. "Sound and Sign." *Organised Sound—An International Journal of Music Technology,* 7(1): 15-19. Cambridge: Cambridge University Press.

Mayr, Albert 2002. "Die komponierte Stadt—Ein klangzeitlicher Zugriff auf den Raum." In D. Henckel/M. Eberling (eds.), *Raumzeitpolitik*. Opladen: Leske + Budrich.

Contact:
Albert Mayr: timedesign@technet.it
FKL website: www.rol3.com/vereine/klanglandschaft

SYMPOSIUM

Klangumwelt: schon gehört?—Chi ha suonato? L'ambiente!"

Forum Klanglandschaft (FKL)

March 15, 2003
Meran, Italy

Information: Albert Mayr timedesign@technet.it
Web: www.rol3.com/vereine/klanglandschaft

For more details see Announcements on page 62

Canadian Association for Sound Ecology (CASE) Association Canadienne pour l'Écologie Sonore (ACÉS)

by Darren Copeland

For this issue of *Soundscape*, I wanted to touch on a few research initiatives and publications in Canada that expand upon the information available at the WFAE's on-line resource at http://www.wfae.net.

The Centre for Acoustic Ecology Research (CAER) has recently been established as an interdisciplinary research team that is based at the University of Calgary and lead by Dr. Marcia Epstein. CAER is building an interactive on-line database of literature in Acoustic Ecology and its component science of Sound Cognition (psychoacoustics) at http://commons.ucalgary.ca/~sanchez/caer/. The purpose of the database is to provide a system for streamlining interdisciplinary literature searches in an extended bibliographic field spanning several component disciplines.

With a particular focus around human auditory information processing, The Acoustic Ecology Project at the University of British Columbia is combining traditional disciplinary research on listening (e.g. audiology, linguistics, neuroscience, otolaryngology, and psychology) with other research on physical environments (room design, computer science, engineering) and social situations (anthropology, education, and linguistics). Their research interests are broken into three categories: (1) The psychology of listening; (2) Synthesis of complex environmental and human sounds; and (3) Ethnographies of acoustic ecology. The group's web site can be found at http://www.cs.ubc.ca/~kvdoel/acel/acel.html.

Also in Vancouver, Simon Fraser University continues to house the World Soundscape Project Archive consisting of soundscape recordings from the 1970's to the present of mostly the Greater Vancouver area, but also from the 1970's of other parts of Canada and of Europe. Barry Truax maintains the archive and continues developing the teaching curriculum on acoustic communication established by the World Soundscape Project. An on-line course, Acoustic Dimensions of Communication, taught by Robert MacNevin, is offered year round with deadlines of September 30, January 31, and April 30 for applying. Detailed course information can be found at http://www.sfu.ca/cde/cp/cmns/cmns259.htm.

The proceedings for the *Sound Escape* conference in 2000 at Trent University in Peterborough are available from Penumbra Press under the title *Sonic Geography: Imagined and Remembered*. It is recommended reading for both those who attended and didn't attend. (For details see page 59.)

Also in the Peterborough area is Arcana Editions who publish all of Murray Schafer's books, including *The Tuning of The World*. A number of people have contacted me about where to pick up copies of Murray Schafer's writings on acoustic ecology. The best place to start is to contact Arcana Editions, Indian River, ON, K0L 2B0, Canada or on-line at http://www.patria.org/arcana/.

If you have any acoustic ecology activities or announcements in Canada that you would like to share, then please contact me at darcop@interlog.com. Also I would like to hear from you if you are interested in initiating new acoustic ecology projects in your community and could use assistance or support from CASE. We are open to new ideas!

Contact:
Darren Copeland
phone: +1 905-454-7940, e-mail: cansound@interlog.com

United Kingdom and Ireland Soundscape Community (UKISC)

by Gregg Wagstaff

At time of writing, the UKISC journal *Earshot 3* is just about to go to print—ready to fill its members' Xmas stockings (or should that be ear-muffs?). This issue, is entitled "Time and Visibility-Essays on Sound & Architecture"(see page 45) and includes contributions by Daniel Libeskind, Brandon LaBelle, Bernard Delage and Mark Bain. *Earshot's* chief editor is Rahma Khazam, assisted by Pedro Rebelo and Andrew Deakin.

Future issues of *Earshot* will contain a section devoted to 'UK Affairs.' This comes at an opportune moment when the UK Government's Department for Environment, Food and Rural Affairs (DEFRA) is spending a massive £13 million on a noise-mapping scheme of England. Data is being collected from various sources such as the Ordinance Survey (i.e. proximity to major conurbation, motor ways and air traffic 'corridors'), Local Councils and noise level measurements. This is the Government's attempt at moving towards a National Ambient Noise Strategy in 2007, to meet with European Union (EU) directives. Critics of this scheme, such as the National Society for Clean Air and Environmental Protection, point out that besides excluding Scotland, Wales and Northern Ireland, it only focuses on environmental noise and fails to address occupational and neighbourhood noise. Also, it contains no measures for further identifying and protecting our shrinking Areas of Tranquillity (for which the funds were originally allocated).*

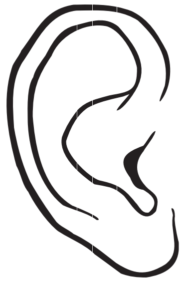
Alternatively, given only a shoestring budget, UKISC member Isobel Clouter has produced a wonderful series of five soundscape radio programmes that, in my opinion, are far more illustrative and awareness-raising than a £13m DEFRA noise-map. The *Sound Hunter* programmes were recently broadcast on BBC Radio 4 and followed Isobel to Canada (to speak with Murray Schafer), China, Japan (JASE), Russia and Scotland (TESE), in search of endangered and unique sounds(capes). Isobel works for the British Sound Library in London and is tabling a proposal to open up a Soundscape section, into which existing and new recordings can be archived, conserved and made publicly available. We'll keep you updated on this in 2003.

Listening back on this year 2002, things have been quite productive: there has been the completion of the *Touring Exhibition of Sound Environments (TESE)* on the Isles of Harris & Lewis, Scotland; the completion of the *Sounding Dartmoor* project in Devon, England; the MAXIS symposium; and the *Sound Hunter* programmes. In addition, December's THE WIRE magazine** carries an article by Phil England on Soundscape Studies. The January issue will include a follow-up interview with Steven Feld. Do I sense a general level of heightened interest in the soundscape? Let's hope the UKISC and the WFAE can capitalise on this in the New Year. Next stop Melbourne! Good health and best wishes to you all.

*www.noise-management.co.uk. Newsletters (pdf) Issues 22 & 23, 2002.
**www.thewire.co.uk

Contact:
Gregg Wagstaff: earminded@ecosse.net

Dialogue



We invite your comments and criticism in response to anything you read in Soundscape*, including other members' comments. Please send your reactions to: jwfae@sfu.ca, or to the mailing address at the bottom of page 2.*

[Ed. Note: We were made aware of this article after the previous issue of Soundscape *had been published ("The Tech Issue...to be continued", Volume 3 Number 1). Although it was neither written in direct response to this journal nor to the theme of acoustic ecology, we nevertheless felt it would give our readers continuing food for thought on how sound enters public spaces like museums and galleries and how this may be perceived from an acoustic ecology standpoint.]*

Listening to Art

Works by 'Sound Artists' Are on the Rise in Museums
By Kenneth Baker

The catalog of the 2002 Biennial Exhibition of the Whitney Museum of American Art comes with a CD embedded in its cover. So does the San Francisco Museum of Modern Art's limited edition book *Richter 858* and the catalog of the recent Frankfurt show *Frequencies (Hz): Audio-Visual Spaces*. SFMOMA has also issued a CD recapitulation of *Variable Resistance: Ten Hours of Sound from Australia*, a 10-day audio program that ended last month.

When CDs become a regular feature of museums' publications, the status of sound as an art medium must be changing. But how and why? Some recent museum sound events offer clues.

The Whitney Biennial, organized this year by former Bay Area curator Lawrence Rinder, turned the gallery just off the Whitney lobby into a sound space. Works by "sound artists," lasting from about five to 15 minutes each, played in a padded space lit only by a handful of LEDs. Distinctions between musical and nonmusical works were left to listeners.

Pieces that used conventional instruments, such as Marina Rosenfeld's work, fell readily on the musical side of the line, despite some abrasive moments. Others, heavily reliant on electronics or found noise, may have sounded musical only to ears adjusted to the work of composers such as Karlheinz Stockhausen and Iannis Xenakis.

Many were quickly driven from the room by the high volume and abrasive character of some pieces, such as Maryanne Amacher's electronic collage *A Step Into It, Imagining 1001 Years: Entering Ancient Rooms* (2002) or Christian Marclay's *Guitar Drag (outtakes)* (1998). And the low sonic definition of Richard Chartier's *series [6] (edit)* (2000) failed to hold listeners for long.

Only Stephen Vitiello's six-minute excerpt from *World Trade Center Recordings: Winds After Hurricane Floyd* (1999/2002) gripped everyone who knew what they were hearing. Never imagining the archival interest and emotional power his work would acquire after Sept. 11, Vitiello had attached a contact microphone to a 91st floor window of the World Trade Center's Tower One the day after Hurricane Floyd swept Manhattan in 1999. In retrospect, the rumbling of wind and creaking of architecture he captured seem a prescient revelation of a vulnerability that no one then associated with the Twin Towers.

The Biennial's sound works gallery gave clearer inklings of an answer for why sound art is on the rise than did the "Listening Room" of SFMOMA's *Variable Resistance*. SFMOMA's "Listening Room" was simply the Phyllis Wattis Theater, dimly lit, with two large speakers on-stage. The Whitney's sound gallery was immersing. Hearing sound art in it was an experience of the whole body, not just the ear. Visitors to SFMOMA's "Listening Room," on the other hand, could keep their distance. Only a few of the program's most assaultive moments, such as *f— to mandatory detention* by Jim Knox (Xonk), delivered a sense of the artists' intent to alter the conditions of reception, an ambition that to some extent explains the new wave of sound art.

Modernist sound works stretch back to the Dada and Futurist performances of the World War I era, but the sources of the current wave of sound art can be found closer to the present. Many younger artists recently have revisited and revised canonical art of the '60s. At Hosfelt, for example, San Francisco painter Andrea Higgins is showing paintings that resemble '60s Op art, but in fact faithfully translate fabric patterns from presidential wives' dresses.

Some of the new interest in sound springs from investigation into that moment when boundaries among art media caved in and countless people awoke to the idea that an artwork's meaning depends on the many-layered circumstances of viewers' encounters with it. Happenings and other performance works of the period sometimes had aural components.

Prominent postminimalist sculptors of the time saw themselves allied with composers and musicians such as Steve Reich, Philip Glass and La Monte Young, who sometimes thought like visual artists about the space, time and perceptual limits their works' performance entailed. Sculptors and installation and performance artists also shared in a redressing of what they viewed as a cultural prejudice in favor of the eye, at the expense of the other senses.

Some contemporary sound artists share that critical interest but see the issue weighted differently. The younger among them seem conscious of addressing a peer audience that grew up with a choice of music channels available 24 hours a day on cable TV. To them, the unhinging of sound from music and from image appears a more immediate problem than the cultural tyranny of the eye.

Video installations, such as Kristin Oppenheim's *Numbers* at SFMOMA, provide an immersing experience that acknowledges the inescapable influence of pop music. But Oppenheim's piece makes a faint challenge to MTV expectations. On four facing walls, she projects giant moving video images of hands: two girls playing the slapping and counting game called "numbers." The implicit sense of the action shifts between violence and camaraderie with the overlay of a short sound loop that begins with a childlike melody and ends with a low roar of electronics. Oppenheim's piece inadvertently hints at another explanation for sound's invasion of the museum: it may breathe life back into the ill-defined genre of installation art, which has begun to seem moribund.

Many of the Australian sound artists in SFMOMA's *Variable Resistance* appear conversant with the legacy of "noise music" that descends from composers such as Stockhausen, John Cage and Alvin Lucier, as well as with more recent techno-pop material.

To judge by the statement of *Variable Resistance* curator Philip Samartzis, young sound artists from abroad see in their medium and its evolving technology a renewal of the tension between sense and non-sense, or between reference and impact, from which much modern art drew strength, at least when it was new. Those tensions have allowed artists to fine-tune the pace of their work's consumption. Against the background of a consumer society, the meaning of new artworks—their ability to communicate an artist's intentions at least—often depends crucially on that sort of control.

Yet ordinary listeners, that is, ordinary museumgoers, may already be so sophisticated aurally as to be inured to such artful manipulation. Those with the patience to listen to *Variable Resistance* or the Biennial's sound program quickly discovered new pleasures, if not new meanings, perhaps where they were not even intended. But those lacking the necessary patience appear to be the audience sought by sound artists who see themselves engaged in cultural confrontation.

Kenneth Baker has been art critic for the San Francisco Chronicle since 1985. He is the author of *Minimalism* (Abbeville Press, 1985/97) and of a monograph on Walter De Maria's Lightning Field, forthcoming from University of California Press. Baker has taught at institutions on both coasts, including Brown and Stanford, the Rhode Island School of Design and the California College of Arts and Crafts.
E-mail: kennethbaker@sfchronicle.com.

The original article can be found on SFGate.com here:
http://www.sfgate.com/cgibin/article.cgi?file=/chronicle/archive/2002/11/04/DD39709.DTL

QUOTES

THE SOUND OF THE SEA

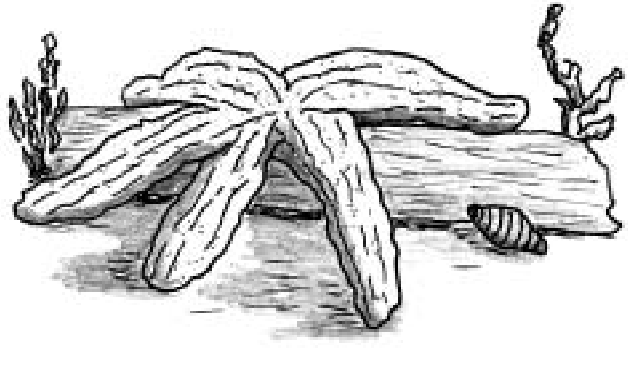
The sea awoke at midnight from its sleep,
And round the pebbly beaches far and wide
I heard the first wave of the rising tide
Rush onward with uninterrupted sweep;

A voice out of the silence of the deep,
A sound mysteriously multiplied
As of a cataract from the mountain's side,
Or roar of winds upon a wooded steep.

So comes to us at times, from the unknown
And inaccessible solitudes of being,
The rushing of the sea-tides of the soul;

And inspirations, that we deem our own,
Are some divine foreshadowing and foreseeing
Of things beyond our reason or control.

Henry Wadsworth Longfellow (1807-1882)



Different Strokes — Moving to the Beat of Just One Drummer.

The Acoustic Dimensions of the Sport of Dragonboating

By Florence Chee

[Ed. Note: This paper was written originally as an assignment for Acoustic Dimensions of Communication, CNMS 359, School of Communication, Simon Fraser University, Burnaby, B.C., Canada. Instructor, Barry Truax.]

Abstract

This field project identifies sound as a key component in the execution of the sport known as dragonboating. Interviews were conducted with members of the dragonboat team Adrenaline, chosen for their relative positions in the boat. Interviewees were asked about what sounds they heard while paddling at practices and races; and in which way sound did or did not determine how they paddled. The results of the study indicated that the further back in the boat one paddled, the more visual the sport became for the paddler. However, those closer to the front of the boat were found to rely extensively on sound.

Introduction

My primary motivation in doing this field study had two reasons. First, I am the Lead Stroke of a dragonboat team and have paddled every season for the last five years. As a Stroke, I have to paddle at a consistent rate. I wanted to see how relevant sound is in a sport I enjoy so much. Second, the existing literature on dragonboating is sparse because the sport itself is relatively new in North America. This soundscape study on the sport of dragonboating will add something new to the discourse in acoustic communication.

The origins of dragonboating date back more than 2000 years in China. Fertility rites on the rivers of Southern China were held on the fifth day of the fifth lunar month of the Chinese calendar, which is the equivalent of Summer Solstice. There, people held dragonboat races to avert misfortune and to sacrifice to the Dragon water deity, thereby encouraging rains for prosperity. The first races were meant to be mock dragon battles staged to awaken the hibernating Heavenly Dragon. Sacrifices of various types, sometimes human, were made to this being. Even much later, when a paddler or an entire team fell into the water they would receive no assistance because it was believed to be wrong to interfere with the will of the gods. Some said it was not lucky if there was not at least one death!

In another story, Qu Yuan, a legendary poet, leapt into the Mi Lo river clutching a heavy rock upon learning of his state's demise. When the local villagers learned of his suicide, they raced out in their fishing boats in a vain attempt to save him. They beat on drums and splashed their paddles in the water trying to scare the fish and water dragons away from his body.

In time, dragonboating evolved into a violent clash known as the "To Fight and Cross Over" ceremony. Often, the race resembled a naval battle, with crew members of competing boats throwing stones and striking at one another with cane sticks.

Photo: Jason M. Grant

Inside the dragon boat, Vancouver.

Spectators cheered for their teams and fired stones at opposing boats. It was thought to be unlucky if there was not at least one drowning. There were multi-coloured boats adorned with dragon heads and tails. There might have been more of a musical aspect to the sport, as crews might have included a hand-clapper to accompany the drummer and as many as four singers. Smaller boats carrying food and wine catered to the competitors.

Since that time, dragonboating has calmed down substantially. The modern dragonboat resembles a lengthened canoe that can fit a drummer at the front, twenty paddlers, and a steersperson at the back. It spans over fourteen metres in length, and weighs over 1400 pounds (www.adrenalinedragonboat.org). These warring boats were originally made of heavy teak, but are now lighter fiberglass constructions, and instead of food and wine, we have a food fair and beer garden. It is now a widely recognized sport, with many festivals taking place worldwide.

Dragonboating was initially introduced to Canada, namely Vancouver, by the resident Chinese community for Vancouver's Expo 86. The sport grew at an exponential rate, and in 1996 the city hosted the first World Championship Dragonboat festival to be held anywhere outside of Asia (Craig 1996:48).

Dragonboating is a sport that requires as much mental as physical discipline, in that its short sprints require extreme focus, correct timing, and excellent technique to coordinate all of its paddlers. I have come to realize how very much sound plays a part in how well I paddle. Sitting at the front of the boat, my partner and I work with the drummer to set the timing. All twenty paddles must enter and exit the water at the same time. This is to ensure that the boat is moving forward, with no one's paddle acting as an impediment. In general, "...the paddlers at the front are those with the best timing and technique" (www.adrenalinedragonboat.org). I wanted to see how much sound was on the minds of my fellow paddlers, and if one has to use sound in order to be successful at dragonboating.

It is interesting to read how literature has described sound components of the sport. According to Wickens (1996:4) the sport has attracted much attention because dragonboating is a very "colourful and loud" sport. Musical terminology pervades much of the description, with paddlers stroking "in sync" (Davis 1995:37) while the drummer "...sits at the prow and beats out a droning cadence." I was also able to use existing literature on soundscape, acoustic community and communication, to create the lens through which I will view perspectives on listening and sound in the sport. There is much to analyze in the soundscape of the practice and races in the festival.

The process of listening in the boat fascinates me, the results of which I catalogue in my interviews. Truax (1980:8) writes that listening includes how usable information is extracted from the complex acoustic sounds in one's environment, its classification, how the information affects subsequent behaviour, and the process of listening itself. This is a very useful way of thinking about listening in the context of dragonboating and I will include these theories in my analysis.

In dragonboating the emphasis is on timing. A drummer assists the paddlers with keeping time. My coach has brought a metronome onto the boat in practice to assist with determining paddling rate—yet people rarely make the connection that dragonboating is very 'musical' because it is a sport. However, as found in Schafer (1994:227), "the heartbeat has had a strong influence on the tempo of music." The athletic endeavour of dragonboating makes the heart indeed audible. However, the challenge in this sport is to focus on an internal beat experienced in *calm* practice sessions, and recall it for the race, when the heartbeat is likely to be elevated because of anxiety. Schafer mentions breathing as well: "... breathing... also varies in tempo with exercise and relaxation" (Schafer 1994:227). Like with the heartbeat our strategy with practices as opposed to races is similar. With the audible metrical divisions of heart, breath, foot, and actions of the nervous system that Schafer mentions (1994:228), the bodies on the boat need to be as much in sync with each other as possible. No other sport can rival the combination of focus, discipline, musicality, and unity that is required in the boat. Ancient (and contemporary) Chinese society valued balance and regulation (Schafer 1994:238), and there is the value of sacrifice for the good of the whole. "The 'unison' effect of synchronized bodily movement is easy for any group to create. Such phenomena are fundamental to music, as well as to speech and the sound environment" (Truax 2001:75).

Dragonboat races are anywhere from 500 to 640 metre sprints and take about 2 to 2.5 minutes to complete. The 'factual' account of the mechanics of the race as I have researched and experienced it is necessary for understanding the terminology used by those interviewed. It will be interesting so see what the interviewees actually recollect as opposed to what really happens in the start, middle, and finish. In brief, an average race strategy would involve a *Six-sixteen*, with six long intense strokes, followed by sixteen shorter faster ones. The P*ower series* is then called by the drummer. The *Finish* is called at the drummer's discretion. The team paddles at this hyper-intensity until the drummer calls "Let it run," at which point the team can finally relax and have an idea of how they placed in the race. The ideal level of focus for a team in a race should be not to be aware of anyone else on the water. It is the responsibility of the drummer and steersperson to watch out for other teams and instruct by vocal cues. The sounds associated with dragonboat races provided both "positive or deleterious psychological effects" (White 1975:473) as we will see in the interview results. I documented these attitudes and found them very revealing in how paddlers dealt with their acoustic surroundings and distinguished sound intrusions and clutter from desired community sound signals (Schafer 1977:52).

Methodology

I sought to use the models found in soundscape and acoustic community research to describe the sound environment of dragonboat practices and races. My project was a listener-centered qualitative evaluation of the sounds experienced in and associated with such events. I recorded short-term "earwitness accounts" (Truax 2001:19) of the dragonboat festival. The interviews were quite impromptu and made in informal settings. I interviewed Denise from the front of the boat (my Stroke partner); Tom, a 'meat seat' who sits in the middle of the boat; and Jason from the back of the boat. The responses were very subjective, as those interviewed each classified their recollections of the sounds based on their own perceptual categories.

My background knowledge is mainly comprised of first hand knowledge, folk tales, and in-depth interviews with three members of my dragonboat team.

I personally looked for sound oriented responses and honed in on anything the interviewees said noting their preferences, attitudes, and habits regarding their listening. I told them that I would like to interview them about dragonboating, and nothing more. I wanted to see if other dragonboaters detected patterns and assigned the same meanings to sounds as I did, and what relationships they had to their sound environment.

Because my interest is sound and timing, I wondered if the other two thirds of the boat, with their varying responsibilities relied as much on sound. They are the paddlers in the middle, where seats are spaced the farthest apart, and who are usually the larger members of the team with the most power; and the paddlers in the back who can paddle the quickest without compromising their technique. (www.adrenalinedragonboat.org)

It was my initial assumption that paddlers in the front of the boat would most likely report a different sound experience from paddlers in the back. The results of the study will determine whether my assumptions were correct. To dissect the components of dragonboating one inevitably discusses the importance of communication in the effectiveness of a paddling team.

Results/Analysis

In the analysis of the interview data as it relates to the paddlers' perceptions of dragonboating sounds, I compared the various focus and timing strategies of front, middle, and rear paddlers. Each person's strategy and experience differed depending on their level of experience with the sport. I catalogued how they each used selective hearing, mantras, and possibly other focusing techniques in paddling and doing the sport.

Photo: Bernice C. Lee

The Dragon Boats in mid-race cluster together as the race's intensity increases.

I shall now describe the races on a micro-level with the experiences of those interviewed and my own experiences. I will discuss the sequence of events during a race, then I will compare what the front, middle, and rear sections said respectively about a particular portion of the race—if they said anything at all. Where it was important to compare paddlers, I presented their dialogue as separate and identified the paddler. Other times I interspersed their comments with my narrative because I found what they said to be descriptive or particularly interesting.

The Race

When the team is at the dragonboat festival ready to race, we first focus on blocking out any sound that might distract us during the race. We load the boat, and follow the steersperson's commands to paddle out of the dock area, at which point we warm up according to the beats of the drummer. The race official then commands the boats to approach the start line. A few minutes are spent to align the boats. At that point everyone is "listening-in-readiness," (Truax 2001:22), to make sure we adhere to the commands and are not disqualified.

When the official is satisfied with the positions of the boats, s/he is supposed to announce, "Starter you have the race." The Starter then takes command of the microphone and does some last minute alignments and says, "Are you ready. Paddles up." Now everyone is "listening-in-search" (Truax 2001:79) for anything. My Stroke partner describes the experience as "...nothing really registering... for me its kind of a noisy silence."

We then hear the cannon or air horn marking the start of the race. The race sequences begin. These are examples of the listening in search in progress.

> Denise: You're waiting for that horn to go... all the background noise just wells into a ball of... nonsensical crap.
>
> Tom: We hear the announcer... "Starter you have the race." We're listening at our hardest at that point. At that point it's all sound.
>
> Jason: You get out into the water, we paddle to the starting line, and it's mostly just waiting for the starting buzzer to buzz.

The race begins with the *Six-sixteen*. This involves six short powerful strokes to lift the stationary boat up out of the water and forward, followed by sixteen rapid, increasingly lengthening strokes to gain momentum.

> Denise: Hopefully you hear a chorus of voices in your boat counting your 6-16 along with you... its very crucial... timing in the 6-16 is completely different from anything else we do in the race.
>
> Tom: I'm in the middle of the boat... so I can't hear the fronts very much. The middles usually don't count. They have to kinda act as intermediaries... if they don't shout [the commands], the back half won't be able to hear.
>
> Jason: We start out giving it everything we've got, going through the 6-16.

The middle sequence constitutes the bulk of the race in which steady strokes of perfect technique are alternated with three *Power 20's*. They are sequences of twenty long hard strokes.

> Denise: as soon as you hit the 16, they're going to have to slow down the length of their strokes. Reach... it... out... *Power... 20*... and those types of words will get you into the right rhythm.
>
> Tom: The *Power 20* is from the drummer and the [countdown] 3..2..1. is from as many people who can shout in the boat. It helps keep you in sync with the rest of the team... so after that's over we have to make sure our timing doesn't fall AFTER the power piece.
>
> Jason: ...and the *Power 20s*...

After the last *Power series*, the race is almost completed. But paddlers are often at their most difficult personal point then, as this moment requires much discipline and arguably the most focus due to fatigue. Their mantras might or might not kick in.

> Denise: You no longer really have your counting to focus on so that's when your mantra kicks in. After the *Power 20* you're chanting whatever it is you can keep in your mind... just as long as you concentrate on timing.
>
> Tom: In my mind, I've just tried going into the whole ONE TWO thing... that's not bad... but I don't use it terribly often.
>
> Jason: Not really, I actually don't have one.

The *Finish* component is usually called about 30 to 40 m before the finish line and involves a rapid increase in rate and power to give the boat a final boost of speed before finishing the race.

> Denise: The Strokes will usually have to call something in time... like UP UP UP UP... and then they stay at the rate. And you don't stop until the drummer shouts... let it run.
>
> Tom: You know what's going to happen, you're waiting for the drummer to call it. And finally she screams "FINISH IT NOW!" At that point sound kinda goes away... and the drummer finally shouts "let it run" and everyone completely drops it.
>
> Jason: And then all of a sudden the race is just over. And then we win... we're either second or third place, which is good.

Afterwards we journey back to the dock. "We might sing on the way back occasionally... sometimes we sing a spirit-lifting song in time and we'll all chant ... and it will help us coast on through."

In terms of general paddling, I asked the interviewees what mental process(es) they go through when they paddle. One can see that as we get testimony from the front of the boat and progress to the back, that there is less mention of timing and sound, and progressively less priority attributed to acoustic aspects of paddling.

> Denise: Hang one, hang two, hang one,... pause one, pause two <laughs> not a lot basically...
>
> Tom: Sometimes I just zone out... actually, honestly. It is harder to keep timing when you're not concentrating.
>
> Jason: When I paddle, mostly just timing... I just have to watch when everyone's paddle goes down, mine goes down at the same time, and you know the top hand has to keep up, to keep the timing..

There is a feeling of alienation and disconnectedness from one's surroundings despite the team nature of the sport. During the race, a "lo-fi environment seems to encourage feelings of being cut off or separated from the environment" (Truax 2001:23). The actual act of paddling ends up becoming quite individualized. I then asked each paddler how they keep time.

> Denise: Part of it is of course feeling the boat, the other part of it is that metronome. Listening to the sounds... the Strokes will call out the hits.
>
> Tom: You keep timing generally by 'feeling the boat' to a certain extent, sound does help... and you can tell the boat's outta time just by listening... almost get tranced into it.
>
> Jason: Well, it's just so noisy and loud, with water in your face and stuff... it's mostly visual... I just watch what everyone else is doing.

Tom's 'trancing' describes "...a constant pattern or loudness in a sound [that] quickly produces a psychological reaction called 'habituation'" (Truax 2001:19).

Due to the fact that "...listening always involves a basic process of receiving, attending to, and assigning meaning to messages" (Wolvin and Coakley, cited in Truax 2001:22), I asked each one what they perceived the difference in sounds to be in races as opposed to practices.

> Denise: Practice doesn't have the sounds of pressure... there are no air horns, other boats.. no background rumble at all. It's nice that it's quiet, but competitive-wise, you need the other people on the water. You need the sounds of chaos around you.
>
> Tom: You hear noise from everywhere [in the race]. You have to spend at least 20 minutes before the race just focusing... to be able to block out everything.
>
> Jason: No. When I race and when I practice I don't have any sounds going through my head.

Subjects often used the term "white noise" (Truax 2001:26) colloquially to describe other sounds not belonging to our boat during the race.

Each of the paddlers have a different strategy to block out sound and stay focused. This is related to a paddler's mantra in that these strategies kick in when the paddler needs to focus or is experiencing pain.

> Denise: I choose a focus point. Its so easy to get distracted... but find one focus point... like... tunnel vision... you just see that one thing.
>
> Tom: When I'm focusing I try not to talk to anybody....unfocus my eyes... I try to minimize sensory input basically.
>
> Jason: I find myself really focused when I'm racing.

Negative listening habits (White 1975) were employed in Tom's case as he tried to reduce sensory input in general. Both Tom and Denise found that altering aspects of their vision helped block out noise. Tom unfocused his eyes, while Denise gave herself a sense of "tunnel vision." This could possibly be their attempt at obscuring their auditory image thereby reducing information, definition, and clarity. I then asked what sound at the festival sticks out most in their minds.

> Denise: Basically, it's the background rumble of voices... you hear bits and pieces of ONE TWO... power 20... power it up... or longer reach... reach it out... those massive voices...
>
> Tom: The drumbeats. It's a good feeling 'cause it gives the whole festival atmosphere....
>
> Jason: There's a lot of yelling and screaming... and another thing is that all the boats are so close together that I get splashed in the face by them.

Conclusion

My initial hypothesis and assumptions reflected my bias towards sound, as the paddlers in the back of the boat did not just report a different sound experience. It turns out that they relied primarily on the visual instead of what I assumed initially: that everyone in the boat relied heavily on sound. Dragonboating is more of an

Photo: Elaine J. Lee

Photo: Bernice C. Lee

aural rather than visual sport for me because as Stroke I personally have nothing but the drummer in front of me.

I thought that everyone in the boat would find sound integral, but as I progressed further towards the rear of the boat, the sport became more visual for the paddlers. This shocked me, because I interviewed people who were in their third season or more, and I would have expected these paddlers to rely on sound as much as on their other senses, as we are often told to do.

Further work could include a studio compilation of interviewee's descriptions of the sounds juxtaposed with recordings of the actual sounds in their actual context. Given the time and resources, this would have been an ideal undertaking to convey more completely the extent to which sound is used in the sport. Interviewing more people in general would be where I would start next.

In conclusion, while I still maintain that sound is an essential part of dragonboat racing, I have found through the data I gathered in my interviews that dragonboating is not entirely reliant on sound, but on vision and 'feel' as well. Hopefully I have at least encouraged those who do not rely on sound so much to clean the water out of their ears and become acoustically more aware—as we should all be.

References:

Craig, John. (1996) "Paddling Fever". *Maclean's* 109 (29), 48.

Crowley, D. and Heyer, P. (1999). *Communication in History.* Don Mills: Longman.

Davis, Elaine. (1995) "Year of the Dragon". *Women's Sports & Fitness* 17(4), 37.

Hsiao, Andrew and Yeomans, Matthew (1997) "New York's Secret Sports." *Village Voice* 42(43), 134.

Schafer, R.M. (1994). *The Tuning of the World*. Rochester: Destiny Books.

Schafer, R.M. (1977). The Tuning of the World. New York: Knopf.

Schafer, R.M. et al. (1977) *Five Village Soundscapes*. Vancouver: A.R.C. Publications

Truax, B. (2001). *Acoustic Communication*, Second Edition. Connecticut: AblexPublishing.

Truax, B. (Ed.). (1978) *Handbook for Acoustic Ecology*. Vancouver: A.R.C. Publications.

White, F.A. (1975) "Physiological and Psychological Effects of Sound." *Our Acoustic Environment*. Wiley.

Wickens, Barbara. (1996) "Heroes of an Ancient Sport". *Maclean's* 109 (28), 44.

Web references

Adrenaline Team
http://www.adrenalinedragonboat.org

Alcan Dragonboat Festival Web Site
http://www.canadadragonboat.org

Videos of our team and official commentary at the 2001 Vancouver Dragonboat Festival
http://www.botelho.ca/alcan_2001_video

Florence Chee is currently an Honours student completing her studies in Communication and Anthropology at Simon Fraser University, Vancouver, BC, Canada. In addition to an avid musical interest, her primary academic pursuits include research on the social implications of technology and how ethnographic narrative can inform technological design.

ATOC - A Marine Mammal Problem within Context

By Angela Kouris

[Ed. Note: The following text is a programme note for a soundpiece composed by the author for the course Advanced Digital Sound Production, *Communication Studies Department, Concordia University, Montreal, Quebec, Canada. The course was conducted by Professor Andra McCartney. The mammal sound sources were recorded by researchers at Cornell University (see details below) and sent to the author for this project. It should be noted here that some of the author's characterisations of the vocalisations are her impressions as a listener/composer. They are not based on actual proven knowledge of what these sounds may mean when heard in the context of the mammals' habitat.]*

ATOC: A Marine Mammal Issue

The Acoustic Thermometry of Ocean Climate (ATOC) is a research project primarily conducted by the United States with the support of seven other nations. The US Department of Defense (via the Strategic Environmental Development Program) funds this 35 million-dollar project.

The alleged object of the project is to study climate changes using underwater acoustic signals in order to obtain data that may aid in explaining and clarifying the effects of global warming. Sound travels faster in cold water than in warm water. Thus, by monitoring the rate at which a signal travels from its source to its destination, researchers can determine temperature and subsequent climate changes.

Launched in 1997, ATOC fell under the attack of many individuals and organizations in the scientific community as well as environmental groups and Members of Congress. In order to appease and gain support from their critics, the ATOC organization launched a pilot study and established the Marine Mammal Research Program whose object was to determine the effect of ATOC sounds on marine mammals. The original ATOC plan was modified but nevertheless executed despite the accumulated inconclusive data available on the effect of low frequency sound on marine mammals. What is known as fact is that marine mammals rely on the ability to hear in order to perform the vital activities necessary for their survival. Whether feeding, mating, alerting other whales to danger or navigating, the ability to hear is paramount for a marine mammal.

Contextualizing a Problem

The aim of my project is to recreate an underwater ocean soundscape interrupted by powerful, resonant and low frequency sounds in order for the listener to judge the effects of ATOC on marine mammals.

Framed by the familiar sound of waves crashing against a shore, the composition is meant to lead the listener into the water where they will be immersed in the marine environment as well as into the cradle of the ATOC controversy.

Since low frequency sound signals (such as those generated by the ATOC) are perceived primarily by baleen whales, the majority of vocalizations used in the soundscape include members of this classification. Furthermore, since the ATOC sound signals are generated in Kaui, off the coast of Hawaii and Point Sur, off the coast of California, many of the vocalizations used were selected amongst those recorded in the Pacific Ocean in areas within a reasonable range of these generators. Thus, many of the subjects used for this soundscape are those thought to be at highest risk of harm caused by the ATOC sounds. Nevertheless, since the ATOC low frequency sound transmissions can travel across an enormous distance under water (a span of approximately 80% of the total ocean surface) all of the marine mammals used in this piece could somehow be affected.

The original ATOC source signal was measured at 70 Hertz, with a sound pressure level of 195 dB and was initially transmitted for 20 minutes, every 4 hours of a day followed by 7 days of silence. The ATOC imitation sound used in my project was created on the keyboard in Studio D. The equivalent of a pianos' 19th key (whose frequency in Herz is 69.269[1]) was held on the keyboard and recorded in order to create an accurate perception of the ATOC sound.

These sounds were initiated after the first minute of the project in order for the listener to become accustomed to the underwater environment and perceive the ATOC sound as an actual interruption. Once the ATOC imitation sounds began, the nature of the marine mammal vocalizations also changed. In the beginning of the piece the whale vocalizations were more playful: minke whale clicks, the rhythmic, pulsating sounds of the Fin whale and the cheerful clicks and pops of dolphins. Those included in the latter part of the soundscape were distressed and pained: quick paced pumping sound of the Fin whale, the mournful, searching cry of the Blue whale. A short audio clip of humpback whales moaning, repeated throughout the soundscape in order to create a sense of continuity and harmony, was altered in pitch in the last 2 minutes of the piece. The elevation of pitch of these vocalizations gave the sounds a more frenzied, anxious quality. The last minute of the soundscape was meant to be chaotic, leading the listener to the climax of the damage incurred by the ATOC and finally out of the ocean and into the human environment.

Implications and Conclusions

The implications of this piece are that the creation of the ATOC generators and the project were initialized by humans, installed and activated in a foreign, aquatic environment and left there to accomplish irreparable damage on the already threatened lives of marine mammals. As the installation of the ATOC is an acoustic "innovation" and the damage it may cause to whales will affect their ability to hear, it is essential for individuals to be able to contextualize the problem in terms of sound. Thus, the soundscape creates a clear statement against ATOC by immersing a listener into the problem and allowing them to perceive the type of damage such a project may cause[2].

Bibliography

Alten Stanley R., *Audio in Media* (USA: Wadsworth/Thompson Learning, 2002) front cover.

Berta Annalisa and Sumich L. James. *Marine Mammals Evolutionary Biology*. US: Academic Press, 1999.

Buck, Eugene. Congressional Research Service. Acoustic Thermometry of Ocean Climate: Marine Mammal Issues, 1995 (http://www.cnie.org/nle/mar-2.html).

Sound Sources

Blue Whale. Pacific. Cornell Univeristy Bioacoustics Reaserch Program, 1993.

Fin Whale. Atlantic. Cornell Univeristy Bioacoustics Reaserch Program, 1993.

Minke Whale. North Atlantic. Cornell Univ. Bioacoustics Reaserch Program, 1993.

Humback, Dolphins and Weddell Vocalizations. Cornell Univ. Bioacoustics Reaserch Program, 1993.

Angela Kouris is a Communication Studies and Biology student at Concordia University with an interest in Documentary Sound and Bioacoustics. Having travelled extensively and lived abroad, Angela will begin Graduate Studies in Marine Science in New Zealand as of February, 2003.

Footnotes

1 Stanley R. Alten, Audio in Media (USA: Wadsworth/Thompson Learning, 2002) front cover.

2 In effect, prolonged listening to the imitation ATOC sound is painful to one's ears!

The Not So Silent Sea

Few people are aware of the vibrant sounds of the ocean, except for the roaring crash of a wave against a craggy headland. Whales, shrimp, seals, dolphins, and a variety of other creatures of the deep live in a watery acoustical environment.

The arrival of steamships and other human-made interventions into the ocean soundscape has contributed disturbing noise to this rich soundscape.

Here is a chart of various ocean acoustic sources and their ranking on the decibel scale.

Lightening on surface	260 dB
Seafloor Volcanic Eruption	255 db
Low frequency sonar	235 dB
Seismic oil exploration	210 dB
ATOC experiment	195 dB
Blue whale	188 dB
Gray whale moan	185 dB
Ice Breaker	183 dB
Large tanker	177 dB
Humpback whale moan	175 dB
Supply ship	174 dB
Southern Right Whale	172-187 dB
Dredging boat	167 dB
Whale watching boats	145 to 169 dB
Fin whale	160-186 dB
Bowhead whale	158-169 dB
Harp seal call	130-140 dB
Undersea Earthquake	93-125 dB
Bottlenose dolphin	~150 dB
Wind and waves	~ 85 dB

Primary reference:
Science Communication Program—University of California, Santa Cruz, SURTASS LFA Environmental Impact Statement.

Ocean Bio-Acoustics and Noise Pollution:

Fish, Mollusks and other Sea Animals' Use of Sound, and the Impact of Anthropogenic Noise in the Marine Acoustic Environment

By Michael Stocker

Many marine animals use sound and acoustic energy sensors to adapt to their environment. Most biological studies closely examine a particular species' relationship to a specific stimulus. This report examines the field of biological adaptations to sound through research since 1950, assembling an overview of the biological importance of sound in the ocean. It also examines the various sources of anthropogenic noise in the sea with a focus on the potential impacts of that noise on the marine acoustic environment.

Table of Contents:

1. Overview
2. Sound in the Ocean
3. The Ocean's Acoustic Environment
   3.1 Naturally Occurring, Non–biological Ambient Noise
   3.2 Naturally Occurring, Biological Ambient Noise
4. Sea Animals and Sound
   4.1 Marine Mammals—Whales and Dolphins
   4.2 Fish—Teleost (Bony Fishes) and Elasmobranches (Sharks and Rays)
   4.2.1 The Sound Organs of Fishes
   4.3 Mollusks—Clams, Mussels, Oysters, Squid and Octopi
   4.4 Crustaceans—Shrimp, Krill, Lobsters and Crab
   4.5 Cnidaria—Jellyfish, Anemones, Hydra and Corals
5. Summary of Animal Sound Perception and Production Modes
6. Anthropogenic Noise in the Sea
   6.1 Sources of Anthropogenic Noise—Boats, Ships and Watercraft
   6.2 Non–vessel Commercial and Industrial Noises
   6.3 Research and Military Communication
7. Impacts of Anthropogenic Noise on the Sea—Discussion
   7.1 Anthropogenic Noise Mitigation

Appendix
A1.0 Sound Behavior in the Ocean
A1.1 Soundwaves and Ocean Geometry
A1.2 Particle Motion

Acknowledgements
References

It has long been known that ocean creatures produce and use sound. Recognition of the musicality of sea animals dates back at least as far as the 7th century B.C., when dolphins rescued Greek musician Arion from the sea because they recognized him as a kindred musician. Throughout all cultures, the earliest tales of seafaring include accounts of singing sirens, howling serpents and other noisy denizens that inhabit the deep.

Perhaps these tall tales were dismissed by those on the shore as madness induced by sailors' endurance of long and lonely stretches over the silent seas. It was only during the Second World War when sonar surveillance of enemy submarines became critical to national security that the danger of underwater noise produced by fish became apparent.[1] When hydrophones were placed in coastal waters to listen for submarine traffic, they were overcome by all manner of strange noises. If the Navy were going to be safe from enemy submarines, animal noises would need to be identified and distinguished from the noises produced by the subs.

In the sixty years between WWII and the present, much work has been done to identify and qualify the marine acoustic environment—but due to the expense of underwater research, this research has largely been driven by military or industrial concerns. This has left many gaps in our understanding of how marine animals use sound. As we learn more about how human survival is dependent on the health of the planet, we realize that a greater understanding of the effect of underwater sound in the oceans is needed. With the increased use of the marine acoustic environment by the military and industry, it seems that it is not so much the safety of our Navy, but the viability of our marine fisheries that is now at risk.

The 'background' noises that we took for granted as some indication of marine life are increasingly being re-evaluated as the necessary sounds of animal survival—sounds that sea creatures use to communicate, navigate, hunt, bond and breed. This perspective has been most apparent in whales and dolphins due to the natural human empathy for these intelligent, air-breathing creatures. It has also been obviated by the catastrophic events caused by interfering with their sound perceptions.[2] The relationship that fish and other sea animals have with sound is less understood. Many reasons account for this:

- We don't often experience these animals in their environment—they are not as large or interactive with humans as some whales and dolphins;
- Encounters with these animals and determination of the vitality of their populations have been largely anecdotal and dependant on 'fisherman's luck'; and
- Human familiarity with most sea animals ends at the dinner plate.

With all of the vagaries of fish stock vitality, it would be hard to determine what impact anthropogenic noise has on it, particularly with all of the other factors that stress or compromise ocean life. A thinning population of any species can be attributed to over-fishing, unusual weather conditions, bad fisheries management, water pollution, wetland depletion, or just bad fishing luck. We can never know when a catastrophic event decimates a fish population because the victims just decompose and sink to the bottom, never to be seen; and in order to determine the long term affects of a compromised environment, we need to evaluate trends over years. In light of this, if we want to maintain the viability of marine fish stocks, we need to carefully consider the possible risks of any action that impacts their environment, including the impact of anthropogenic sound.

This report will consider the known relationships that various ocean animals have with sound, and their dependence on sound perception. It will also consider how various ocean animals are affected by ocean noise caused by human activities such as industrial, military and commercial exploitation of the sea.

2. Sound in the Ocean.

Most people consider the ocean a silent place. This is largely due to the fact that humans are poorly adapted for underwater sound. We typically consider air a necessary component to sound generation because it is air that sets our vocal cords in motion, producing the sound of our voice. Air is a scarce commodity underwater, and while the whale songs with which we are familiar, are easy to understand knowing that these animals breathe air, most whales and dolphins do not expel air for their vocalizations. (In many cases, we really do not know how most whales and dolphins vocalize underwater.)

Another reason we believe that the ocean is silent is that our own ears (which are also poorly adapted to hear underwater) are not obvious appendages on sea animals. The assumption is that if an animal doesn't have some form of sound gathering attachments on the sides of their head, they don't have well developed ears. This assumption is reinforced by the fact that when we dive underwater our delicate ears shut down under the water pressure. We can hear, but the sound is muffled.

Due to these human perspectives on sound and hearing, our natural assumption is that sound is a terrestrial animal adaptation—better suited to lions and birds than to fish and crabs. We assume that fish and other sea animals rely on sight and smell for their perceptual connection to their surroundings.

The truth about underwater sight is that the ocean environment yields poor visual clarity. Unless the water is devoid of life, it will be clouded by plankton and micro organisms. Even the clearest waters rarely yield a visibility of one hundred feet at the surface. And once you descend to a few hundred feet in depth the water above absorbs all sunlight, so it is dark even during the day. As it happens though, sound actually works very well underwater, so in lieu of sophisticated organs of sight and light perception, many sea animals rely on very sophisticated organs of hearing and sound perception.

Perception is a creature's method of sensing environmental properties, translating them to neural impulses, then further converting the neural impulses into adaptive action. Because sound is a mechanical conveyance of energy, it impinges on the environment in many subtle and complex ways. Sound, or acoustical energy is a pressure gradient over time in a medium—an energy that sets molecules in motion on a specific axis. This energy can be an impulse, an oscillation or a combination of these two. Once the molecules compress, or move, they tend to relax back into their original position. The net affect is that acoustical energy doesn't actually displace anything, only the energy moves. (For a more thorough treatment of underwater acoustics, see Appendix A.)

From the perspective of the organism, this movement of energy can be sensed as a dynamic change in pressure gradients, an oscillation of particles, or a vibration of the medium. Sea animals have many different ways of sensing these properties, and many more adaptive responses to what they sense. To reveal the diversity of sensing methods, we will examine some aspects of the ocean's acoustic environment.

3. The Ocean's Acoustic Environment

There are many sources of sound and noise in the ocean: naturally occurring noises that have been part of our planet since the birth of the sea, and anthropogenic noises that date back to the first seafaring people and have been increasing exponentially over the last 100 years.

Naturally occurring environmental noises include the sound of wind and waves, tides and currents, weather, tectonic and volcanic activity, as well as all of the sounds produced by ocean animals. Anthropogenic noises include the sound of watercraft (from jet skis to supertankers); offshore oil/gas exploration and production noise; sonar—especially military high-power equipment; underwater telemetry and communication for mineral exploration and research; fish 'bombing' and other underwater explosives; civil engineering projects, and overflying aircraft.[3]

3.1 Naturally Occurring, Non-biological Ambient Noise

Even devoid of life, the ocean is not a silent place. Wave action, wind and rain on the surface create a background din that ranges between 40dB-70dB SPL (re: 1(Pa)[4] in deep water, and up to 90dB in shallow coastal areas. Other non-biological sources of sound include geological sounds that can add significantly to the ocean ambient noise.[5]

In polar regions the shifting ice packs—melting, cracking and breaking away, and the tidal surge under broken ice fields—creates an incredible cacophony of noise.[6] The ambient noise due to ice action may be as high as 90dB throughout the year. The sounds of weather on the ocean are variable and transitory; rain and hail hitting the ocean surface, lightning, thunder and the ever-present winds occur throughout the seas, moving across the globe. Regional sound sources include the sounds of tides and currents. Tidal flows are periodic and currents are more constant, but as water in motion moves across the submarine terrain—from sea mounts to kelp beds—sounds are produced that are akin to the sounds produced by wind over land.

Tides and currents interacting with sea bottom features, the seabed, river deltas and estuaries create unique soundscapes that are geographically specific. (Sounds from the tidal swings in New Foundland are as unique to that area as are the deep sounds of the Humboldt Current to its course.)

Volcanic activities such as deep hydrothermal venting or volcanic eruptions, are geographically specific and can be a continuous source of sound in some areas. Seismic events—either the sudden or gradual sifting of tectonic plates—adds to the cacophony, creating an ocean soundscape that is rich and varied, and unique to their locations. The geographic specificity of noise sources is an important feature to ocean biology because it has been surmised that certain whales may navigate by recognizing acoustic features of ocean geography[7].

3.2 Naturally Occurring, Biological Ambient Noise

Of the many sources of biological noise in the ocean, we are probably most familiar with the songs of whales and dolphins, but there are countless other sources of biological noise in the sea. Various fish grunt, grind, sing or scrape to produce sounds for territory, bonding, and hunting purposes. Many crustacians are adapted to sound making in ways as diverse as their terrestrial insect cousins are. Even the sounds made by barnacles when opening and closing, and by the movement of their appendages, can be picked up for many miles from barnacle beds.[8] In tropical and semitropical coastal regions, the dominant biological sound is the crackle and hiss of Snapping or Pistol Shrimp (Cragnon, Alpheus and Synalpheus). These shrimp stun their prey with a loud report from a claw-trigger mechanism. Their sound is so predominant in these latitudes that placing a hydrophone underwater in their habitat sounds like placing a hydrophone in a glass of champagne. The ambient noise level attributed to these creatures can exceed 70 dB.[9]

Until recently, biological sounds only came into question when they somehow interfered with human activity—when the humming of 'Harbor Midshipman' (Poricthys) made life in a marina hard to bear, or when the noise of Croakers (Sciaenidae) and Sea Robins (Triglidae) interfered with sonar surveillance. Since 1990 and the end of the 'Cold War' some of the expensive and confidential military technologies became available to industry and research, and with it a deeper inquiry into the sources of animal sounds in the sea. With these tools the rich and varied biological soundscapes of the sea began to emerge: schools of singing fish; mysterious tapping, humming and oscillations; long distance sounding of whales; pops, chortles, grunts, bells and bangs. It is over this naturally occurring acoustical ambience that sea creatures of all species live, hunt, bond, procreate and die.

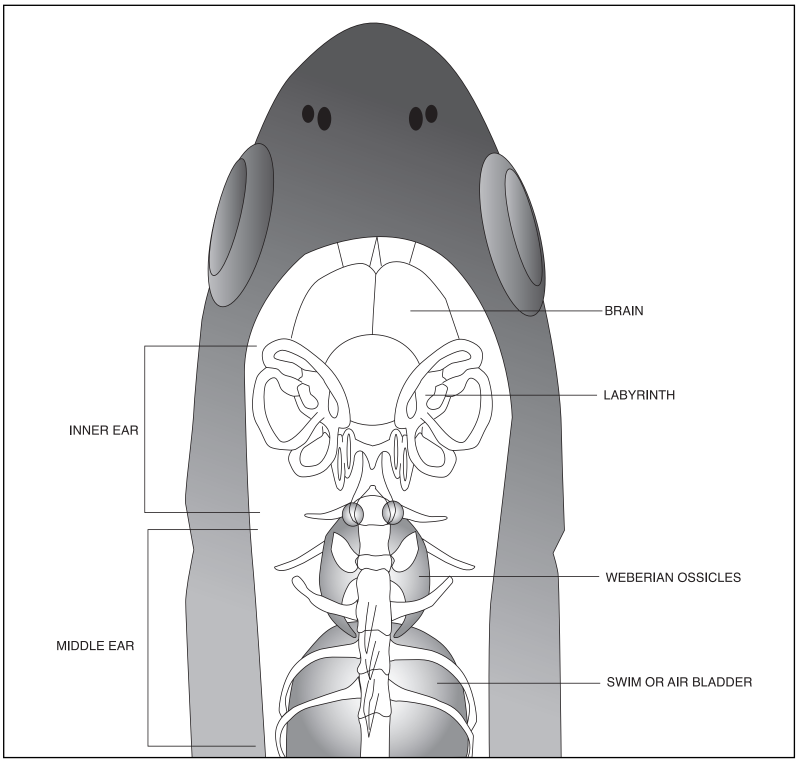


Fig.1 How Fish Can Hear:
Vibrations in the water are picked up by the swim or air bladder, passed on to a series of four small bones—the Weberian ossicles—then to the inner ear where they agitate the fluids that fill the labyrinth. Hair cells in the labyrinth sense these movements and trigger nerves, which in turn send signals of the vibrations to the brain.

4.0 Sea Animals and Sound

The animals considered in this report do not represent all 'sound specialist' animals in the sea. Animals discussed herein were chosen because of the available information on them, and because of their commercial and apparent environmental importance.

Whales and dolphins are considered briefly in this report because there is more common knowledge about these creatures' relationship to sound than any other class of sea animal. They are included as a touchstone for our common knowledge, but even with the body of knowledge about cetaceans and their sound perception, it is clear that we actually know very little about how they use sound. This sets the broader perspective that while considerable efforts are being made to understand the auditory perception of sea animals, our understanding is miniscule compared to the vast diversity of sea animals and their adaptations to sound.

The inquiry into fish is farther reaching because this class includes so many species with so many different ways in which they use sound for survival. The inquiry into mollusks is scant due to the scarcity of research on molluscan senses. This is also the case with the crustacians—shrimp, crabs and lobsters, and Cnidaria—jellyfish, anemones and hydroid plankton. These last are included herein because their primitive organs of motion sensing, balance and location are considered the early adaptations of what has become the vertebrate ear.[10]

Wavelength, frequency, period and decibels are all abstractions to sea creatures; their only concern with sound and acoustical energy is in how this energy impinges on their organs of perception, and that they can adapt to it in order to survive. Survival means different things to different animals: to a Grouper it involves setting territorial boundaries; to a Sea Robin or Midshipman it involves community and breeding relationships; to the Tuna it involves synchronization to the swimming patterns of the school, and perhaps navigation; to Anchovies it involves evasion from predators; to clams and scallops it involves sensing currents for food and threat evasion.

All of these different uses of sound are activated through various sense organs. Some have common structural analogies to mammals—such as the neuromasts on the lateral line of fish and the same nerve structures in mammalian cochlea; others are unique to the creatures, such as the statocysts in mollusks and cnidaria, or swim bladders in fish. In any event it is clear that most sea animals have a biological dependence on sound and acoustical energy. This fact should yield a rich vein of information as we develop the tools, the language and the understanding to explore their secrets of sound perception.

4.1 Marine Mammals—Whales and Dolphins

People are quite familiar with the sounds of whales and dolphins. It is not the purpose of this report to reiterate this common knowledge. Suffice it to say that it is generally known that cetaceans communicate and navigate with sounds. It is also fairly common knowledge that dolphins and porpoises use sonar to echolocate and distinguish things in the water. Some dolphins and whales also use loud noises to stun their prey.

The hearing mechanisms of various whales and dolphins are only partially understood. While these animals do have the inner ear mechanisms of other mammals—the cochlea, tympanic membrane and approximation of semicircular canals—there is some informed conjecture that these animals have other organs of sound perception. The 'melon' of some odontocetes is generally assumed to be an acoustic organ, the trigemnal nerves in mysticeti and other enervation around the skull may serve as acoustic sensors. Various cavities in the bodies of whales may serve as pressure sensors. The studies continue.

4.2 Fish—Teleost (Bony Fishes) and Elasmobranches (Sharks and Rays)

Heretofore the study of sound perception in fish has divided this class of animals into two camps: those that are 'sound specialists' and those that are 'sound generalists'. Some of the distinctions between these groups arise around whether the animal has a method of producing sound, and how complex their known organs of sound perception are. These qualifications have served as general guidelines for the inquiry; but the question that keeps the door open for further exploration—and continues to erode the distinction—is "Why do sound generalists need to have a relationship with sound anyway?" As a result, the specialist/ generalist distinction is rapidly becoming obsolete, as we learn how various fish use sound in their environment.

Perhaps most intriguing to this is the recent consideration that ambient noise in the ocean may actually serve as a source of 'acoustic illumination', similar to how daylight illuminates objects we see. The theory is that objects and features in water cast acoustic shadows and reflections of ambient noise that fish can perceive and integrate into the perception of their surroundings.[11], [12] This has far reaching implications for the distinction of how fish and other animals use sound in the sea, and muddies up the distinction between the sound specialist and sound generalist groups.

There are some common adaptations to various environments by fish. Those that live in estuaries or muddy environments often have distinct methods to perceive that environment. This often includes the ability to produce sound and mechanical sensors that facilitate the perception of the sound they produce. However, fish that do not live in muddy water may also have these same sensing organs—even if they don't produce sound. There are organs in some fish that sense water pressure due to depth that also sense pressure gradients due to acoustical energy. Some fish have sense organs that are extremely sensitive to subtle particle and impulse motion—organs that work even in strong currents while the fish is moving. From a physical/mechanical standpoint, their swimming should overload the sensitivity of the organs. From this we could surmise that these fish have complex ways of integrating motion stimulus which might be akin to our being able to hear a mouse whisper while driving on the freeway.[13]

One challenge in determining what a fish or any animal hears, is the bluntness of the available testing procedures. Most audition tests are based on the Skinnerian model of behavioral research. This involves cultivating recognizable responses to specific stimulus. The researcher either rewards or punishes an animal coincidentally with the appropriate stimulus—sound in the case of audition testing. The animal is trained thoroughly enough so that their willful response to the stimulus becomes apparent. When the stimulus is modified in some manner, the relationship between the modification and the original training stimulus can be established. Problems arise when dual thresholds are found.[14] This condition might indicate a shift from one hearing mechanism to another—such as a shift from swim bladder to lateral line sense, or a shift from pressure to particle velocity perception, or even a shift from a voluntary to an autonomic nervous system response that somehow co-stimulates a voluntary response. Even stimulus/response testing that induces autonomic responses could be subject to similar response threshold shifts.[15]

Most audiograms of fishes indicate a low threshold (higher sensitivity) to sounds within the 100 Hz-2 kHz range. This narrow bandwidth could be due to mechanical limitations of the sense organs, or physical constraints of the testing systems.[16] If the acoustic illumination theory proves correct, it could account for a high frequency response that is not anywhere in the realm of a voluntary stimulus/response modality. It could indicate a response mode akin to training a fish to seek food when a bell rings, and then expecting the same fish to seek food when you put blue sunglasses on it.

The difficulty in unraveling many of these mysteries lies in the simple fact that while we may be able to invoke repeatable and observable responses in some fish, we will never be able to figure out what they perceive. To paraphrase an axiom of cognitive science, "If a fish could talk, we wouldn't understand what it was trying to say." We can look at the physiology, environment and social setting of various creatures and surmise how they use the stimuli of their surroundings, but even our most basic understandings depend on perceptual assumptions that we humans can grasp.

In light of this, the best we can do is continue to explore the many organs of perception that fish use, examine their behavioral responses to acoustic stimulus, and attempt to open our windows of understanding to include broader slices of time, larger frequency spectra, and wider dynamic ranges.

4.2.1 The Sound Organs of Fishes

(See Figures 1 and 3) Probably the most distinct organ associated with fish aside from their gills is the 'swim bladder'. This organ serves many purposes. Its most basic function is to serve as a hydrostatic regulator, allowing the fish to mediate buoyancy and equalize internal and external pressures. In some fish such as the Grunts (*Pomadasyidae*) this bladder is also used as a resonator to amplify the grunting sounds they make by grinding their pharyngeal teeth. Other fish such as Drums and Croakers (*Sciaenidae*) have special muscles attached to an elaborate swim bladder to produce sound for navigation and maintain contact with their school in the heavily silted estuaries in which they live.[17]

Many fish have a mechanism of small bones called 'Weberian ossicles' that fasten to the swim bladder and transfer vibrating energy from the bladder to the labyrinth of the inner ear. This structure has a kinship to mammalian middle and inner ear structures. The analogies are between the swim bladder and the tympanum; the Weberian ossicles with the hammer/anvil/stapes; and the labyrinth with the cochlea and semi-circular canals.[18] The weberian ossicles of fish typically comprise four, rather than the three bones in the mammal middle ear, and the labyrinth appears a bit more complex in fish than in the human inner ear. This may be due to the fish's need to sense rotational and linear acceleration, and bathymetric stimuli with more acuity than terrestrial animals, as well as their need to perceive the seismic, gravity and sound stimuli that terrestrial animals also require.

Fish also have structures within their labyrinth called 'otoliths.' Larger than the 'otoconia' of other vertebrates, they are concentrations of calcium salts suspended in a sensory envelope of gelatinous membrane.[19] Because of the location and orientation of the otolith organs in the labyrinth, it is tempting to assume that they are somehow associated with orientation and vectors, though they seem to be more associated with particle motion sensitivity (see Appendix A1.2 below) and in some cases pressure gradient sensors.[20]

Because of the physical properties of a swim bladder, its contribution to audition involves pressure gradient sensing. This is in terms of both comparative hydrostatic sensing, as well as sensing the more rapid changes or oscillations of pressure gradients—i.e. acoustical energy. This capability would allow fish to sense long distance sound generation and ambient noise by way of this organ. Not all fish have swim bladders; bottom dwelling fish such as sole or halibut do not have swim bladders.[21] In lieu of this, their sound perception abilities derive from cilia, or hair cells located on the upper surface of their body. These cilia are located in various concentrations on the bodies of all teleost fish, but most particularly, they concentrate in the form of a lateral line that runs parallel to the spine (see Fig.2). It could be surmised that the cilia distributed over the body are predominantly current flow sensors, and the lateral line is more of a frequency discriminating particle motion sensor.

The similarities of lateral line enervation to the human cochlea is an environmental adaptation that gives us clues to how some fish may discriminate sound.[22] While there is a general agreement that the lateral line does serve as a mechanoreceptor, there continues to be some discussion about its true function. The broader view is that it serves in one or more of the capacities to sense water movement (distance touch), surface waves (frequency dependant particle acceleration), or low frequency sound (pressure gradients).[23]

While there is unambiguous evidence supporting all three modes, there remains confusion as to how an organ that can sense pseudo-random displacement from locally generated currents and water movement [24] can also simultaneously discriminate frequency dependant acceleration, oscillating pressure gradients,[25] and the direction of the sound source.[26] The general assumptions are that certain fish have overlapping receptors that allow them to perceive or distinguish various qualities of acoustic stimuli.

All of these aforementioned perceptual modes are characteristics of various species which allow them to perceptually lock into their surroundings with acoustic adaptations particular to their species—for hunting, territory, bonding, spatial orientation, navigation, predator aversion, etc. An inquiry more specific to the vitality of fisheries involves how schooling fish—tuna and herring for example—use the acoustic energy generated by their school to keep them connected with each other. Evidence suggests that the lateral line as a pressure gradient and particle motion sensor enables schooling fish to mediate their proximity and velocity within the body of the school. [27],[28] One inference that could be drawn from this is that a school could be modeled as a low frequency oscillating body to which the individual fish synchronize. This view is supported by schools that 'flash' simultaneously as they respond to threats. This is also substantiated by evidence that, when startled by very loud noise (e.g. air guns), schooling fish fall out of rank and take some time to re-assemble.[29] This 'startle' response does involve establishing a tighter grouping, so the response is not a scatter response. The interruption—or startle response—observed in the air gun study might indicate that the hearing process of each individual fish is momentarily compromised, or the pressure gradient field of the school loses integrity and takes some time to resettle, or perhaps a bit of both.

Fish colonies in stationary habitats also need to establish and maintain contact with their co-species. In these cases they can't rely on the low frequency pressure gradients generated by swimming bodies because the fish in these colonies may be largely sedentary. Rock Fish, Grouper and Toadfish all dwell in areas often concealed by rock caves, thick kelp or muddy water. All of these animals 'vocalize' by way of their swim bladders coupled with muscles or other mechanical means of sound generation. The 'Midshipman' in the Toadfish family is probably the most known for their long, low frequency humming. They often dwell in shallow bays and their humming is heard through the hulls of nearby boats. While each animal has a hum fundamental frequency of 80-100 Hz, the colony will set up infrasonic beat frequencies of 0-8 Hz. These animals have an ability to discriminate these beat frequencies.[30] This ability probably has something to do with maintaining identity and contact with their colony.

Elasmobranches—sharks, skates and rays—rely on low frequency sound to locate distressed prey. While sharks do have refined electro-chemical receptors, a research diver noticed the immediate appearance of sharks upon spearing a food fish, even while the prevailing currents did not favor the dispersal of blood in the shark's direction.[31] His further inquiry established a relationship between low frequency sound and other behavior, including aversion behavior associated with rapid increases in low frequency sound levels by 15 to 20 dB—a change in levels that alerted the sharks about unexpected phenomena.[32]

Evidence presented here indicates that fish as a class have very complex and diverse relationships with sound and acoustic energy.[33] The complex hearing mechanisms of fishes, and fish audition are rich fields of inquiry that are sure to challenge our assumptions and yield fantastic results as we explore further.

4.3 Mollusks—Clams, Mussels, Oysters, Squid and Octopi

Probably the most challenging aspect of the study of sound sensitivity in mollusks involves the sustained belief that these animals are far too primitive to have significant communication systems. A complication with the evaluation of marine invertebrates' response to sound is that their reaction time scales are significantly different than human time scales. Our identification with birds, fish and mammals devolves around their being symmetrically structured vertebrates (two eyes, two fins, hands or wings, etc.,) and that their response time is more closely aligned to human stimulation/response behavior.

'Hearing' is not really discussed when speaking about invertebrate sound perception because by and large these animals do not have the type of nervous system that vertebrates have. When speaking of invertebrate physiology, the term 'phonoreception' is more appropriate when describing an organ or mechanism that responds to acoustic energy. These organs may be a hybridization of gravity, orientation and hydrostatic sensors, or specific mechanisms that answer unique survival adaptations to acoustic energy by each organism.

The mollusks reviewed herein include clams, oysters and mussels, snails and slugs, and squid and octopi. The inclusion of squid and octopi with other mollusks may seem counter-intuitive because we have learned that these highly mobile animals demonstrate perceptual modes that are identified with observable intelligence. This observation may actually be due more to framing them in an anthropomorphized time context rather than a lack of perceptual abilities on the part of less mobile, or slower species of this phylum. That being said, we do know that octopi have a highly adaptive intelligence that goes beyond mere pattern recognition to a degree of associative reasoning and problem solving (or problem causing, by the accounts of some aquarists). Interestingly enough, octopus species have not demonstrated an adaptation to even rudimentary sound perception.[34]

Squid, on the other hand, have demonstrated responses to sound. This may have something to do with their schooling nature that requires synchronization with the school, and predator aversion perception akin to that of schooling fishes. Research on squid audition is currently scant. Only the bluntest studies seem to have generated funding—studies of destructive noise levels and startle responses. We know from these studies that squid are adapted to particle and pressure gradient acoustic energy. The current belief is that they hear by way of statocysts,[35] or possibly by proprioception—the sensing of sympathetic movement of muscles and tissues in the body acted on by acoustic energy.

While researchers noticed a predictable startle response at 174 dB (firing of ink sacks and avoidance behavior) from instantaneous impact noise, a ramped noise indicated a response threshold of 156 dB by way of a noticeable increase in alarm behavior—an increase in swimming speed and presumed shifts in metabolic rates. The squid's response to ramped noise also includes their rising toward the surface where an acoustical shadow of 12 dB occurs. This would indicate an annoyance sensitivity of perhaps 144 dB.[36]

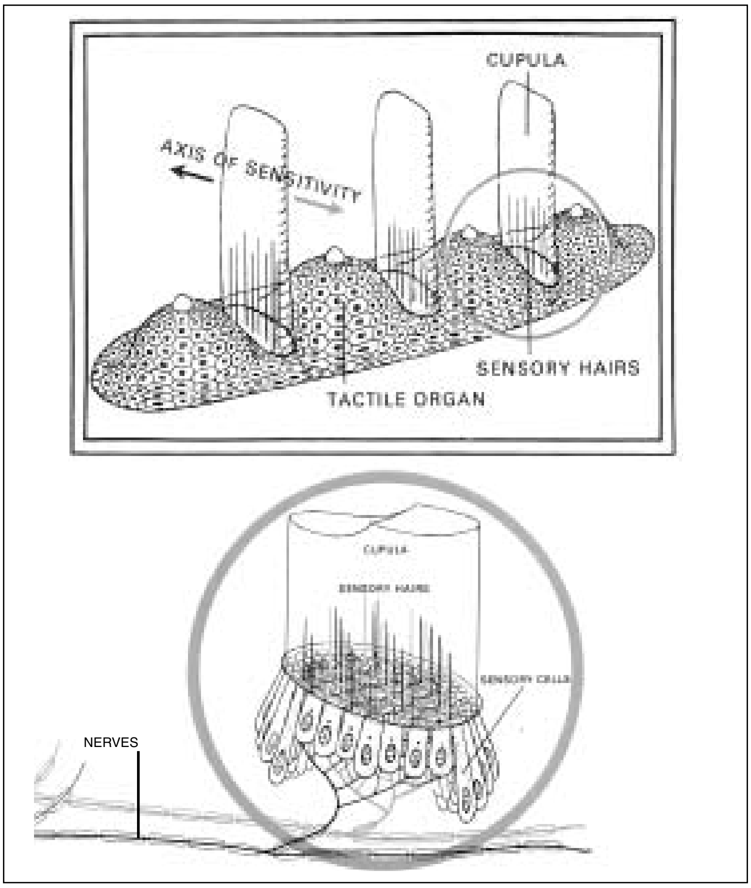


Fig.2 The Lateral Line System:
Two nerves run under the skin and are attached to the sensory stitches on the surface. A single stich (see box above) consists of four or more hillocks which are sensitive to touch. Between them are gelatin-like columns called cupulae, which react to water currents moving cross-wise to the stitch. A close up of the cupula base (see circle above) shows how sensory hairs and cells are connected to the two nerves. The hair cells are similar in construction to those that convert vibrations to nerve impulses in the inner ear of mammals.

Little is known about squid hearing, but even less is known about Lamellibranches (bivalves such as clams and muscles) and Gastropods (snails, slugs and limpets). Any acoustic response in these is typically measured by aggravation response—a study that successfully used ultrasound to eradicate zebra mussels,[37] for example. Given that the purpose of this study was aimed at killing these creatures, threshold auditory levels were not revealed. It would be hard to determine if it was an aversion to noise or some other physical action that killed these animals.

The marine lamellibranch, Glossus humanus or Ox-Heart Clam, has demonstrated a remarkable sensitivity to vibrations well below what would be considered a 'shock wave'. That their heightened sensitivity might be used for something other than escaping predators is shown by the studies of surf clam tidal migrations. On the incoming tide, the breaking waves cause the clams to rise to the surface and be carried in with the waves. These animals would need to be able to sense the shifting of the tides in various surf patterns to determine when to cast loose and let themselves be cast up to the tide lines. (When research biologists stamped their feet on the wet sand, these clams would hurriedly rise to the surface.[38]

In gastropods, some animals that do not respond to wave or particle motion in the water will none-the-less respond to substrate-borne vibration on the surface of what they are perched on. This might indicate that they are directly coupled through their foot to the bottom, sensing vibration through proprioceptors in their muscles. If this is the case, seismic motion may have a strong affect on them that waterborne sounds would not. This substrate vibration sensing may serve for rudimentary predator detection, or as sophisticated as community identification and bonding sense. The scraping radula that these creatures use for eating would set up vibrations in the substrate that may serve to keep these creatures in their colonies.

While some of the sound perception modes of mollusks discussed herein may seem speculative, these conjectures are not beyond reason. Hopefully, they will serve as steps toward the understanding of how and why various mollusks respond to sound.

4.4 Crustaceans—Shrimp, Krill, Lobsters and Crab

Crustaceans could be considered as 'insects of the sea.' Like their terrestrial cousins, they have exoskeletons and segmented appendages, many live in communities that school or 'swarm' like insects, and many make noises akin to the buzzing, chirping, clicking and singing of crickets, cicadas, mosquitoes and beetles. Crustacians that do not specifically make noise none-the-less respond to acoustical cues. Many animals that do not seem to communicate by way of sound are suspended in the 'collective' sound of their school—synchronizing their movements in response to the body of the school as previously mentioned in schooling fish and squid.

Crustaceans and insects do not have ears, bladders or lateral lines, but they possess chordotonal organs. These organs appear at the joint segments and are internal mechanoreceptors. As such they serve as proprioceptors, or as highly specific mechanoreceptor organs—e.g. hearing organs.[39],[40]

Chordotonal organs account for the acoustical sensitivity of fiddler crabs (Uca pugilator), hermit crabs (Pagurus), and other small tidal crustaceans. Many of these animals are sound sensitive to predators from both in and out of the water. They also use sound cues to scavenge their food. An associate in Queensland related how the Aboriginals in his homeland would call the crabs out of hiding by mimicking the sound of crabs eating. The crabs would hear 'feeding' and come out to investigate, at which point the callers would pluck the crabs off the rocks for dinner. The complexity of sound perception in these tidal animals is indicated by their ability to distinguish survival sounds from the ambient sounds of waves and surf. The ability to discriminate the sound of predators' footfalls from the sound of water splashes, from the sound of scampering prey all in a din of tidal backwash would require a fairly sophisticated auditory signal processing ability.

Deeper water scavengers also use sound cues to hear food as it falls to the sea floor. Studies indicate that sensitivity to 'micro-seismic' events in the frequency range of 30Hz-250Hz enables deep-water scavengers to detect food-fall to distances of 100 meters.[41] These deep-water animals also require sensitivity to the sounds of predators. The adaptation of animals to sounds of threat is indicated in the recent anecdotal evidence that schools of pelagic shrimp have adapted evasion strategies to the sound of shrimp trawlers. When the trawlers circle in, the shrimp dive deep, below the nets.

We typically do not associate the scampering claws or the bubbling noises of tidal crabs as 'deliberate sound,' just as we don't consider the swimming noises of pelagic shrimp or schooling fish as 'deliberate,' though these sounds are significant elements of the creatures' survival. They are not 'words,' but if you spend any time in a tidal mudflat, the "snap, crackle and pop" of crustacians clearly signals the existence of living organisms in their environment—useful information to any organism dependant on that environment.

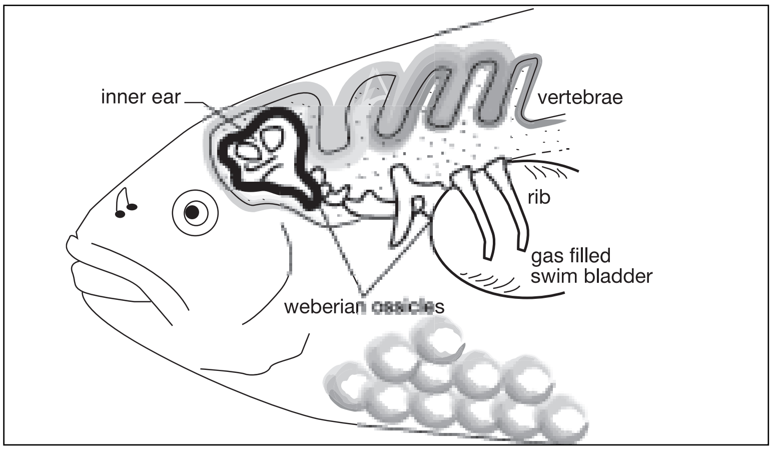


Fig.3 The Inner ear and sound-transmitting apparatus of ostariophysine fishes.

In 70% of the world's coastal areas, the dominant crackle of snapping or pistol shrimp speaks for itself about the biological importance of the noise. That these creatures use sound as a hunting tool seems remarkable enough; continuing the inquiry into whether the shrimp use this sound to maintain contact with other snapping shrimp—i.e. for communication—boarders on the extraordinary: could the acoustic illumination principles mentioned above be used by the shrimp themselves? Signal coherency of their snapping may give clues to whether they coordinate their snapping with the acoustic community, or just snap randomly.[42] While studies are still in progress, this characteristic would not be dissimilar from how the sound of individual crickets and cicadas is mediated by the sound of the community, creating the pulsing and humming choruses of terrestrial summer nights.

Spiny lobsters have comb-like rasps on their antennae that they scrape on the tops of their shells in a manner akin to crickets' scraping of the comb-like rasp on their elytra together to produce sounds.[43] In lobsters, this sound is presumed to be gender and breeding associated, because the male lobsters become agitated when this sound is played back to them.[44] Similar gender associated sound generation also plays a role in the acoustic life of the fiddler crabs (Uca pugilator),[45] although the mechanism of sound generation is by way of their singularly large claw.

We are just beginning to listen for and hear the myriad of sounds used and generated by marine crustacians. By deeper inquiry and understanding, we may be able to employ some of their methods of sound communication, adapting our uses of ocean acoustics to their highly evolved adaptations to the marine environment.

4.5 Cnidaria—Jellyfish, Anemones, Hydra and Corals

This phylum of marine invertebrates includes jellyfish, anemones, hydra and corals. Understanding of the sense organs of these animals is only rudimentary, which is probably due to the fact that as specimens, most of these animals are physiologically simple, lending themselves to the lowly role of student biology dissecting practice. The perceived economic usefulness of Cnidaria generally ends here.

What this understanding does reveal though is the presence of statocyst organs in some of these creatures. These organs consist of a calcareous 'statolith' in an enervated envelope, considered to be organs of equilibrium; gravity acting on the statocyst allows the organism to orient itself. This mechanism is considered an early adaptation of the organs of balance in mammal inner ears. Because it is found in creatures with ancient evolutionary history and is so simple in form, statocysts may have been the first sense organ developed in multi-cellular animals.[46]

One mystery that may cue us in on reasons to explore broader bandwidth of the Cnidaria statocyst involves how these creatures navigate. Many of these 'free floating' creatures have annual migrations that circumnavigate large areas in the oceans. Their migrations are largely unseen as a pattern because of their slow underwater course. Fishermen or researchers will only come upon them in migrating colonies during particular seasons. In one case, the 'By-the-wind Sailor' Valella valella, lives in large migrating colonies that have an annular migration path. The Valella do not have statocysts, but must have some other organs of mechanical energy perception. They use an 's' curved sail to propel themselves through their journey in large rafts floating on the ocean surface, body to body. Each individual organism sets its sail angle by adjusting against the body of the colony, and thus most of the colony avoids blowing ashore even in coastal areas that are dominated by onshore winds. (The ones that do break away are seen on beaches at specific times of the year.) The Valella need to establish angular relationships to the prevailing winds in order to sail in the proper direction. Can they also integrate the angles and the rhythmic undulations of the swells to help them know where they are?

While it is possible that the individual organism does not have phonoreceptors or other mechanoreceptors that can be monitored within the organism, the entire raft of Valella may somehow constitute a type of 'superorganism' (as defined by E.O. Wilson), that enables the raft to sense and respond to environmental stimuli, with which the individual organisms are not equipped to interact. It is also true that a number of marine planktonic organisms respond to pressure changes by moving up and down in the water column. The hydrostatic receptors that mediate this are still undetermined, but speculations on their nature usually implicate some sort of pneumatic device.

If this hypothesis proves true, the animals also have a device suited to sound reception[47] sensitive to low and ultra-low frequency pressure gradient acoustic energy.

One class of cnidaria that does have sound responsive sense organs is the anemone. These creatures have proprioceptors that help them trap their fast swimming prey. Some species have relationships with anemone fish that take up residence in the stinging tentacles of the anemone. Protection of the fish from stinging by the anemones apparently involves special rhythmic movements of the fish that inform the mechanoreceptors of the anemones of their presence, inhibiting the capture response of the anemone.[48] The discussion around anemones includes whether rhythmic stimulation amounts to acoustic perception, or just a "musical" sense. Unfortunately some of the perceptual studies in a lab using mechanical stimulation with glass pipettes may indicate as much about the researchers' patience as it does about the presumed insensitivity of the anemone to subtler stimulation.[49]

The same could be said about corals, in as much as the stimulus response models in the literature seem to focus on mechanical stimulation alone. Corals are responsive to hydrostatic disturbances—particle motion induced by currents, predators and prey. Literature is sparse on the acoustic adaptations of corals, or how they respond to coherent or persistent sound or noise sources.

At present there is still a dearth of research and understanding about how Cnidaria—with their ancient evolutionary history—actually perceive and adapt to their environment through acoustic energy and vibration, and how this has enabled them to survive over the eons despite their 'simplicity.'

5.0 Summary of Animal Sound Perception and Production Modes

From the preceding it is clear that many sea animals use sound in a variety of ways. Some animals use sound passively, others actively. Passive use of sound occurs when the animal does not create the sound that it senses, but responds to environmental and ambient sounds. These uses include:

1. Detection of predators.
2. Location and detection of prey.
3. Proximity perception of co-species in school, raft or colony.
4. Navigation—either local or global.
5. Perception of changing environmental conditions such as seismic movement, tides and currents.
6. Detection of food sources and feeding of other animals.
7. "Acoustic illumination" akin to daylight vision.

Active use of sound occurs when the animal creates a sound to interact with their environment or other animals in it. Active uses include:

1. Sonic communication with co-species for breeding.
2. Sonic communication with co-species for feeding, including notification and guidance of others to food sources.
3. Territorial and social relations.
4. Echolocation.
5. Stunning and apprehending prey.
6. Alarm calls used to notify other creatures of the approach of enemies.
7. Long distance navigation and mapping.
8. Use of sound as a defense against predators.
9. Use of sound when seized by a predator (perhaps to startle the predator).

The methods of sound production are as varied as the uses. Some methods are still not entirely understood, but they include:

1. Mechanical clacking or rattling of plates or teeth.
2. Grinding or scraping of bones, shells, appendages or teeth.
3. Oscillations of bladders by way of special muscles.
4. Oscillations of the entire body.
5. Distribution of fluids or gasses within the body through sound producing organs.
6. Forceful ejection of fluids or gasses outside of the body through sound producing organs or mechanisms.

The sounds produced and/or perceived through these methods can be attributed to pressure gradient and/or particle motion energy. The useful frequency ranges incorporated by these various methods span the range from 'human infra-sonic' frequencies of 0.1 Hz through ultrasonic frequencies nearing 300 kHz.

Due to the physics of sound in the sea—and the wavelengths of the various frequencies—the infrasonic frequencies (0.1 Hz-20 Hz) are probably dominant in long distance navigation, communication, and environmental monitoring; the lower frequencies (1Hz-100Hz) are likely involved in proximity detection, predator/prey interaction and feeding; the mid frequencies (1000 Hz-10 kHz) dominate close range communication and 'communicative' interaction with other organisms; the higher frequencies (10 kHz-300 kHz) are likely used for echolocation, acoustic illumination, holophonic imaging, and perhaps co-species communication.

It has not been established that any sound in any frequency range predictably stimulates voluntary, sympathetic, or autonomic responses in any species, e.g., that low to mid frequencies are used exclusively for communication in teleost fishes, or that low frequency impact noise predictably induces startle responses in all squid. It is likely that any sound in any regime could stimulate any, none, or all response modes. It is also possible that certain sounds could stimulate systemic responses that do not fall under the rubric of 'nervous system response,' but none-the-less stimulate the system in some fashion—observable or otherwise.

There is much to learn, but with the increasing sophistication of our research tools and breadth of our curiosity, the mysteries of the marine acoustic environment are becoming ever more open to exploration. As we learn more about how various animals have adapted to their ocean surroundings, our understanding will undoubtedly have a positive impact on the quality of our own lives.

6.0 Anthropogenic Noise in the Sea

In 1490 Leonardo da Vinci observed how the sound of ships travelled great distances underwater. The sound of ships in the 15th century included the noise of rudders and rigging, oars and the handling of cargo. Seafaring, while not in its infancy, was a "life driven" technology; the power of wind and human muscle generated the only anthropogenic noises in the sea. Over the next 400 years, acoustic technology at sea involved innovations such as underwater bells and whistling buoys on submerged rocks and reefs to warn navigators and captains away from marine hazards. With the advent of steam powered engines, the quality and level of noise began to shift dramatically. With the ability to navigate to, and develop the far reaches of the globe, the use of dynamite and diesel driven pile drivers began transforming the soundscape of coastal waters worldwide.

Once the mechanization of seafaring and coastal civil engineering took hold, ocean noise began increasing exponentially. Over this time there was little scientific inquiry about the sounds of the sea, so the changing profile and density of ocean noise went unnoticed until the strategic value of anthropogenic noise became apparent. In response to the very effective submarine warfare in WWII, after the war the U.S. Navy developed an underwater network of sound gathering hydrophones. The first generation of ocean-bottom listening device arrays were deployed in 1954-1955 in a system that eventually was called SOSUS—an acronym for 'Sound Surveillance System.'[50]

SOSUS was strictly a passive, "listening only" technology. As it developed, the ability to monitor ocean traffic became quite accurate, with the capability of monitoring individual vessels at long distances, determining their position, course, class, and size. Once the 'Cold War' ended, SOSUS was made available to research scientists.[51] When military tools for undersea listening were made available to the curious, amazing things were discovered. The perspective had shifted—what had been considered interference became information, and while the diversity of biological sounds became apparent, so too did the incredible din generated by human activity.

6.1 Sources of Anthropogenic Noise—Boats, Ships and Watercraft

In 1992, when the SOSUS program was opened to civilians, researchers got an earful. In addition to being able to hear, locate and track individual whales by way of their vocalizations, for the first time scientists also heard the density of anthropogenic sounds that cluttered the marine soundscape. The most pervasive of these ocean noises were caused by transoceanic shipping traffic. At that time the international ocean cargo fleet included some 75,000 vessels, and the average shipping channel vessel noise level ranged between 70-90 dB[52]—as much as 45 dB over the natural ocean ambient noise in the surface regions. In the last 12 years the fleet has swelled to close to 87,000 vessels.[53] While the mathematical model would only represent an increase of less than 1 decibel to the overall ambient noise, the temporal density and geographic spread increase of 16% over that time more closely represents the equivalent impact of the noise increase.

The ambient noises in an average shipping channel are due to propeller, engine, hull, and navigation noises. Any cargo vessel or tanker will generate 170-180 dB of noise at close range; this dissipates over distance through spreading and attenuates as a result of sea surface texture and geometry.

In coastal areas the sounds of cargo and tanker traffic are multiplied by complex reflected paths—scattering and reverberating due to littoral geography. As a result, shipping noise in coastal areas near harbors may easily reach 100 dB, and peak at 150 dB in major ports and seaways.[54] These cargo vessels are also accompanied by all other manner of vessels and watercraft:

- Commercial and private fishing boats;
- Pleasure craft, personal watercraft (jet skis, etc.), as well as coastal industrial vessels;
- Public transport ferries;
- Shipping safety and security services such as tugs boats, pilot boats, Coast Guard and coastal agency support craft; and
- All varieties of navy ships, from submarines to aircraft carriers.

Every one of these vessels with a motor and a propeller increases the coastal area ambient noise level. Marine engine and drive noise is in the low frequency band of 10 Hz to 2kHz and is typically much louder than the noise of equivalent service terrestrial vehicles. They are louder because for a given drive purpose, the engines are much larger—there is a significantly "higher horsepower per vessel" factor required to just push a hull through water. (Transoceanic vessels have much larger engines than anything found on land.) They are also louder because the ocean environmental law has not stipulated the same muffling devices required for land based vehicles. Additionally, propellers are much louder drive devices than the wheel, and vessels can have as many as eight engine-to-propeller drive systems. Most of these vessels also have various other engines such as cooling pumps and generators which couple noise into the sea through the hull, and through ocean water coupled cooling and exhaust systems.

Most of these vessels also have their own sonar systems for navigation, depth sounding and "fish finding." There are various types of sonars used. A large number of commercial devices operate in the 15 kHz to 200kHz frequency range with a few watts to a few kilowatts of power.[55] Other locating, positioning and navigational sonars operate in the mid frequency band of 1 kHz to 20 kHz,[56] and yet other long-range sonars operate in the 100 Hz to 3kHz range. [57] All of these devices operate in an acoustical power range of 150 dB-215 dB.

Some commercial fishing boats also deploy various "Acoustic Harassment Devices" (AHD's) to ward off seals and dolphins from the easy meals that the fishing boats provide, as well as aversion devices to keep dolphins, seals and turtles from running afoul of the nets. These AHD's include simple explosive devices, pingers, ringers and squeakers that annoy or harass the subject animals—or call them to dinner, by some fishermen's accounts. Explosive devices are somewhat self-explanatory—they are either charges set off in the water, or rifle propelled "blanks" to frighten individual animals. Pingers are short duration blast devices that deliver 130 dB pulses of mid frequency noise to startle, but purportedly don't harm net-predatory dolphins and seals. Ringers and squeakers are significantly louder, emitting 11 to 17 kHz noises at source levels of ~187-195dB designed to stun, and thus repel net-predatory mammals.[58] These devices are used around fishing boats, but they are also used in stationary applications around marine aquaculture.[59]

6.2 Non-Vessel Commercial and Industrial Noises

The loudest noises revealed by the SOSUS system were the sounds of marine extraction industries such as oil drilling and mineral mining. The most prevalent and remarkable of these sounds are from the seismic 'air guns' used to create, and then read seismic disturbances. These devices generate and direct huge impact noises into the ocean substrate. The tectonic reflections are read to reveal the varied densities of the sea bottom. The noise is directed into the earth, and consequently produce noises throughout the surrounding sea. The peak source levels of these explosions are typically between 250-255 dB, though horizontal transmission is more in the range of 200 dB.[60] Air gun impact noise may have repetition rates of one every few seconds and may be heard up to thousands of miles away for hours on end—from each exploration site.

After the 'exploration stage' involving air guns, the explored areas need to be exploited. Drilling, coring and dredging performed during extraction generate their own sets of loud noises. There is also a high degree of acoustic telemetry associated with positioning, locating, equipment steering and remotely operated vessel (ROV) control to support extraction operations. Acoustic transponders are well suited for these tasks; they replace vulnerable and costly wire and cable technology, and radio fre-

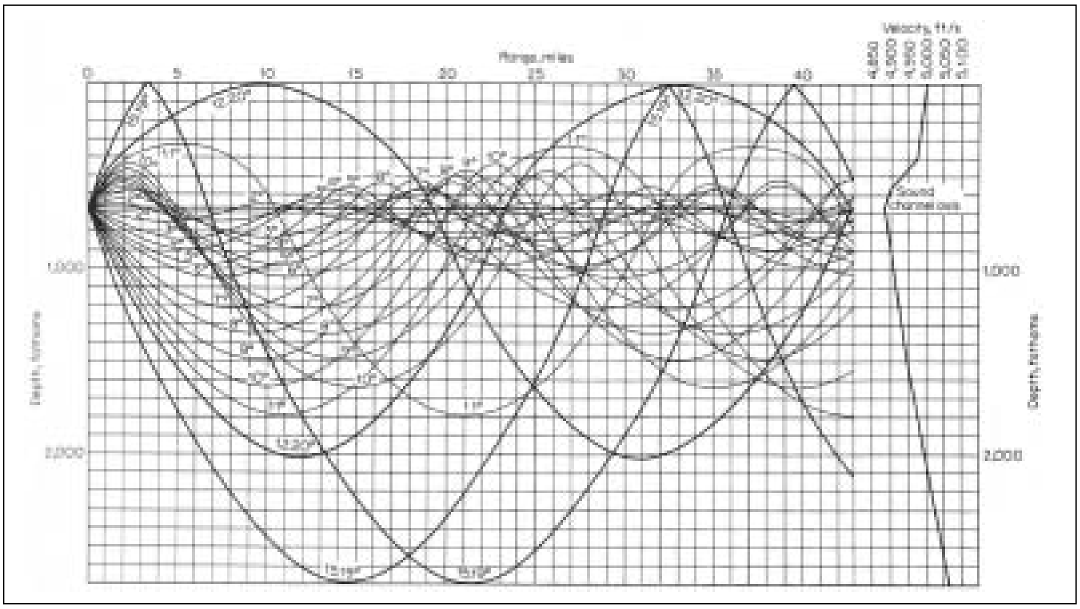


Fig.4 Sound Channel:
The sound will tend to focus around the sound channel axis. We start noticing a channel adherence as the angle approaches 10 degrees. But as the angle of incidence approaches 0 degrees, it really follows the axis.

quency transponders do not work in the ocean. Increasingly sound is used to communicate with well heads, positioners, caps, valves and other hardware. At present there has been little call to keep the noise level down, so acoustic transponder design is driven more by signal reliability and longevity than noise profile. Transponder volumes of 185-200 dB at frequencies ranging between 7kHz-250 kHz are typical, with effective communication ranges of 10 km.[61]

With the exception of the deep water shipping routes, most of this industrial and commercially generated noise happens within the boundaries of the continental shelf. This is where the accessible harvests occur. While this would account for the most noticeable impact on the marine biota, the "up side" is that the physical make-up and conditions of coastal waters provide for a distance-related attenuation rate that is somewhat faster than the spherical spreading factor of 6 dB for every doubling of distance. Factors affecting sound attenuation in littoral areas include relatively shallow waters with a dynamic thermocline, variable bottom geography and composition, and variable and dynamic surface geometry. Depending on the specific conditions, a single 185 dB mid-low frequency noise source may be masked by ambient noise within 100 km (60 miles) or so toward the sea, and perhaps much faster toward the shore. However, it would not be remarkable for this same noise to travel 500 km (300 miles). Of course hearing this single acoustic event presupposes that it is the only event within the subject radius. Increasingly these events are 'buried' in the surrounding anthropogenic noise floor before being masked by the natural ambient noise of the sea.

6.3 Research and Military Communication

Because the ocean transfers sound over long distances so effectively, many schemes have been designed to make use of this feature—from long distance communication, to mapping, to surveillance. In 1991 a group of scientists from nine nations designed a test that sent sounds 18,000 kilometers (11,000 miles) underwater through all of the oceans but the Arctic.[62] Called the Heard Island Feasibility Test (HIFT), this test confirmed that extremely loud sound could be transmitted in the deep-ocean isotherm and could be coherently received throughout the seas. The first program that HIFT spawned was a program designed to map and monitor the deep ocean water temperature. The speed of sound in water is dependent on temperature; this characteristic is used to measure the temperature of the deep water throughout the sea. The theory is that long-term trends in deep-ocean water temperature could give a reliable confirmation of global warming. This program was named Acoustic Thermography of Ocean Climates (ATOC), and after a few false starts due to environmental concerns, the program was authorized in 1996 with two Pacific transmitters, one off Monterrey Bay in California, the other off the island of Kauai. The receivers are stationed throughout the Pacific basin from the Aleutians to Australia. While the 196 dB transmission levels of ATOC are not as loud as the original HIFT program, the transmission schedule spans ten years with 20 minute long transmissions every few hours.

ATOC is a long wavelength, low frequency sound in the 1 Hz-500 Hz band. It is also the first pervasive deep-water sound channel transmission, filling an acoustical niche previously only occupied by deep sounding whales and other deep-water creatures.

Concurrent with the development of ATOC the U.S. Navy and other NATO navies have developed other low frequency communications and surveillance systems. Most notable of these is a Low Frequency Active SONAR (LFAS) on a mobile platform, or towed array. Used in conjunction with a towed array of passive sensors called Surveillance Towed Array Sensor System (SURTASS), the entire system acronym is SURTASS/LFAS.

The SURTASS / LFAS signal is comprised of two or more swept tones in the 100 Hz to 500 Hz range. Sweeping these tones across each other creates lower frequency combination tones in the 0.1 to 50 Hz range. These long wavelengths adhere well to the curvature of the globe. In conjunction with the mobile platform, the system will be capable of ensonifying 80% of the world's oceans. The specified source level of a single transducer is 215 dB—100 times more powerful than the ATOC signal. However, because the transducer is an array of 18 individual transducers rated at 215 dB, the effective source level is 240 dB. This signal is 55 dB or 320,000 times louder than the ATOC signal.

7. Impacts of Anthropogenic Noise on the Sea—Discussion

The difficulty in determining the overall impact of any human activity on the sea is that we are unable to see any immediate affect of the activity on the environment. Aversion by sea creatures, organic stress or even catastrophic damage is hidden in the depths. Our ability to observe long-term trends in fishery vitality involves seasons, years or even decades of circumstantial observations and assumptions about causes. Fishery depletion, which we often assume is caused by over-fishing, may well be caused by other factors. Chemical pollution and destruction of estuary and coastal wetland nursery habitat often figure in discussions about the collapse of once abundant fish stocks. As we learn more about the ocean environment and the creatures that live in it, we will surely find many other elements that constitute a healthy and vital living environment, and what factors compromise that vitality. In consideration of how various creatures adapt to their surroundings through sound perception presented herein, it is probable that anthropogenic noise has greater impact on the ocean environment than we have heretofore understood.

Anthropogenic noise covers the full frequency bandwidth that marine animals use (from 1 Hz-200 kHz). Anthropogenic noise also occurs throughout the ocean habitats, from coastal inlets and bays, across the continental shelf down into the deep sea, and even into the sea floor. Due to the efficiency of sound transmission in the sea, any noise travels far greater distances and containment is difficult. All human activity in the sea produces noise, and with the exponential growth in ocean resource industries and military use of the sea, that noise is increasingly pervasive.

The information that we have collected over the years on the affects of sound and noise on various marine organisms have largely focused on the more obvious short term responses of living specimens to sound stimuli. The study of marine animals in the lab is far less complicated than habitat observation inasmuch as the complexities of containment and the broad extent of marine environment interactions challenge habitat observations. Lab studies to determine the auditory sensitivity of fish typically involve observing alterations in learned behaviors; auditory studies of mollusks and crustacians involve aversion strategies or specimen health after a regimen of sound exposure. In many cases, organism acoustical interaction studies involve some measure of temporary or permanent tissue damage.

While tissue damage would be a significant factor in compromising marine organisms, other effects of anthropogenic noise are more pervasive and potentially more damaging to fisheries. Masking—the burying of biologically significant sounds in a noise floor of anthropogenic interference—would compromise all acoustical interactions, from feeding to breeding, to community bonding, to schooling synchronization and all of the more subtle communications between these behaviors. Alternately, anthropogenic sounds that falsely trigger these responses would have animals expend energy without results. Sounds within autonomic response ranges of various organisms may trigger physiological responses that are not environmentally adapted in healthful ways. And lastly, the biological stress induced by higher density acoustic stimulation may be akin to the same biological stresses induced in humans who live in increasingly cacophonous urban environments—triggering or inducing non-survival adaptive responses that damage the organism or damage the community.

Through behavioral and cognitive science, we are developing the tools to ascertain subtler effects of stimuli on organisms within their habitat; increasingly, organisms are evaluated in terms of environmental and community relationships rather than individual collections of tissues, organs and nerves with a set of adaptive behaviors. Newer behavioral models, along with the increasing accuracy of monitoring technologies will enable us to observe in-habitat animal relationships that include elements of community density and distribution trends, trends in shifting predator/prey relationships, and epidemiology. These meta-themes will give us clues into the impact of anthropogenic noise on the marine acoustic environment.

7.1 Anthropogenic Noise Mitigation

While technology is considered a driving force behind marine habitat destruction, developing technologies will also provide us with opportunities to adapt our harvest and resource extraction operations more efficiently and with more finesse. If we include the importance of ocean quietude into our design criteria, acoustic transducer systems can be designed around more sensitive receivers rather than more powerful transmitters. Digital communication technologies and system-tuned code/decode algorhythms may allow higher data densities without higher acoustic volume. Even seismic exploration can be tailored toward "smaller and more sensitive" rather than "larger and more powerful." Ocean transport noise can be reduced with anti-fouling technologies for hulls and drive systems; low or non-cavitating vortical drives[63] will replace high cavitation 'brute force' propulsion systems. Understanding more about the noise fields generated by various organisms may help fishing vessels locate fish schools with passive SONAR technologies, just as the SOSUS surveillance system allows the U.S. Navy to passively locate and identify vessels and submarines. The acoustic illumination method highlighted in this report could be developed for underwater imaging using only ambient noise.[64]

The Navy could continue development of SOSUS accuracy for vessel surveillance, and perhaps use remotely operated reconnaissance vessels for submarine communication and surveillance purposes. In this setting, the use of current SURTASS/LFAS technologies would be a strategic (and environmental) liability; a quieter sea would more clearly reveal the position of loud signal sources generated by active SONAR technologies.

Research funding in any field is directly proportional to economic benefit. Only as biologists are sounding alarms of mass extinction are studies being sponsored that focus on habitat preservation and long-term viability of our planetary biosphere. The survival of our species is dependent on the viability of the ocean fisheries. As we become more acquainted with the dependence of these fisheries on sound, we can focus our research and tailor our activities to promote a quieter marine acoustic environment.

Appendix

A.1.0 Sound behavior in the ocean

One of the most distinct differences between airborne sound and underwater sound lies in the density of each medium. Water is 3500 times denser than air, so sound travels five times faster in water than in air. Density also accounts for the ability of water to transmit sound energy over long distances better than air. The deep ocean also acts as an expansive open space; there are no trees, roads, grassy fields and houses to block and attenuate noises created within the expanse. These factors account for how sound can travel great distances underwater.

Sound is an oscillation over time that is generated by some mechanical action at a location. The energy imparted by the mechanical action moves away from the source at a particular velocity and causes two types of actions; it causes an oscillation in pressure in the surrounding environment, and it causes an oscillating movement of particles in the medium. These properties are true for sound in air as well as in water.

A.1.1 Soundwaves and Ocean Geometry

One of the characteristics of the oscillation of pressure is "wavelength"—a pressure gradient over a distance. Sound wavelengths in water or air can be measured much in the same manner that waves at the beach can be measured—in terms of the distance from crest to crest. This wavelength is dependent on the frequency. The energy of these waves moves at a predictable speed in the medium, so if the frequency of the waves increases, the distance between them gets shorter. If the arrival time increases (the frequency is lowered) the distance between the crests, or wavelength, gets longer.

The relationship between wavelength and frequency is also dependent on how fast sound moves in the medium. Sound moves at approximately 1000 feet per second in air. In water, sound moves at approximately 5000 feet per second. This means that the wavelength for a given frequency in water is five times its wavelength in air.

Sound energy moves faster in water because water is denser than air. From this we can surmise that the speed of sound is dependent on density. Sound moves faster in denser mediums (in water sound energy travels at ~ 5000 ft./sec., in steel it travels at ~16,000 ft./sec.). This is important particularly in water because there are three factors that influence the density of water: temperature, pressure and salinity. In the deep ocean—away from rivers and estuaries—salinity is relatively constant. The pressure gradient is also constant in that the pressure increases in direct proportion to depth—approximately one 'atmosphere'[65] for every 34 feet in depth.

Near the surface of the sea, wave action and solar heating cause turbulence that is weather dependant. This surface zone also exhibits seasonal and diurnal changes in temperature that affect the transmission of sound. Below this zone there is a thermal boundary that defines an "isotherm" or deep layer where the ocean temperature is relatively stable at ~4° C. The depth of this boundary varies from near the surface to 4,000 feet, depending on season and proximity to the arctic latitudes. (See Fig. 5, from Urick p. 118.) This abrupt thermal and density boundary acts as a sound reflective surface underwater. Sound generated above the isotherm will tend to bounce off of it back up toward the surface; sound generated below it will bounce down back into the deep.[66] This characteristic creates a 'channeling' effect, whereby sound generated within a layer will tend to remain in the layer, channeling over the curvature of the earth adhering to the layer it is generated in. (See Fig. 4, from Urick p. 160.)

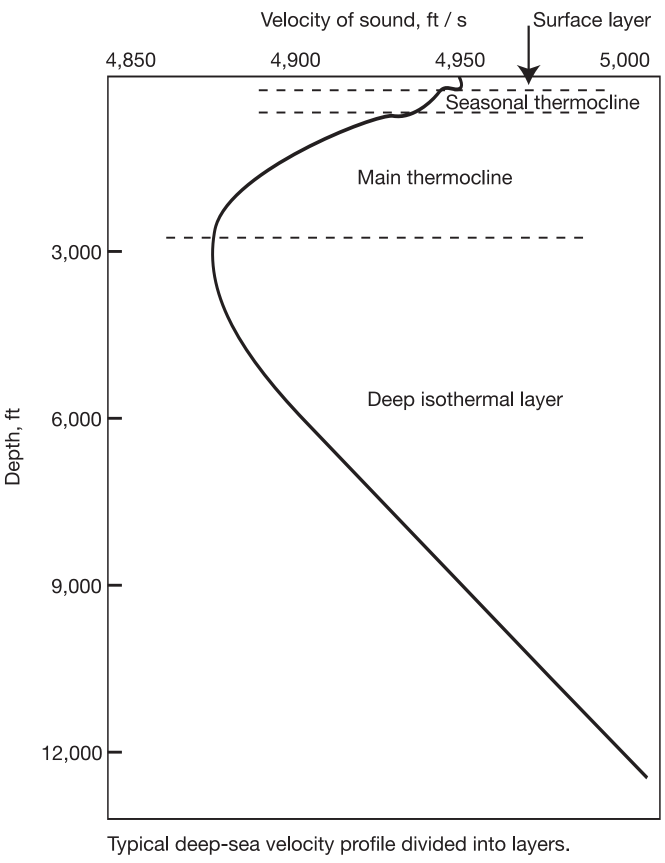
In the surface layer, sound will diffract off of the surface irregularities and diffuse through surface turbulence. This is particularly the case with shorter wavelength, higher frequency sound, where the shorter wavelengths interact with surface conditions. As a result, the channeling affect at the surface is better at lower frequencies than at higher frequencies—but in any case, subject to the vagaries of weather and turbulence.

In the isotherm, the channeling is considerably more pronounced as sound is not scattered by turbulence, and the depth is not a limiting factor on wavelength.[67] In this "sound channel," whales have been heard at distances exceeding 1500 miles, and anthropogenic noise has been transmitted over 11,000 miles in the Heard Island Feasibility Test (HIFT).[59]

Due to the long-range characteristic of sound channel transmission, it is likely that whales that produce loud sounds use it for long-distance communication. It is likely that migrating animals also use the sound channel's acoustical cues for navigation—deriving location cues by listening to the distance and sources of waves and currents interacting with ocean geography.[7]

A.1.2 Particle Motion

The second type of action imparted on the environment by acoustical energy is termed particle motion. This term is not specific to the movement of actual particles suspended in the water, but rather it is a description of the subtle movement of the water molecules back and forth, compressing and relaxing the medium along the axis of sound transmission. Their distance of travel in water is typically miniscule, and animals' organs sensitive to this type of motion are also used to sense turbulence or the close-by movement of prey or predator[68].



Typical deep-sea velocity profile divided into layers.

Fig. 5 This graph illustrates the velocity variations of sound in water due to density variations in the sea. As the ocean gets deeper, the pressure rises increasing the density, and thus the velocity. This is the case in the "deep isothermal layer." The velocity of sound in the "main thermocline" area changes dynamically due to long term climate changes and turbulence caused by global currents. The "seasonal thermocline" varies dynamically over seasons and due to deep weather generated turbulence. Finally the speed of sound in the "surface layer" varies due to diurnal temperature changes and surface turbulence.

Acknowledgements: The author would like to thank Mark J. Palmer with Earth Island Institute for his participation on this report, and Earth Island Institute for sponsoring it. He would also like to thank John Potter with the Acoustic Research Laboratory, Crescent, Singapore, for engaging in correspondence about acoustic imaging. Deep gratitude is expressed to William Wilgus, who voluntarily combed though this manuscript with a thorough editor's hand. Additional thanks are due to the many dedicated environmental advocates who continue to work for the acoustical sanctity of the sea.

Michael Stocker is an acoustical designer and bio-acoustician by trade and a naturalist and musician by avocation. He is currently writing a book titled *Hear Where We Are* (University of California Press) a popular science book that explores the affects of sound and sound perception on our sense of self, community and surroundings. The book reveals how humans and other animals use sound to establish their placement in their environment, and communicate that placement to others.
Website: www.msa-design.com

Endnotes

Abbreviations:
JASA-Journal of the Acoustical Society of America
JEB-Journal of Experimental Biology

[1] Donald P. Love and Don Proudfoot (1946)."Underwater Noise Due to Marine Life". *JASA,* Vol. 18, #2.

[2] Mark Schrope (2002). "Whale Deaths Caused by US Navy's Sonar" *Nature,* # 415, Vol. 106.

[3] Potter J.R., Delory E (1998). "Noise Sources in the Sea and the Impact for those who live there," *Acoustics and Vibration Asia,* '98, Singapore.

[4] Decibel (dB) references in this document are expressed relative to 1(Pascal per convention when referring to sound underwater.Decibels in an airborne environment are most commonly referred to relative to 20(Pascals—the apparent threshold of human hearing. The numerical difference between these two references expressed in decibels is 26dB. For this reason, citations to underwater noise and sound sources may seem quite high for those most familiar with airborne sound level expressions. For a more thorough explanation of the numerical differences between underwater and airborne sound see M. Stocker "How Loud is the Navy Noise?" Earth Island, 2002.

[5] R.J. Urick (1983). Ch. 7 "The Noise Background of the Sea." in *Principals of Underwater Sound Peninsula Publishing*, Los Altos, CA.

[6] I. Dyer (1984). "The Song of Sea Ice and other Arctic Ocean Melodies" in *Arctic Technology and Policy,* ed. I Dyer and C. Chryssostomidis. McGraw Hill.

[7] Clark, C.W. (1994)."Blue deep voices: Insights from the Navy's Whales '93 program." *Whalewatcher,* Vol.28 (1): 6-11.

[8] Hubert and Mable Frings (1977). *Animal Communication,* Univ. of Oklahoma Press.

[9] R.J. Urick, (1983). (ref. 5)

[10] S.S. Stevens, Fred Warshofsky (1965). "The Evolution of the Ear" in *Sound and Hearing,* Time-Life Science Library.

[11] Potter J.R. & Chitre, M.A. (1999). "Ambient Noise Imaging in Warm Shallow Seas; second-order moment & model-based imaging algorithms," *JASA*, Vol. 106 #6.

[12] Peter H. Rogers (1986). "What Are Fish Listening To?" *JASA,* Suppl. 1, Vol. 79.

[13] J. Engelmann, W. Hanke, J. Mogdans & H. Bleckmann (2000)."Neurobiology: Hydrodynamic Stimuli and the Fish Lateral Line,"*Nature,* 408, 51-52.

[14] Tavolga, W.N., Wodinski, J. "Auditory Capacities in Fishes. Pure Tone Thresholds in Nine Species of Marine Teleost." *Bulletin of the American Museum of Natural History*, Vol.126, 177-240 p. 133-145.

[15] Otis, L.S., Cherf, J.A., Thomas, G.J. "Conditioned Inhibition of Respiratory and Heat Rate in Goldfish."

[16] Due to the speed of sound in water, lower frequency, longer wavelength sounds require either large tanks or pressure coupled apparatus to test. The former is often not available due to real-estate constraints; the latter does not accurately reflect true habitat conditions. Testing tanks that are constructed with parallel sides and bottom are also subject to specular reflections that would influence frequency linearity at various frequencies.

[17] Alwynne Wheeler, J.W. Jones (1981). "Fishes." T*he New Larousse Encyclopedia of Animal Life,* p. 258.

[18] Edwin R. Lewis, Ellen L. Leverenz, William S. Bialek (1985). *The Vertebrate Inner Ear,* CRC Press.

[19] Ibid. p. 27.

[20] A.D. Hawkins (1981). "The Hearing Abilities of Fish" Chapter 6 in *Hearing and Sound Communication in Fishes,* ed. by William N. Tavolga, Arthur N. Popper, Richard R. Fay. Springer-Verlag.

21 Chapman, C.J., Sand, O. (1974). "Field Studies of Hearing in Two Specimens of Flatfish Pleuronectes Platessa (L.) and Limanda limanda (L.)" *Journal of Comparative Biochemistry and Physiology,* Vol.47A, p.371- 385. Provided a prosthetic "hearing aid" to a flounder and determined that its hearing would improve 10dB with a swim bladder.

[22] Wever, E.G. (1974). "The Evolution of Vertebrate Hearing" in *Handbook of Sensory Physiology,* Vol. 1, Keidel, W.D. and Neff, W.D. eds. p. 423.

[23] Olav Sand (1981). "The Lateral Line and Sound Reception" Chapter 23 in *Hearing and Sound Communication in Fishes*, ed. by William N. Tavolga, Arthur N. Popper, Richard R. Fay. Springer-Verlag.

[24] J. Engelmann, W. Hanke, J. Mogdans & H. Bleckmann (2000) "Neurobiology: Hydrodynamic stimuli and the fish lateral line," *Nature,* 408, 51-52.

[25] Olav Sand, (1981). (ref. 23).

26 W.N. Tavolga (1977). "Mechanisms for Directional Hearing in the Sea Catfish (Arius felis)," *JEB,* Vol. 67, Issue 1 97-115.

[27] B.L. Partridge, T.J. Pitcher (1980). "The Sensory Basis of Fish Schools: relative roles of lateral line and vision." *Journal of Comparative Physiology,* Vol. 135 p.315-325.

[28] P.H. Cahn (1970)."Sensory Factors in the Side-to-Side Spacing of Tuna, Euthynnus affinis," *U.S. Fisheries Bulletin,* Vol. 70(1) p.197-204.

[29] R.D. McCauley, J. Fewtrell, A.J. Duncan et. al. (2000). "Marine Seismic Surveys: Analysis and Propagation of Air Gun Signals and Effects on Humpback Whales, Sea Turtles, Fishes and Squid." Curtin University of Tech., *Center For Marine Science and Technology Publication.*

[30] Andrew H. Bass (2001). "Listening in the Dark: Behavioral and Neural Mechanisms of Acoustic Recognition in Singing Fish," *JASA,* Paper delivered to the 142nd meeting.

[31] Arthur A. Myrberg Jr. (1978). "Underwater Sound—Its Effects on the Behavior of Sharks" in *Sensory Biology of Sharks, Skates and Rays,* Edward S. Hodgson, Robert R. Matherson eds. ONR.

[32] Arthur A. Myrberg, Jr., Charles R. Gordon, and A. Peter Klimley (1978). "Rapid Withdrawal from a Sound Source by Open-Ocean Sharks," *JASA,* Vol. 64 #5.

[33] Arthur N. Popper, Xiaohong Deng, John Ramcharitar, and Dennis M. Higgs (2000). "The Enigma of Fish Ear Diversity." Paper delivered to the December 2000 Acoustical Society Meeting.

[34] Hubbard, S.J. (1960). "Hearing and the Octopus Statocysts,"*JEB,* Vol. 37.

[35] R.D. McCauley, J. Fewtrell, A.J. Duncan et. al. (2000). p 185 (ref. 25).

[36] Ibid. p 185.

[37] Dimitri M. Donskoy, Michael Ludyanskiy, David A. Wright (1996). "Effects of Sound and Ultrasound on Zebra Mussels," *JASA*,Vol. 99, #4. Paper delivered to ASA meeting.

[38] H. Frings (1964). "Problems and Prospects in Research on Marine Invertebrate Sound Production and Reception," in *Marine Bio-Acoustics,* William N. Tavolga ed.

[39] Laurence H. Field and Thomas Matheson "Chorodotonal Organs of Insects," *Advances in Insect Physiology,* 27. 1-228.

[40] Salmon, M, K Horch & GW Hyatt (1977). "Barth's Myochordotonal Organ as a Receptor for Auditory and Vibrational Stimuli in Fiddler Crabs Uca Pugilator and U. Minax." *Marine Behav. Physiol.* 4:187-194.

[41] Michael Klages and Sergey I. Muyakshin (1999). "Mechanoreception for Food Fall Detection in Deep Sea Scavengers," *JASA,* Vol. 105 #2.

[42] John R. Potter and Teong Beng Koay (2000). "Do Snapping Shrimp Chorus in Time or Cluster in Space? Temporal-spatial Studies of High-frequency Ambient Noise in Singapore Waters." *Proceedings of the Fifth European Conference on Underwater Acoustics,* ECUA 2000, Eds. P. Chevret and M.E. Zakharia, Lyon, France.

[43] Lindberg, R.G. (1955). "Growth, Populations Dynamics and Field Behavior in the Spiny Lobster Palinurus interruptus," (Randall) *Univ. Calif. Publication in Zoology*. V. 59.

EARTH ISLAND INSTITUTE
INTERNATIONAL MARINE MAMMAL PROJECT

Recommendations

1. Research:
Clearly, expanded research on the environmental effects of anthropogenic sound on marine species and the marine environment is needed to answer the many questions raised in this report. More research on the use of sound by marine species to feed, find mates, communicate, and migrate can set the frame for evaluating the potential adverse effects of anthropogenic noise.

2. Determine Levels of Sound Impacts and Set Limits:
Many kinds of human activities cause sound pollution in marine environments, including military activities (underwater explosives, active sonars, and vessel traffic), oil exploration and drilling activities, seabed mining, seabed construction, and general ship traffic. These sources of sound need to be evaluated for potential impacts on marine life. Limits on anthropogenic sound in marine habitats to preserve marine life should be set based on available science, at conservative levels. Sound pollution can be reduced substantially from human causes, but the political will to act is needed, combined with a strong enforcement regime, all based on adequate scientific research to justify sound limits.

3. Establish Interim Sound Levels for Marine Habitats:
Ongoing studies will take time to establish anthropogenic sound levels in marine environments that do not pose a threat to the welfare of marine life. As an interim measure, utilizing the Precautionary Principle, conservative sound level limits should be put into place, based on existing research, to protect against sound pollution pending further results.

4. Emphasis for Marine Habitat Protection:
Primary emphasis for limiting noise in the marine environment should go to protect endangered and threatened species. A secondary emphasis should go to protect depleted species, to reduce stress and allow recovery in marine species depleted by overfishing, water pollution, and other human-caused effects.

5. Need for International Protocol: An international instrument is needed to address the global reach of noise pollution, either using existing ocean pollution and management regimes, or developing a new one.

[44] Hubert and Mable Frings (1977). *Animal Communication,* Univ. of Oklahoma Press.

[45] Salmon, M. and J.F. Stout (1962). "Sexual Discrimination and Sound Production in Uca pugilator," *Zoologica,* V. 47, 15-20.

[46] S.S. Stevens, Fred Warshofsky (1965). "The Evolution of the Ear" in *Sound and Hearing,* Time-Life Science Library.

[47] Pumfrey, R.L. (1950). "Hearing" in *Physiological Mechanisms in Animal Behavior,* 1950 Symposium of the Society of Experimental Biology, Vol. IV Academic Press, N.Y.

[48] Frings, H. and M. Frings (1967). "Underwater Sound Fields and Behavior of Marine Invertebrates." in *Marine Bio-Acoustics.* Tavolga W.N. ed., Oxford, UK, Pergammon Press.

[49] I'm not naming names here, but this study used glass pipettes to stimulate sea anemones with water pressure. In this paper, the researcher indicated that they could insert the pipette into the mouth of the anemone and inflate it until it burst. The comment on this observation was that the creature did not show subtle response to being killed thus, so it probably needed robust stimulus to induce response.

[50] "IUSS/ISR Program History" (2000). *U.S. Navy website:* http://c4iweb.spawar.navy.mil/pd18/pd18hist.htm

[51] Anonymous (1998). "Using Cold-War Technology to Study Distribution and Behavior of Large Whales Research Utilizing the Integrated Undersea Surveillance System (IUSS)" from the Whale Research Program at the Cornell Lab of Ornithology.

[52] R.J. Urick (1983). Ch. 7 "The Noise Background of the Sea." in *Principals of Underwater Sound,* Peninsula Publishing, Los Altos, CA.

[53] Lloyd's Register of Shipping World Fleet Statistics.

[54] Kenneth Chang, "Researchers Study Beluga Whales' Responses to Shipping Noise in Canadian Rivers" quoting Peter Scheifele, researcher, National Undersea Research Center at the University of Connecticut in St. Lawrence Seaway peak noise levels.

[55] From Faruno company data sheets for commercial and industrial depth sounders and fish finders.

[56] From Benthos company datasheets for industrial transponders, positioning and locating devices.

[57] Department of the Navy (2001). "Final Environmental Impact Statement for SYRTASS/LFA Sonar".

[58] R.Reeves, R. Hofman,G.Silber, D.Wilkinsen (1996). "Acoustic Deterrence of Harmful Marine Mammal-Fishery Interactions" Workshop Proceedings. NOAA, NMFS.

[59] George Iwama, Linda Nichol and John Ford (1998). "Aquatic Mammals and Other Species: Discussion Paper," *Salmon Aquaculture Review.*

[60] Arill Engås, Svein Løkkeborg, Egil Ona, and Aud Vold Soldal (1996). "Effects of Seismic Shooting on Local Abundance and Catch Rates of Cod and Haddock,"*Canadian J. of Fishing and Aquatic Science,* Vol.53.

[61] From Benthos company datasheets for industrial transponders, positioning and locating devices.

[62] Victoria Kaharl (1999). "Sounding Out the Ocean's Secrets," for the National Academy of Science Beyond Discovery program.

[63] Australian Maritime College (2001). "Open Water Testing for PAX Fluid Systems" Performance report from a low cavitation propeller in the Tom Fink Cavitation Tunnel. Non published.

[64] C.L. Epifanio, J.R. Potter, G.B. Deane, M.L. Readhead and M.J. Buckingham (1999). "Imaging in the Ocean with Ambient Noise: the ORB experiments,"*JASA,* Vol. 106 #6.

[65] An atmosphere is approximately 14.7 lbs./in.2.

[66] See the `Critical Angle' of Snell's Law, wherein the refraction of sound in a layered medium is described in terms of the transmission velocity in each descrete layer. The dimension of a layer is a limiting factor on the transmission wavelength of the sound in that layer. If the wavelength of the sound at the intersection angle is greater than the thickness of the layer, the sound will reflect back into the layer. Due to the typical dimensions of ocean thermal layers, lower frequencies will tend to remain in the deep — and thicker — isotherm layer creating the 'sound channel' effect.

[67] For a more thorough treatment of underwater sound transmission, see R.J. Urick, *Principals of Underwater Sound,* Peninsula Publishing, Los Altos, CA 1983.

[68] Peter H. Rogers, Thomas N. Lewis and Michael D. Gray (1995). "Startle Reflex in Fish," *JASA,* Vol. 98 #5.

Antarctica: Austral Soundscapes

Sonic adventures in the realms of white at the bottom of the world

by Douglas Quin

Greatness of dimension is a powerful cause of the sublime.
— Edmund Burke

A Gathering of Senses/A Question of Scale

Collecting impressions about a destination is an exciting part of planning for a trip. Visceral stirrings and the anticipation of travel are fueled by images, both graphic and literary. Maps have always appealed to me as a way of grasping or conceiving in the mind's eye: a means by which I might construct a notion about space and place. However abstract and limited, pulling out a map communicates a stage upon which I project many scenarios and eventualities. In this sense, consulting the atlas is a ritual beginning of sorts—the first steps taken in an imaginary landscape. Comprehending Antarctica was another matter ...

It was several years ago, on a sweltering summer afternoon, that I remember poring over an atlas of the world, drafting plans for a sound-recording expedition to *Terra Australis Incognita.* This voyage would be the complement to several months spent in Alaska gathering sound for a new composition, *Australis/Borealis: Sounding Through Light.* Outside my apartment window, the sky flashed and cracked. I thumbed through the maps and turned to a Mercator projection of the largely unknown southern land we call Antarctica. It was hard to get a sense of the continent's extent and shape and I could not easily summon a mental icon—the way I could for Africa or North America, for example. The coastline meandered along the bottom of the map, describing an apparently vast region of the planet. The Antarctic Peninsula reached for Tierra del Fuego, swept into the Westerlies and Roaring Forties; ocean currents pulled archipelagos to South Africa. The plateau interior and the Transantarctic Mountains faded to white at the edges of the pages and thin blue lines traced the suggestion of glaciers and ice shelves.

In other sections of the atlas, different images were used to convey information about diverse planetary resources including food, energy, and minerals. Each topic was presented with overarching authority, in a myriad of projections with both the Arctic and the Antarctic subject to various permutations. Goode's Interrupted Homolographic projection parcelled polar regions between projecting lobes. A series of *Eckert Equal-Area* images attenuated the earth into a neat oval track; Antarctica appeared as a smear on the inside lane of the home stretch. The physical map of the world was presented as a van der Grinten projection. Here, pinched poles gave Antarctica the appearance of a cumulonimbus cloud. My mind wandered and I conjured Pangaea and Gondwanaland, yet other projections. I saw fossil-rich forests churning for an eternity: a haphazard metamorphosis folded into geologic strata of deep time and distant space. Some pieces of this puzzle lay beneath more than several kilometres of ice at the Antarctic. Near the back of the atlas an *Azimuthal Equidistant* composite, based on satellite images, gave me a compelling illusion. Antarctica was at the centre of the pages. Absent detail, the white of the interior was filled with facts and superlatives: the coldest, the highest, the driest, the windiest. Nearly two years later, while I was in Antarctica, I learned about an ice shelf calving. The news media reported that a piece of ice, roughly the size of the state of Rhode Island, had fallen into the sea. I thought of the atlas map and a neat, rectangular slice being removed by cartographers. What was Rhode Island, USA, with the left-over bits of Narragansett Bay carefully reconsidered as neat azure contours? When it came to scale, it was hard to place myself: a figure in the landscape, a listening voice in the soundscape.

Knowing space and developing that faculty of understanding called "spatial intelligence" is an obtuse proposition. The term refers to educator Howard Gardner's classification, described in his theory of multiple intelligences. He contends that there is not a single seat of intelligence, but rather frameworks of knowing including verbal/linguistic, logical/mathematical, interpersonal, intrapersonal, musical, bodily/kinesthetic, and spatial. Perceiving and comprehending space has its own discrete regions of cerebral processing in the human brain and, as such, represents an aspect of our intellectual capacity. Traditionally, our sense of space and the articulation of spatial relationships have been more closely associated with visual experience rather than aural—linked to tangible expression in architecture, sculpture, painting, and the graphic arts. It is, however, through both seeing and hearing that we come to know space and, through kinesthetic engagement, give it meaning.

R. Murray Schafer once commented, “We are always at the edge of visual space, looking in with the eye. But we are always at the centre of auditory space, listening out with the ear.” The statement is revealing. The language of edges, an external point of view, and being drawn into space suggest a pictorial construction—a reflection of the power of images to provide us with a lexicon for interpretation. Furthermore, we tend to look “at” the visual world. In the Oxford English Dictionary (OED) the word is taken to mean, “The most general determination of simple localization in space, expressing, strictly, the simple relation of a thing to a point of space which it touches.” But when we wish to convey a heightened state of awareness, we often look “out,” in the OED definition of “expressing motion or direction from within a space.” Looking in, looking at, and looking out, listening in, listening to and listening out—this dynamic of sensory interaction gives us space. One of the most enduring sensations from Antarctica is how overwhelming and challenging it was to arrive at this knowledge, or spatial reckoning. For very little was scalable in the visual, acoustic, or temporal terms I knew.

Antarctica is vast in every sense. The effects of light on snow and ice have a way of attenuating space, and distances seem elastic. Mirages and scattering light can make the terminus of a glacier appear far taller and closer than in reality; mountain ranges apparently float on the horizon; flat light, a continuum of ice and sky, can intimate infinity.

If a visual imagining of Antarctica was hard to evoke, the soundscape in the mind’s ear was even more remote. I read about the vocal behaviour of many of the species I was likely to encounter—seals, whales, penguins and other avifauna. I had also heard about atmospheric whistlers, Very Low-Frequency (VLF) phenomena. Prior to my journey, however, the only Antarctic sounds I had actually heard, were from nature programs on television. These seemed disembodied—soundbites and segues between narration. My expectations where “myaural,” to say the least. I use the term as an aural analogy to myopia, or near-sightedness-of near-hearing or limited perceptual acuity with regard to hearing.

Sonically, an extraordinary silence embraces much of Antarctica. In this regard, my most profound listening was inward. Sitting on a scree slope in the Taylor Valley, on a windless afternoon, the only sound I heard was that of my pulse, a dull thud and swish against the hood of my parka. By contrast, concentrations of life at the continent’s edge resound with remarkably varied voices. Under the sea-ice shelf of McMurdo Sound, in waters of minus one degree Celsius, Weddell seals can be heard at a distance of thirty kilometres. At Cape Bird on Ross Island, the murmurous stirrings of 160,000 Adelié penguins on a shoreline rookery is a unique soundscape. Antarctica is one of the most arid places on earth, and sound propagates uniquely in freezing dry air. Even surface sounds seemed brittle, imbued with a clarity and crisp resonance that would often belie the distance and location of the source.

I had some experience against which to measure my relationship to my surroundings “on the ice”: recording in Alaska and childhood memories of Quebec, Lapland, Iceland, and the Sahara. Antarctica was different. The following are accounts of listening and recording at several locations in and around McMurdo Sound in the Ross Sea—a series of journal entries from the time, plus subsequent reflections.

Life in the Fast Ice

Big Razorback Island is one of the Dellbridge Islands, a desolate archipelago of igneous rock, bound fast in the vernal sea ice of McMurdo Sound. The island is about one kilometre long, black and narrow—a serrated silhouette against the sky. Variable snow cover, a constantly shifting network of tidal cracks, and the upheaval of associated pressure ridges give the island a different appearance daily and sometimes even hourly. The fast ice of Big Razorback provides refuge for a breeding concentration of Weddell seals (*Leptonychotes weddelli*). Here they are safe from predators like orcas (*Orcinus orca*) who patrol the open water of the Ross Sea. James Weddell’s first encounter with these creatures in 1820 lead him to speculate that he was hearing mermaids, “making a musical noise.”

I had planned the timing of my field recording to coincide with the Weddell seal mating season and joined Don Siniff, of the University of Minnesota, and his team at their camp. They were continuing nearly three decades of research into population dynamics and Weddell seal ecology. Much of my work at Big Razorback took place at the onset of rutting, in November and early December—following pupping. This is apparently a peak time of vocal activity, particularly among males. Dominant male Weddells spend very little time on the ice surface. They devote a lot of attention to patrolling underwater territories, or maritories as they are called—a space twenty metres in diameter, centred around a breathing-hole in the ice. Competition for females and maritorial defense take a toll. On more than one occasion, I saw less successful males retreat to the surface. Their chests were marred by bites and they left a bloody trail in the ice from wounded flippers. For the most part, however, the drama of mating behaviour is more often heard than seen.

Antarctic Journal, November 6, 1996

Big Razorback Island (77o 18’ S 166o 50’ E)

It was a relief to see the horizon again after several days of whiteness; Black Island and Mt. Discovery measured the distance across the McMurdo Sound. Over the last several days, several inches of powdery snow had fallen. We moved on snowmachines past the Erebus ice tongue, whose blues were iridescent. The wind picked up. In the distance, Tent Island seemed to hover over the sea ice; the wind blew snow in a dense sweep about twenty metres high. Occasional eddies would rise like dust devils and disappear. The surface held reticulated patterns and myriad finely tapered drifts, some no more than a centimetre wide and a few centimetres long. These indicated the prevailing wind direction—howling off Mt. Erebus and into the sound. Snow snakes meandered along the ice. The horizon features became obscured and we crawled along, keeping one track flag after another in sight. Above, the sky was a pale blue. In front of us everything was white.

We arrived at camp and off-loaded gear from the Spryte, our tracked vehicle. The sky cleared. I surveyed the tidal cracks off Big Razorback and looked at groups of seals; two gatherings of mothers and pups were concentrated at either end of the island. Many had been at the surface for a while, for the snow formed a thick crust on their fur. The pups were a honey-coloured brown, their lanugo not yet shed. The surrounding snow was stained with blood and urine as skuas strained at placentas, half-buried in the ice. Their gull-like calls and the pleading of the pups pealed and reverberated off the face of Big Razorback. The island arcs slightly to yield a shallow parabolic curve. Standing at the mid-point, promontories at either end rise in peripheral vision to compress the composition. Sounds scattered and focused in the leeward shelter. In a curious collusion between *trompe l’oeuil* and *trompe l’oreille*, I could discern details in distant reflected sound, while calls closer to my ear dissipated instantly in the frozen air. Scree loosened, fell, and skated across the ice like breaking crystal. I wanted to situate myself so that I could enjoy this space. I set up my hydrophones for recording in a parallel relationship to the tidal cracks. In this way, I could listen at the surface and below to the passing parade of Weddells. In testing the ice, I could hear powerful and eerie sounds from under more than two metres of sea ice. Percussive chugs of posturing males played on the soles of my feet. Some Weddell vocalisations have been measured at nearly 200 decibels!

With help from the "sealheads," members of the research team, I dug down to the sea ice through about fifty centimetres of snow and cleared the surface for pitching my Scott polar tent. We then paced out three sites, about fifty metres apart, and proceeded to drill a series of thirty-centimetre holes in the ice for lowering my hydrophones: one of which would be located in my tent. This first hole was drilled slightly below sea level and, when we broke through at about two metres, it gushed and flooded my floor. As the sea water froze it helped level the array of cracks that had developed over the winter; it was nice to have an even floor. The sun slanted over the sound, and it was time for a break. After dinner, as my colleagues turned in for the night, I returned to my tent, set up a pair of hydrophones to a depth of twenty metres, and listened ...

The ocean seemed to be an infinite realm of otherworldly soundings—all the voices of one species, the Weddell seal. In the course of classifying more than thirty calls in these vociferous creatures, Jeanette Thomas and Valerian Kuechle described and named a compendium of terms employed by various researchers. Colourful and evocative in their aural suggestion, these include trill, guttural thump, chirp, chi-chi-chi, chirrup, eeyoo, chug, what-chunk, chnk-chnk, too-loo, rr-whmp, jaw-snap, jaw-claps, chink, pulses, click, teeth chatter, guttural glug, cricket call, knock, seitz, growl, and mew. The most compelling calls were long, thin glissandi of complex tones. They whispered like radio frequencies at night, sounding one over another, in a lulling chorus that seemed to come from all over McMurdo Sound. It was hard to know from how far away the sounds were coming. Through my headphones, I discerned creakings and the occasional ping of tension being released as the ice settled at ebb tide. Tidal action was also heard as a crackling and tinkling: water pulling at a veneer of newly formed crystals on the underside of the ice. I lay in my tent, recording until 3:00 am, earwitness to an amazing-sounding world. It was hard to sleep, and I was up in a few hours to record again.

Emperor Penguins

Without a doubt, emperor penguins (*Aptenodytes forsteri*) are among the most extraordinary creatures on the planet-uniquely adapted to living in extremes. They lay their eggs on newly formed sea ice in the darkest and coldest months of the austral winter, and have been known to dive to depths of over 300 metres in search of food. Penguins are a charismatic species and seem to touch our own deepest biophylic impulses (the term "biophylia" was coined by Edward O. Wilson, to signify "the innate tendency to focus on life and lifelike processes"). Their gregarious nature, social cohesiveness and apparent curiosity are a reassuring reflection of our own humanity. And there is something about the upright posture and the clear delineation of plumage that communicates both dignity and comedy. Almost without exception, every penguin researcher I encountered smiled as they described their work. I was looking forward to my first encounter. Emperor penguin voices are an example of acoustic dimorphism, in that males and females have different calls. In fact, it is hard to tell the sexes apart at a glance, but for

Seal pup in the chilly arctic waters

their sound. These had been variously described to me as overblown saxophone mouthpieces or, in chorus, as a detuned brass ensemble. I was intrigued, but wondered how I might get close enough to record them. I soon discovered that this was not a concern at all.

Antarctic Journal, November 19, 1996

Sea Ice Edge (77o 37' S 165o 48' E)

I woke up early, with excitement at the prospect of a trip to the sea-ice edge. The night before, I had seen a darkening sky over Minna Bluff between Black and White Islands, in an area known as Herbie Alley—for the "herbies," or storms, that pass this way. To my surprise, it was partly cloudy. The wind, however, had changed and was blowing offshore, down over McMurdo from the hills and the continent. This was not an encouraging situation, either for ice-edge work or for recording. Weather here is localized, and one often may encounter fair or worsening conditions in traveling. I talked to my colleague and safety instructor, Buck Tilley, and we decided it would be a "go."

Quite suddenly, the wind died down completely. We decided not to waste any time, and rode out to yesterday's site—in hopes that the emperor penguins were still there. Our route had been obscured to some extent by the wind covering the tracks of the previous day with snow, but enough remained that we found the spot again, no problem. In usual fashion, our arrival was heralded by the penguins, who filed over in a single line to greet us. They formed a semi-circle around our snow-machines and watched us unpack. With the wind abated, and no guarantee that it would stay nice, I hastily set to placing the microphones near their diving hole. This enabled me to listen to the birds' diving activity: the splashing, the entrances and exits from the water, and the calling that comes as part of the ceremony and ritual of their busy lives.

As I settled in, I ran out six metres of cable, and sat down with my recording gear. Gradually, the penguins came out of the water and waddled over to me. They examined the furry microphone windscreen and pecked at it, walked around the entire rig, looking carefully at everything. The cables lying in the snow were also a source of intrigue and they followed the lines out to the recorder, stooping to inspect and nudging with their beaks. The linear aspect held a special attraction for them: they lined up on one side and stepped over to the other side in a haphazard version of line- or reel dancing—another variation on a loosely choreographed gesture which accompanies much of their social interaction. Eventually, I was completely surrounded by a throng of curious heads and shiny, round white bellies. As more emperors gathered, the circle tightened and they ventured very close—to within thirty centimetres. I realized that, from my

Photos: Douglas Quin

Majestic emperor penguins pose for the camera.

seated position, they were as tall or taller than me. I looked down at their feet, black and scaled with three pronounced toes, toenails, and one seemingly vestigial thumb or dew-claw on the topside—curiously reptilian. One rather bold penguin made an exploratory peck at my jacket, as if to say, "What are you?" I was nervous about being pecked at—images from an Alfred Hitchcock movie came to mind—so I sat up and rolled my head, as I had seen them do. They all shuffled in ranks and adjusted their positions; nobody backed off but neither was another peck forthcoming, and I did not try to touch one of them—a comfortable boundary seemed to have been acknowledged. The next point of interest was the blue and pink freezer-bag in which I keep my tape-recorder and batterie. Several birds sauntered up and peered inside—no beak probing, just a quick scan and a look around. All throughout this coming together, one bird had sidled up to me and just stared. I deferred, occasionally making eye contact for nearly an hour; I had a companion. Meanwhile, a pair of birds stood belly to belly, off to my right. From time to time they drew themselves up to attention, shrugged their shoulders, lowered their heads and let loose with wonderful, ratcheting trumpet sounds. In time, most of the flock casually ambled back to the water—except for my companion, who lingered with a glistening gaze.

In all my years of field work, I have rarely come across a species so overtly curious and apparently fearless. Unlike the Arctic, there are no land predators here, and penguins have no reason to avoid people. As humans, we generally relate to animals as pets, as quarry, as food, or as subjects of observation in captivity—either in a zoo or "captured" on film or video. These perspectives usually involve notions of dominance, fear, and above all, distance, both physical and psychological. I had never been in this position before with such a large group of feral individuals, and the feelings I had were new to me. It was a powerful encounter, filled with subtle nuances, mutual probing, and shared wonder, quite unlike anything I have know—or will know, I suspect.

McMurdo Dry Valleys

The opportunity to travel inland came in late November. I made arrangements to join the Long-Term Ecological Research (LTER) group at Lake Hoare. The McMurdo Dry Valleys lie some 100 kilometres across McMurdo Sound from the US base. Unique in a unique place, the valleys are among the most harshly arid deserts on earth—drier and colder than most places we could imagine. The region is also the largest area relatively free of ice on the continent—some 4,800 square kilometres. There is life in the valleys, where micro-invertebrates, microbial communities, mosses, and lichens have adapted to conditions in this environment. During the austral summer under a piercing sun, glaciers yield meltwaters: streams come to life, permanently ice-covered lakes are replenished from beneath, and a vital nutrient cycle plays out. To our ears, the microworld is far away. It was the sounds of ice that I was curious about. I wanted to know the intimate resonances of glacial movement.

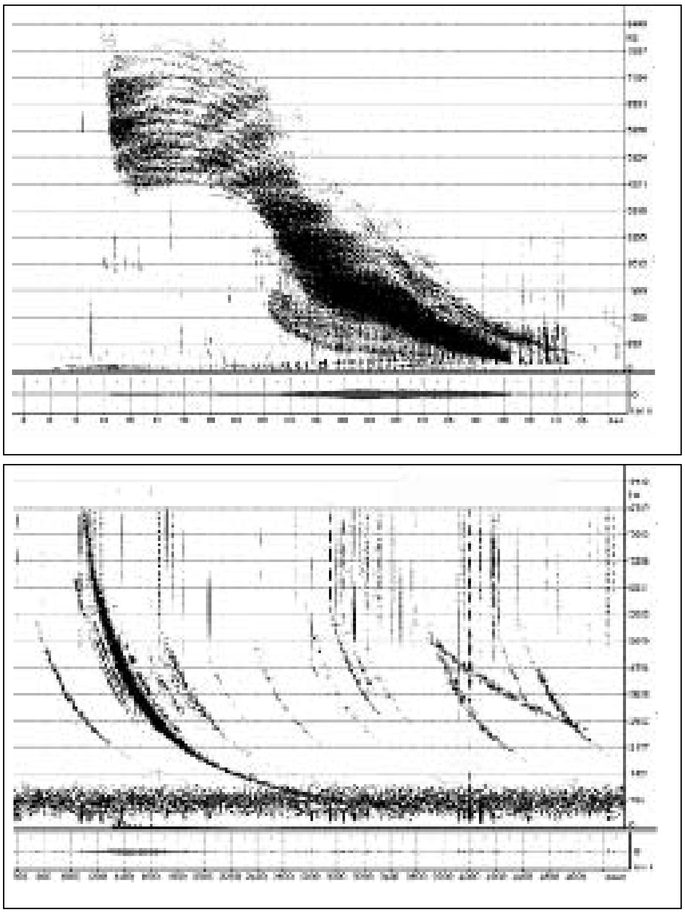
Antarctic Journal, November 29, 1996

Canada Glacier, Lake Hoare (77o 37' S 162o 54' E)

The tent had warmed considerably with the energy of the sun, which now cast long shadows across the face of the Canada Glacier. It was 2:30 am and I had been scarcely asleep for more than a few hours when a loud, resounding boom startled me. The glacier was cooling off in the shade, and refreezing channels of water heaved within the ice. It was time to get up and record some more—these were different sounds than I had experienced earlier! I quickly assembled my hydrophone rig and put on my crampons, scampering up the apron of the glacier to see if the hole I had bored eight hours ago was still viable. Sure enough, a two-centimetre ice-skin had formed over the opening. This was easy to hack through with an ice-ax, and I was in business—just topped off a little water and lowered the hydrophone in. For the next four hours I was treated to an extraordinary percussion performance, as expanding and freezing ice creaked and fractured within.

Of Whistlers and Weddells

In the mounting humidity and heat of an approaching summer convection storm, a bolt of lightning splits the sky over the eastern United States. The strike is heard a few seconds later in an associated crash of thunder. Electromagnetic energy from the lightning also propagates through the upper atmosphere and beyond, at the speed of light, so that, in less time than it takes for that thunder to be heard, the breath of a whistler can be picked up through a receiver at Palmer Station on the Antarctic Peninsula. Don Carpenter, professor emeritus at Stanford University's STAR Laboratory, described the phenomenon to me. Waves of energy from the lightning move through layers in the magnetosphere, measured in distances of earth's radii. They follow lines of force associated with the magnetic field around the planet. These lines of force extend in latitude away from the earth, rounding polar cusps to return along the earth's axis at the poles. Wave energy is channeled in so-called "ducts," to concentrate as atmospheric whistlers in the Arctic and Antarctic. Depending on the distance the waves travel, the media through which they pass (including dense regions of enhanced ionization), as well as the degree of electron precipitation they induce, whistlers will have various pitch, duration, and decay characteristics



Spectrographs: "Atmospheric Whistlers"

when they are heard as sound. I think of the process as a sort of granular synthesis on a cosmic level. Carpenter also described other related acoustic events as "hisses," for their broadband noise components, and "dawn choruses," for their indeterminately pitched material, reminiscent of birdsong.

One curious aspect of whistlers is the way in which they sound like certain vocalizations of the Weddell seal. The relationship is what I describe as "acoustifractal"—referring to scalable sound and morphological similarity in a soundscape. It is interesting to compare several features of a Weddell seal long-duration call, known as a T-call, and an atmospheric whistler. Both sounds have a clearly descending glissando, often with discrete components. The mean maximum fundamental frequency range for the long duration calls in the seals lies between 0.9 and 12.8 kilohertz. In audio playback, whistler sounds have a characteristic signature of a descending glissando occupying variable frequency ranges between one kilohertz to ten kilohertz. They may last as long as four seconds. On the other hand, Weddell T-calls can last for forty seconds. Another shared temporal quality involves overlapping events, creating a sonic continuo. Lightning-strikes occur all around the equator and associated temperate zones, producing a layering of whistlers with varying density. I never heard a lone Weddell seal calling. My experience was one of a collective voice defining the soundscape. I was struck by the haunting sounds of both seals and whistlers and their uncanny similarity. Why are these sounds alike? Is there a reason? Can seals "hear" or sense whistlers in ways that we do not yet understand? I asked myself these questions, knowing that it may be folly to infer a direct correlation. Little is known about hearing capabilities in Weddell seals. Most Weddell vocalizations occur below twenty kilohertz and leopard seals (*Hydrurga leptonyx*) have been known to emit calls as high as 164 kilohertz. Furthermore, I had the opportunity to listen to recordings of the bearded seal (*Erignathus barbatus*), an Arctic counterpart to the Weddell. These two species share, more than other pinnipeds whose sounds I have heard, an especially rich vocal range, and aspects of their calls are not dissimilar. Weddell and bearded seals live in regions where whistlers are a common phenomenon. At this point, I can only wonder. To describe patterns and similarities is a beginning.

We often "draw" a conclusion in writing—a visual analogy and an enactment of circumscription and closure. The acoustic ecology of this remote world lies at the edge of human experience and its complexities are still only dimly perceived. I left Antarctica with an open ear, humbled by knowing spaces and voices I could scarcely have imagined.

... to the degree that we come to understand other organisms, we will place greater value on them, and on ourselves.
—Edward O. Wilson

Douglas Quin, Ph.D., is a world-renowned sound designer, naturalist, public radio commentator, and music composer. He has journeyed widely in search of the natural soundscape—from Antarctic ice to Arctic tundra and from African savannahs to Amazon rainforest. Quin's extraordinary recordings of wildlife and disappearing habitats represent one of the most unique and extensive collections anywhere. His recent work includes designing the exhibit: *Without Sanctuary: Lynching Photography in America* and he is currently the Executive Director of the North Carolina Humanities Council.

This article was first printed in Musicworks, Number 69, December 1997.

References

Carpenter, D. L., "Lightning Whistlers Reveal the Plasmapause, an Unexpected Boundary in Space," in *History of Geophysics*, Vol. 7, No. 47, 1997.

Helliwell, R. A. "Whistler Waves and the Magnetosphere," in *The Stanford Engineer*, October, 1982, 3-11.

Schafer, R. Murray. 1994. *The Soundscape*. Rochester: Destiny Books.

————. n. d. "I have never seen a sound," in *Sounds Unseen: An Exhibition of Musical Manuscripts and Sound Sculpture* (exhibition catalogue). Presentation House, North Vancouver, B.C. and Gallery Stratford, Ontario.

Thomas, J. A., and C. L. Golladay. 1995. "Geographic Variation in Leopard Seal (Hydrurga leptonyx) Underwater Vocalizations," in *Sensory Systems of Aquatic Mammals,* The Netherlands (Eds. Kastelein, R.A., Thomas, J.A. and Nachtigall, P.E.), 201-221. Woerden: De Spil Publishers.Thomas, J. A., L. M. Ferm, and V. B. Kuechle. "Silence as an Anti-predation Strategy by Weddell Seals," in *Antarctic Journal*1987, 232- 234.

Thomas, J. A., and V. B. Kuechle. "Quantitative Analysis of Weddell Seal (Leptonychotes weddelli) Underwater Vocalizations at McMurdo Sound, Antarctica," in *Journal of the Acoustical Society of America* 72(6), 1982, 1730-1738.

Wilson, E. O. 1984. *Biophylia*. Cambridge: Harvard University Press.

Acknowledgements

Douglas Quin's work in the Antarctic was supported, in part, by the National Science Foundation and the National Endowment for the Arts. Atmospheric whistler recordings [refer to Musicworks CD 68] from Palmer Station, Antarctica were provided courtesy of the STAR Laboratory at Stanford University.

Listening Underwater

by Lisa Walker

Within the earth's environments of air and water we have two radically different media for the propagation of sound. Entering the underwater environment we find ourselves in a three-dimensional space where the need to breathe becomes regulated and the buoyancy of water acts against the pull of gravity. The creatures that live in the water have responded to these pressures, developing an array of perceptual and physiological adaptations. This brings us into a world that both mirrors our understanding of sound and challenges us to investigate new definitions and relationships.

I was introduced to this underwater world in 1996 when I was invited to join a research team in southeast Alaska studying the acoustic ecology of the Humpback Whale. It was thought that with my background as a classically trained musician, I might be able to identify subtle patterns in the acoustic activity of the whales that were not readably evident to the scientist.

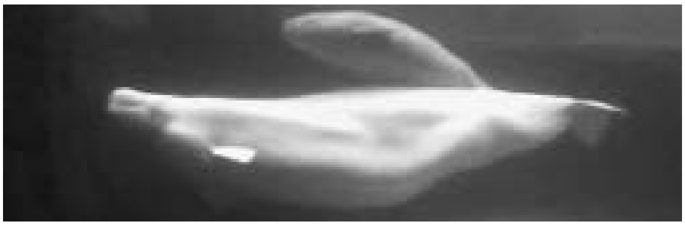
Classified as Cetaceans—or marine mammals—Humpbacks are warm-blooded, give birth to live young ones, use lungs to breathe air, retain similar sensory organs to ours—eyes, ears, nose (blowhole)—and are thought to be descendants of land mammals similar to present day cows.

Humpbacks have two main types of vocalizations, the first of which is the Winter Song—a resonating chorus of deep groans, staccato bursts and high whistles that fills the waters of the Humpbacks' tropical breeding grounds with constant sound. Sung exclusively by the males, the Winter Song is thought to either attract females by the qualities of a particular singer's sound or to warn off competing males. Each year small changes are introduced in the song's 25-minute composition, which are then incorporated into the following year's refrain.

When the humpback's winter vocalizations were first discovered by researchers, Drs. Katy and Roger Payne, they noted a strong semblance between the phrases, rhythms and patterns within the underwater vocalizations and those found in poetry. While many theories abound about the song's purpose, scientists such as Jim Darling are investigating how the execution of the song's components, such as rhythmic accuracy, control over pitch, or the capacity to memorize patterns of great length, may act as a type of 'sonic antlers'—displaying information about the singer's fitness, or desirability, as a mate.

Figure 1 (see page 36) is a sonogram of a small portion of the winter song, recorded in Hawaii in 1999. It shows the rhythmic and patterned nature of the song with the two vertical bars being the 'beats' or low frequency groans and the two horizontal bands the higher frequency 'hoots'.

The second type of vocalization is less well known and is classified as a "call" rather than a "song". The Feeding Call is characteristically short, swooping up and down in elegant phrases with trumpet-like timbre. Lasting anywhere from one to three minutes, these calls are a rare event and are heard only in the feeding grounds of southeast Alaska when the Humpbacks engage in a behaviour known as lunge feeding: it consists of a group of Humpbacks acting in cooperation to encircle a group of herring in an under-



Photos: Lisa Walker

water bubble net. The whales then blast the prey with sound before lunging upwards through the herring ball to the surface, mouths wide open to swallow as much prey as possible.

Feeding calls are always variations on a theme. Octaves change and parts rearrange, yet particular elements lend them a consistency—or as scientists would call it—a signature or voiceprint. Certain whales have been creatively named for the quality of their calls: *Screamer* for his acoustic aerobatics, *Melancholy* for her mournful pleas and *Trumpeter* for his trumpet-like honks.

While the initial reasons for the recordings were scientific, I soon became intrigued by another course of exploration. I found that through careful examination of the calls, subtle qualities began to emerge in the vocalizations—qualities such as overtones, cadences and rhythmic cycles that lent themselves more to terms of music and composition than pure scientific vocabulary.

My goal then became twofold: to learn more about Humpback's system of acoustics from a purely observational point of view, listening and analyzing the sounds much like a scientist would do while at the same time playing with the inherent rhythms and phrases within the sounds to create building blocks of musical compositions.

Explorations

While the tasks of composition and analysis seemed at first divergent methods of exploration, the questions they raised in contrast to one another lead me further down the road of exploration into the purpose and fit of these vocalizations with the underwater environment.

In the brief 50 or so years that cetacean acoustic research has been conducted an amazing variety of vocal behaviour has been revealed. Scientific discoveries in the fields of behavioural ecology, bioacoustics and cognitive ethology are furthering the understanding of how specific information encoded in acoustic communication plays a role in maintaining social cohesion, coordinating group foraging techniques and selection of potential mates. For someone like myself these discoveries are a wealth of inspiration, giving me the chance to inquire about the internal world of the whales, how they structure their societies and form relationships.

More importantly, scientific methodology has provided me with a means to design experiments, test hypotheses and overcome the limitations and ingrained interpretations my own biases bring to the research. During the process of analysis I was always aware of the fact that by no means was I the 'objective' observer—that between the passage of sound from the whale through the water, through my equipment to my ears, I was an inextricable part of the listening relationship

By placing my own perceptual organization in context of evolution and environment, I began to see the extent to which we are defined by our relationship to sound: how language is considered to be the pinnacle of our acoustic achievement as a species and is often the criterion against which other animals' intelligence or acoustic ability is measured; how our complex social behaviour and rise to the top of the food chain is wrapped up in our relationship to sound; and how an alternative evolutionary pathway and an alternate relationship to sound has given rise to the cetaceans at the top of the underwater food chain.

As my definition of acoustic ecology began to deepen, so did the extent of my exploration. Cetacean vocalizations are not exclusively for communicative purposes and in many instances act as an 'eye' in aid of navigation and orientation. Toothed whales, such as Orca (Killer Whale), dolphins and belugas emit a high-frequency click known as echolocation which brings back precise information of distance, texture, composition of the underwater world and provides the whales with a "view" of their surroundings. The more I inquired as to how my ear acted in conjunction with my other senses the more I began to understand how alternate sensory organizations could render sight and sound as interchangeable rather than separate means of gathering information.

I also became curious as to the inherent qualities of water and how different depths and distances affected the transmission of sound. I began experimenting with an underwater speaker system deployed in various locations to measure how different conditions and underwater geographies affected sound, whether attenuating certain frequencies or causing others to rapidly dissipate and disappear.

With this additional knowledge in hand, my musical explorations began to take on value as an analytical tool, revealing qualities of vocal behaviour that were not evident through the more traditional means of scientific analysis, and allowing for further discovery of a world that reflected a non-linguistic understanding of sound.

Comparative Ecologies

While my research techniques run from scientific to experimental and have covered many areas pertinent to cetacean acoustics, a common thread has re-occurred throughout all aspects of my explorations: each vocalization found in this environment has evolved to serve a purpose and has done so by developing its own inherent properties and patterns. The cetacean ear listening to these vocalizations is designed to receive these sounds and interpret the contained information. It is attentive to these tasks.

In gathering information from our external environment, the human ear is designed to do much the same. However in our current state of evolution, we seem to be relying less on the ear and more on the eye to monitor our surroundings. While this shift

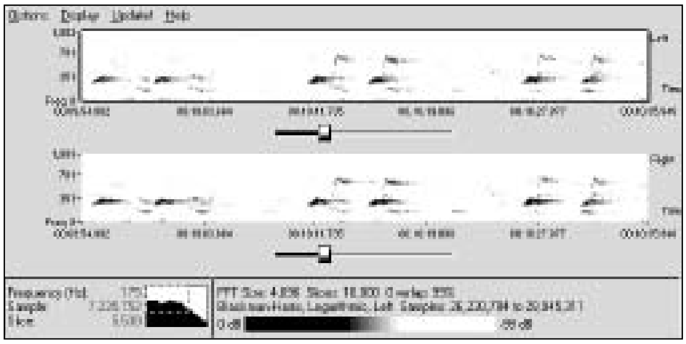


Figure 1: A sonogram of a small portion of the winter song.

could be seen as a consequence of natural adaptation, whereby over the centuries we have outgrown our need to hear, I believe it is more likely a response to the pressures of our immediate environment, to levels and frequency of sound not present in our evolutionary development. Within this perspective, increasing reliance on the visual sense can be seen as an appropriate and even beneficial response to unfavourable auditory conditions.

While our particular sensory organization permits us to adapt or even thrive in our acoustically aberrant world, we are making it increasingly impossible for other species to compete for acoustic space. This is all the more apparent in the liquid environment of the ocean where we too have learnt to use sound to collect information about the underwater environment. The development of long-distance monitoring devices (Sonobouys), assessing evidence of global warming (ATOC) and protecting and defending territory (Low Frequency Active Sonar), all use high-decibel sound propagation to collect information from the ocean's surroundings and threaten the natural acoustics of this environment.

Underwater nuclear explosions, mining explorations, shore based and non-acoustic human activity also create inhospitable underwater acoustic environments. Poisons flushed down the household drain, ramifications of forestry practices, fish farms and other industrial activity degrade the underwater environment, deplete it of its natural resources and have reduced the cetacean population and the ocean's acoustic vibrancy to a small fraction of its historical level. To lose such a system of acoustic beauty and complexity as we find in the underwater environment would be a tragedy and we are in great jeopardy of doing exactly that.

Further understanding of cetacean acoustic behaviour and ecology is needed to make the case for the damage these infringements cause on cetacean populations. We need to establish that the ability to listen to their environment is critical to their survival, that their survival depends upon our conscious monitoring of their environment and our careful attention to sonic detail. By combining our sum knowledge of sound and ecology, whether from the perspective of scientists or composer, sound designer, philosopher, artist, activist or engineer, we can further the understanding of this liquid environment, draw attention to the needs of the ocean's inhabitants and help preserve the ocean as an acoustically viable environment.

Lisa Walker's interest in nature, sound and technology, combined with her classical violin background, has given her a unique blend of skills with which to explore nature's acoustic nuances. Born in Vancouver, Canada and trained at the Vancouver Academy of Music, her musical influences include a wide range of styles and traditions to which she adds a small dose of scientific perspective. Her album, Grooved Whale, is based on her explorations of humpback vocalizations and took home 2001 NAV awards Ambient Album of the year. She currently is involved in a research project studying the vocal learning behavior of belugas and is working on her third album. www.groovedwhale.com

Creatures of Culture?

Making the Case for Cultural Systems in Whales and Dolphins.

By Scott Norris

On a typical summer day, the waters of Johnstone Strait, in British Columbia, are abuzz with the clicks, whistles, and pulsed calls of killer whales. These animals—the summer residents of the inland waterways off northern Vancouver Island—are perhaps the most intensively studied whale population in the world. Through research based on the ability of observers to visually identify every individual in the population, scientists have put together an extensive and detailed outline of the whales' social relationships over the last three decades. And since the early 1980s, researchers have had hydrophones in the water, recording myriad hours of whale conversation.

The glimpse these studies provide into the life of a creature as far removed from ourselves as the killer whale represents a triumph of field biology. Among the tight associations of family groups known as pods, researchers have found stable and distinct vocal patterns, or dialects, that appear to be maintained and transmitted by social learning. For a growing number of scientists, the implications of such patterns are clear: Killer whales are highly cultural creatures and may stand alongside—and perhaps in some ways ahead of—chimpanzees as the exemplar of a nonhuman animal whose life and evolution is shaped by cultural processes. And killer whales may not be unique: in recent years, intriguing evidence of cultural processes has surfaced in other whale species as well.

But as one might expect, claims of culture in cetaceans (whales and dolphins) have sparked controversy. The idea that nonhuman animals can possess culture has long been a contentious issue among behavioral scientists. Recently, biologists, psychologists, social scientists, and philosophers squared off in a lengthy printed debate over the existence of culture in whales and dolphins. The occasion of this remarkable discussion was the publication, in the journal *Behavioral and Brain Sciences* (Volume 24, April 2001), of a paper by two whale researchers who attempted the first general review of the evidence for culture in cetaceans. Hal Whitehead and Luke Rendell, both of Dalhousie University in Halifax, Nova Scotia, Canada, argued that cetaceans possess cultural faculties unique in the animal kingdom—except for humans. The paper appeared together with 39 written commentaries, some supportive and some strongly critical, and an authors' response.

If nothing else, Rendell and Whitehead's paper and the subsequent debate signify a coming of age in cetacean field studies. The discussion is important not just for the light it sheds on one particular group of organisms but also because it points to larger questions, as well as to what may well be a significant gap in our understanding of animal evolution. Culture is one of only two mechanisms by which information is shared and handed down among members of a population (genetic inheritance is the other). And while research over the past century has done much

Killer whale nuclear family—a mother and her two calves. Males remain in close association with their mothers throughout life, whereas females eventually form their own matrilineal group. Pods consist of one to nine of these groups.

to reveal the genetic basis for all of life, the influence of culture on the evolution of species other than our own has scarcely been explored.

The Interpretation of Culture

Culture may be broadly defined as shared variation in behavior that is generated and maintained by social learning, for example, through imitation or teaching. Although many researchers generally agree with this definition, sharp differences exist over its interpretation and application. For Rendell and Whitehead, as for many field biologists, the specific mechanism of information transfer is of less importance than the patterns it generates. Social learning is often very difficult to demonstrate directly. But the presence of culture can be established by observation and deduction: when behavioral differences exist that cannot be accounted for by genetic or environmental factors, cultural transmission must be occurring. The strength of this approach, Whitehead notes, "is that it is firmly rooted in what the animals actually do in the wild."

Critics have several responses. First, it may often be quite difficult to rule out alternative hypotheses suggesting that either genes or learned individual responses to differing environments are responsible for behavioral patterns. Often implicit in this argument is the notion that social learning, thought to be a more complex and cognitively demanding phenomenon than individual learning, should be invoked only as an explanation of last resort. In effect, when it comes to animals, it may be safer to assume that individuals repeatedly reinvent the wheel than to suppose they learn from or imitate the behavior of others, at least until proven otherwise.

A second approach to animal culture is one generally favored by psychologists and behavioral researchers working in experimental settings. According to this view, culture should not be attributed to a species until controlled experimental studies have established a cognitive capacity for social learning—imitation and teaching in particular. "In order to understand cultural phenomena you have to understand the underlying processes, and not focus solely on the results of those," says Stan Kuczaj, a behavioral psychologist at the University of Southern Mississippi, in Hattiesburg. Although the debate over definitions and evidence remains polarized to some extent, many researchers agree that multiple approaches are needed to understand the behavior of advanced and highly social animals like chimpanzees and whales. And although some scientists still deny culture even to chimps, strict behaviorist approaches may be on the wane. At the same time, observational studies are now gaining some of the scientific rigor they have lacked in the past. For Rendell and Whitehead, the important thing is to approach culture in such a way that all of the evidence may be considered. Given all that has been learned from field studies, they argue, culture should not be denied pending experimental data that may be impossible to collect for many cetacean species.

Researchers monitor and record whale vocalization using water hydrophone arrays deployed from boats and from shore stations.

Matrilineal Whales—Structure and Tradition

The strongest case for cetacean culture may come from killer whales. The social universe of these animals consists of a highly stable, hierarchical set of relationships based on the matriline, that is, the family group consisting of a mother and her offspring. In British Columbia, male whales remain with their mothers until the mothers die. Females eventually mate and form their own matriline. Small numbers of related matrilineal groups band together in highly cohesive units known as pods. Pod members travel and forage together; in over 20 years of study, no individual has switched from one pod to another. At an even higher level, different pods preferentially associate and share vocal elements with one another. Some even engage in what has been described as a ritualized greeting ceremony.

Do the vocal dialects of resident killer whale pods constitute culture? Because the pods all share the same waters and interact extensively, the different dialects cannot be explained in terms of responses to different environments. Indeed, the fact that separate dialects are maintained despite extensive social interaction among the groups is precisely what sets killer whales apart from other animals in which dialects have been described. In a number of songbird species, for example, stable regional dialects are maintained, but only for separate populations. But could the patterns of variation in killer whale calls be due to genetic inheritance? This would be possible if mating usually occurred between members of the same pod. Such an explanation, however, now appears unlikely. A recent genetic analysis of the resident population by Lance Barrett-Lennard, of the University of British Columbia, found that killer whales tend to mate with individuals from other pods, who sound very different from themselves.

In perhaps the most sophisticated study to date, researchers John Ford and Volker Deecke, of the Vancouver Aquarium Marine Science Center, combined data from Barrett-Lennard's genetic study with a powerful computer analysis of vocal variation in two killer whale matrilines through time. Closely related groups of whales typically have many vocal elements in common. The researchers used a highly sensitive index of acoustic similarity to compare specific call types shared by the two groups, recorded over a period of 13 years. The analysis revealed that while call types did undergo gradual modification through time, they did not diverge from one another. As with human languages, cetacean vocal elements typically become modified in a gradual and largely random manner over time, a process known as cultural drift. The fact that similar changes occurred in separate groups strongly suggests that an additional process—social learning—was taking place. "The only way the calls could have changed in parallel is if modifications were not only transmitted within each group, but from one group to the next," Deecke says. "There was no genetic exchange between the two groups, which rules out the possibility of genetic coding for the calls."

Sperm whales also have a matrilineal social structure, although group membership is more variable than in killer whale pods. Different sperm whale groups use distinctive and stable patterns of clicks—known as codas—that cannot be explained by genetic or environmental factors. Whitehead's group has found that vocal repertoires correlate with patterns of predator-inflicted markings, raising the possibility that different communal defense strategies are culturally inherited. Sperm whales have been observed defending themselves from killer whale attacks in both tail-out and head-out formations, but there are no data as to whether groups consistently use one strategy or the other.

Matrilineal species, including sperm, killer, and pilot whales, all have about 10 times less genetic diversity in their mitochondrial DNA than other whales and dolphins. In sperm whales, Whitehead has found a strong correlation between groups in similarity of coda dialects and mitochondrial DNA patterns. He has also shown that the lower diversity cannot easily be explained by such factors as reduced mutation rates or past population bottlenecks. The alternative Whitehead proposes is that the genetic patterns are the result of selection acting on maternally inherited cultural traits (*Science* 282: 1708-4711). Cultural differences that give certain groups an edge in survival or reproduction could, over time, result in greatly reduced diversity in the maternally inherited mitochondrial genome. The hypothesis implies that culture may exist at a deeper level than mere vocal dialects, which are probably not in themselves selectively advantageous. "I think probably it doesn't come down to dialects, but more likely to group knowledge," Whitehead says. "For example, knowing where to go to get food to survive an El Nino event."

Conformity and Change

Humpback whales are best known for their elaborate songs, highly structured vocalizations that may last 20 minutes or longer. Culture in humpbacks is manifest not in small group affiliations and dialects but in population-wide conformity to ever-changing musical fashions. In striking contrast to the stable dialects of killer and sperm whales, humpback songs are faithfully duplicated by all the males in a breeding population, which may be spread out over an entire ocean basin. In any given year, for example, virtually identical songs are sung by whales wintering in Hawaii and Mexico, 4500 kilometers apart. Over time, however, the song of any humpback population gradually changes, piece by piece, through the modification of individual song elements.

Photo: Scott Norris

Killer whales from several related pods foraging together. University of British Columbia's John Ford has determined that the 16 summer resident pods of Johnstone Strait can be split into four distinct clans based on shared vocal elements.

How such conformity is maintained among thousands of singing males across vast distances is not entirely understood. Songs may be spread during the summer months, when different groups come into contact with one another, but singing during the summer is thought to be rare. Alternatively, some researchers suggest, songs may actually be heard over very long distances in the deep ocean. Whatever the mechanism, conformity in humpback songs appears to be inexplicable by any process other than social learning. "There appears to be a strong pressure for everyone to sing the 'current' song," Rendell notes. What is most remarkable, he adds, "is the sheer geographic scale over which the songs are shared."

The puzzle of humpback whale singing took a new and unexpected twist last year (in 2001). In an article in *Nature* (408: 537), a group headed by Mike Noad, of the University of Sydney, described an abrupt "cultural revolution" in the song of humpback whales in the Pacific Ocean off the eastern coast of Australia. In 1996, the researchers recorded two individuals singing a song completely different from the one sung by the rest of the population. Two years later, every male in the east coast population was singing the new tune—not an original, it turned out, but an import from the Indian Ocean, on the other side of the continent. The researchers speculated that the song must have been introduced by the movement of a small number of whales from the Indian to Pacific Ocean populations. Such movements are thought to be rare, and since its introduction the song has evolved independently at the normal slow rate in the two groups. But why the East Coast males picked up the new song and dumped the old one so quickly remains a mystery. A preference for novelty might be part of the explanation, but this has to be reconciled with the normally strict conformity of humpback vocal culture.

Mind in the Waters

Observational studies in the wild have yielded strong evidence of vocal culture in killer, sperm, and humpback whales. Notably absent from this list is the species whose cognitive abilities are both best known and subject to the wildest speculation—the bottlenosed dolphin. The notion of advanced dolphin intelligence was planted in the public imagination in the 1960s by maverick scientist John Lilly, who speculated about the existence of a dolphin language that might someday be understood by humans. Although most biologists have remained highly skeptical of such claims, the large and complex dolphin brain—and the feasibility of conducting experimental studies in captivity—have stimulated a great deal of research over the past quater century. "Tremendous progress has been made in the study, description, and analysis of dolphin cognition since the days of John Lilly," says Louis Herman, a behavioral researcher at the University of Hawaii. Experimental work on dolphins provides the strongest evidence of the kind of individual cognitive capacity and learning ability that may underlie the group patterns of cultural transmission observed in other species. Work by Herman and his team has shown that bottle-nosed dolphins are capable of acquiring an artificial language. More significantly, through a series of sophisticated experiments, Herman has shown that dolphins appear to possess many of the core properties of grammar and syntax considered fundamental to human linguistic competence.

Researchers and trainers who work with dolphins have long noted their ability not simply to learn behaviors but to modify and invent new ones. "One of the things we've been struck by in dolphins and killer whales is that they make their play more complex and difficult over time," says Kuczaj. Herman notes that such flexibility of behavior—the ability to respond in novel ways to new situations and events—may be considered the very hallmark of intelligence. "The issue of culture in cetaceans relates to the issue of the extraordinary development of the brain in some cetacean species," he says.

Perhaps most relevant to the question of culture is an extensive body of work on dolphin mimicry. The ability of individuals to learn and copy the behaviors of others is a prerequisite for the cultural transmission of information in any animal society. "Imitation can be an efficient mechanism for social learning," Herman says. "Our studies have shown that dolphins are capable of extensive vocal and behavioral mimicry, a seemingly unique combination of abilities among nonhuman animals." Dolphins appear to understand imitation as a concept, as illustrated by their ability to copy sounds and behaviors almost immediately, without extensive repetition or training. In captivity, mimicry occurs without any training at all. Dolphins may learn each other's trained repertoires through observation only, and caretakers have noted the spread of behavioral fads among tank mates.

A recent study by Vincent Janik, of the University of St. Andrews, demonstrated for the first time the use of mimicry in a dolphin community in the wild (*Science* 289: 1355-1357). Bottle-nosed dolphins develop individually distinctive signature whistles through a combination of learning and subsequent modification in the first few months of life. Janik found that in the wild, individuals out of visual contact communicate with one another by copying and repeating each other's signature vocalizations. This whistle matching suggests that dolphins address each other individually, using learned vocalizations—a phenomenon that may be unique outside of humans.

Bottle-nosed dolphins live in larger, looser communities than other toothed whales, and little work has been done comparing group differences or tracking individual histories through time. But some intriguing evidence of cultural transmission does exist in the realm of foraging behavior. Bottle-nosed dolphins exhibit a variety of individual foraging specializations, some of which may be socially learned. In Shark Bay, Australia, some females have long been observed wearing cone-shaped sponges—benthic organisms apparently harvested by the dolphins—over their beaklike snout, or rostrum. Scientists think the sponges may be used as protection from abrasion while foraging on the ocean bottom. Only a minority of females in the population engage in sponging, but the behavior has been observed in some individuals for over a decade and may be passed down from mother to daughter. And elsewhere in Australia, researchers have described two distinct dolphin communities occupying the same bay but pursuing different foraging strategies. Such evidence may represent only the tip of the iceberg. Cultural transmission may well be common in bottle-nosed dolphins, Whitehead notes, "and it may well be a major influence on behavior. But it's harder to remove the confounding ecological variables for dolphins than for killer and sperm whales."

The Culture Wars

The attitude of a number of skeptics is expressed in the title of one of the written commentaries to Rendell and Whitehead's paper, "Calling it culture doesn't help." Many are willing to grant that whales and dolphins are capable of some form of social learning, and they agree that this is an important phenomenon deserving further study. But the concept of culture is, in the words of yet another commentary title, "Slippery when wet." From a purely behavioral perspective, it may not matter whether social learning in whales amounts to culture or not. "I don't think [the debate over cetacean culture] is productive," says Patrick Miller, of the Woods Hole Oceanographic Institution. "It simply leads to fights between people who define culture differently."

But from an evolutionary perspective, culture does matter. It is significant because of the potential for cultural evolution acting alongside natural selection, and for gene-culture coevolution, as has been suggested for the matrilineal toothed whales. Perhaps the key question then is, How cultural are they? One critic writes dismissively that socially learned behaviors in whales "appear to be of the trivial variety: carrying sponges on the head and so on." But the vocal cultures of killer and humpback whales seem, at least to many researchers, far from trivial. And Rendell believes there is probably much more to discover. "I am almost certain there is more going on than we have been able to observe," he says. "What is striking is how strong the evidence is for cetaceans, given the limitations we face in studying them."

Culture is also important because it has long been viewed as a dividing line between humans and other animals. With evidence of culture accumulating in chimps and whales, this distinction is becoming blurred. It is probably true that in no other species has culture ratcheted upward, or accumulated increasing layers of complexity, as it has in humans. But cetacean cultures do change—and hence evolve. "An exciting aspect of this is that we might be better able to understand how we came to have the kinds of culture that we do, by understanding the evolution of culture in environments radically different from our own," says Rendell. As in humans, the appearance of culture in whales and dolphins probably is the result of a complex set of interacting factors: brain size and cognitive ability; life history traits, such as duration of parental care and postmenopausal life span; complex social systems; and ecological conditions.

Proponents of cetacean culture believe several features of the marine environment may favor the evolution of social learning and cultural traditions, particularly in long-lived, socially oriented species. Marine ecosystems undergo large changes on time scales of months to years, and at any given moment prey such as krill and fish tend to be highly concentrated in some locations but not in others. Cetaceans are highly mobile animals, and movement appears to be an efficient strategy for coping with both a changing environment and a patchy distribution of resources. This efficiency can be increased if groups follow a coordinated movement strategy using shared information, including knowledge of past conditions that may be passed down intergenerationally. The stable social groups of many whale species provide ample opportunity for such cultural transmission to occur, and selection may favor membership in groups capable of coordinated behavior and information sharing. And as has been proposed for humans, a stable and complex social environment may further the evolution of larger brains capable of more sophisticated forms of social learning. Understanding the full extent of cultural behavior in whales and dolphins remains an enormous task, one that may take generations. But nearly everyone who took part in the recent debate agrees that an important start has been made. "Observational work both in the wild and in captivity is incredibly important," says Kuczaj. "And so are attempts to demonstrate processes and abilities experimentally. If the groups that do those things continue to talk to one another, we'll make a lot of progress."

Scott Norris is a science writer and ecologist based in Albuquerque, New Mexico, USA. He holds Master's degrees in ecology and anthropology from the University of New Mexico. He specializes in coverage of ecology, evolutionary biology and conservation science. His work appears regularly in a number of publications, including *BioScience, New Scientist,* and *Conservation in Practice*. Mr. Norris brings a diverse array of talents and experience as a journalist and editor, field biologist, science teacher and business manager. He is a cofounder of *GreenText* (www.greentext.com/).

This article first appeared in *BioScience,* Volume 52 Number 1 (pp. 9-14). It is reprinted here by permission of the author.

Soundwalking the Internet

Ocean Acoustics—Opportunities to Listen to Underwater Soundscapes

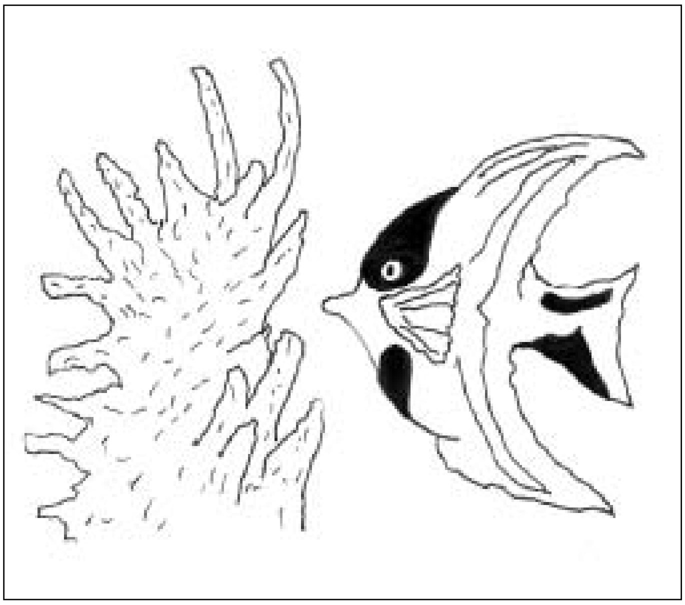
Compiled By Gary Ferrington

The ocean is a diverse soundscape both natural and anthropogenic (made by humans). Natural sound includes underwater landslides, volcanoes, earthquakes, surface rainstorms, wind, lightening, and in the world's colder regions the breaking of icebergs and ice shelves. There is also a vast array of sea life including fish, whales, dolphins and other creatures that enrich the sound of the sea.

Add to this mix the human-made noise of drilling, shipping, recreation, military activities and many other industrial practices.

The opportunity to listen to this underwater world is difficult without the necessary equipment and resources to probe ocean depths. As a result, listening remains inaccessible to most readers of this journal.

This guide suggests that one take an Internet soundwalk along and under the surface of the sea. In researching this issue's topic of ocean acoustics, I discovered many web sites with audio files recorded during oceanic expeditions. Each site provides an opportunity to listen in on recordings of sea and shore soundscapes and to learn more about them.



Voyage of the Odyssey: Voices from the Sea
Public Broadcasting System—USA
http://www.pbs.org/odyssey/voice/index.html

Although this site provides few undersea sound files it does provide an initial starting point for understanding the value of our planet's water rich environment. Host Dr. Roger Payne has been studying whales and working for their conservation for over 30 years. In his online audio series, *A Voice from the Sea*, Payne discusses the fate of the world's oceans.

Payne notes, "Though we distinguish between the Pacific Ocean, the Atlantic Ocean, the Indian Ocean, etc., there is really but one ocean. It is the home of all the fish, crabs, seaweed and whales that exist (except, of course, the river and freshwater species). No matter where you live along any seashore, a whale may pass along your coast, or come into any harbor or bay deep enough to float it. And sometimes they do. When that happens, it is always a thrill. It seems to send a message that speaks directly to people, one that sets up waves that somehow beat down any barrier of disinterest."

Sounds of the Humming
Cornell University
http://www.news.cornell.edu/releases/June98/fish/sounds.html

"When midshipman fish migrate from the deep Pacific waters to the West Coast of North America each summer to mate, the intertidal zone becomes a noisy place. Courting males excavate nests beneath rocks in shallow water and hum to attract egg-laying females. The love song, described as a motorboat-like drone, comes from rapidly contracting muscles on the male's swim bladder and proves irresistible to the female midshipman. Each female deposits all her eggs for that season in one nest and swims away. Hoping to lure more females to the nest, the male resumes singing, all the while remaining on guard until the offspring hatch and mature." Listen in to this courting ritual of grunts and growls.

Marine Animal Sound Production
Mann Laboratory Marine Sensory Biology
College of Marine Science, University of South Florida, USA
http://www.marine.usf.edu/bio/fishlab/fish_sound_production.htm

"Sound is an ideal way for animals to communicate in the ocean. Sound attenuates little in the ocean, is directional, and is very useful where there is no light. Many fishes have evolved the ability to produce sounds by drumming the swim bladder with specialized muscles or bones. While many fishes are known to produce sound, most have not been studied."

Here you will be able to hear snapping shrimp, the signature whistles of dolphins, silver perch, and interesting species including coral reef toadfish, Gafftopsail Catfish, Spotted Sea trout and others.

Fish Acoustics
Sciaenid Acoustics Research Team
East Carolina University
http://personal.ecu.edu/spraguem/drumming.html

"The ocean is often believed to be a silent and tranquil place, but nothing could be farther from the truth. If you lower a hydrophone into the water you will hear noises produced by breaking waves, turbulence, boats and ships, as well as noises produced by marine animals."

At this web site you can listen to animals of the inshore waters of North Carolina including marine mammals (like dolphins and whales), snapping shrimp, oyster toadfish, members of the family Sciaenidae (drums and croakers), and many other fish species.

Fish Talk (A site for children)
East Carolina University
http://personal.ecu.edu/spraguem/drumming.html

"There are different reasons why fish make sounds. Although both sexes have been observed in making sounds, the sounds that a male fish makes are believed to play an important role in spawning, such as attracting females and chasing away their competition. Fish may also make sounds to scare predators away."

This Internet site has been developed for children by staff at East Carolina University and uses many of the sounds from their Fish Acoustics site.

Ocean Explorer
National Oceanic and Atmospheric Administration (NOAA)
http://oceanexplorer.noaa.gov/explorations/sound01/background/seasounds/seasounds.html and
http://www.pmel.noaa.gov/vents/acoustics/sounds.html

The Acoustic Monitoring Project of the VENTS Program has performed continuous monitoring of ocean noise since August 1991 using the U.S. Navy Sound Surveillance System (SOSUS) network and autonomous underwater hydrophones. Here is a collection of under sea sounds including earthquakes, volcanic tremors, large and small ships, airguns, and variety of whales including Blue, Humpback, Fin and Minke.

There are also two mystery sounds. The first is "Slow Down" recorded May 19, 1997 at the Equatorial Pacific Ocean autonomous hydrophone array. The sound slowly descends in frequency over about 7 minutes and was of sufficient amplitude to be heard. This type of signal has not been heard before or since.

The second is called, "Bloop" and was repeatedly recorded during the summer of 1997. The sound rises rapidly in frequency over about one minute and was of sufficient amplitude to be heard on multiple sensors, at a range of over 5,000-km. The origin of the sound is unknown.

Antarctica 2000
http://www.antarctica2000.net/sounds/soundings.html

Doug Quin's informational and image rich web site provides an excellent set of three listening galleries featuring soundscapes and sonic images from Antarctica: Seals, Birds, Ice & Wind.

Each gallery has many sound files, such as a juvenile elephant seal playing with the echo of its call in Arthur Harbor, glacier calving in Loudwater Cover or Canada Glacier cooling with ice refreezing. All sounds are realized as MP3 files.

Orca Live
http://www.orca-live.net/

This site includes extensive information about Orca whales and features live webcasts of Orca when they are near cameras and microphones. You can subscribe and be informed when the broadcasts take place.

Whale Acoustics
http://www.whaleacoustics.com/audio.asp

Whale Acoustics is a small business doing contract and consulting research work. Research focuses on the impact of man-made noise on whales, including navy sonars, ships, explosives and offshore oil exploration work. Because this topic requires interpretation of the whale's behavior to indicate response and because whales tend to habituate to most man-made noises with time, this is a very complex subject. On this site you will find an area of sounds including baleen and toothed whales, dolphins, fish, and an array of other ocean sounds.

Underwater Recordings
Cetacean Research Technology
http://www.cetaceanresearch.com/sounds.html

This is a commercial site for hydrophone recording technology. Of interest are the MP3 sound clips of Orca killer whales in Dye's Inlet, Washington, and clips of Sperm whales recorded in July 1997 for National Geographic's Crittercam.

On March 26, 2000, Seattle's Kingdome stadium was demolished. Cetacean Research owner Joe Olson lowered a hydrophone into Elliott Bay and captured the underwater sounds of the gigantic steel and concrete structure crashing to the ground. The background sounds you hear are from the hundreds of boats that gathered in Elliott Bay to witness the demolition.

Gary Ferrington, Senior Instructor Emeritus, Media Studies. University of Oregon. Currently WFAE secretary and website manager.

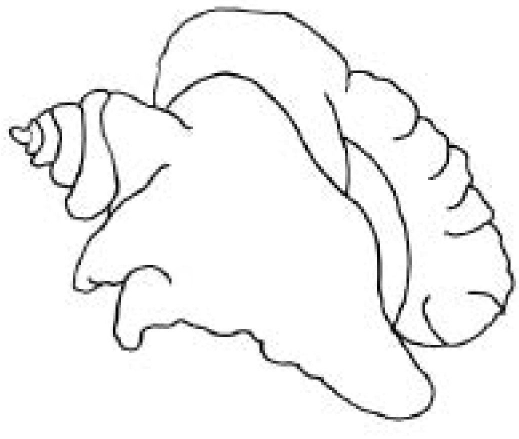
Find a Water Sound

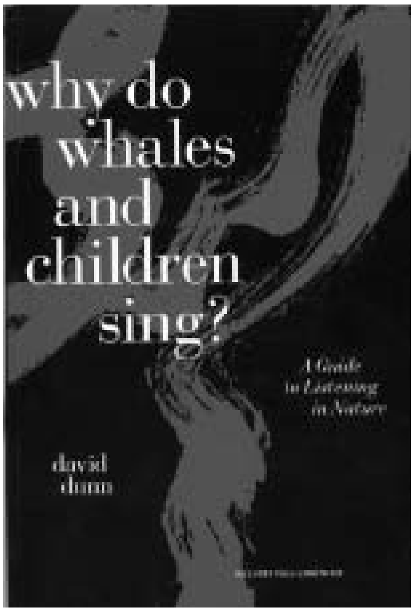
Turn off your computer and listen to your room without the computer hum. Leave the room in which your computer is located. Open the door of the building in which you are and step out and listen. Walk and listen. Stop and listen. Go around the next corner and listen.

Go to a place where you can hear the sound of water.

Don't speak to anyone. Do nothing but listen. Stop for a moment and listen to your thoughts. Remember the sounds you heard on the Internet. Let them pass like the sound of a wave. Follow them until you cannot hear them any longer.

Listen again to the water sound that you found.





LEARNING TO LISTEN TO THE WORLD:

A Review of David Dunn's Why Do Whales and Children Sing?

Published by Earth Ear: www.earthear.com

By Dave Aftandilian

Think about your favorite memory of being in nature. Perhaps it was a trip to the seashore as a child, with the gentle waves and warm sun lulling you to sleep. Or a strenuous hike up a mountain and down into a valley, capped at the end by a splashing, lazy afternoon relaxing beside a happily babbling stream. Or maybe an early morning in the desert, with the rising sun striking a rainbow of colors from the rocks and a keening wind sculpting the endless grains of sand into fantastic dune-shapes.

Chances are, sound will play a crucial role in your favorite nature memory, though you may not hear it that way at first. While we're used to thinking about the visual aesthetics of the wild, we seldom think of its acoustics. In the CD/book *Why Do Whales and Children Sing? A Guide to Listening in Nature,* it is David Dunn argues that it's high time we start paying attention to the sounds of the world around us: "At a time of ecological crisis we need to embrace every tool we have that can remind us of the sacred. Not only can aural and musical metaphors provide us with a means to describe the world in ways that remind us of our physical connection to the environment, but the physical act of using our aural sense, in contrast to entertainment, can become a means for integrative meditation."

For anyone interested in paying more attention to their acoustic environment, David Dunn's *Why Do Whales and Children Sing?* A Guide to Listening in Nature is an excellent place to start. However, the subtitle is a bit misleading. This is not a step-by-step guide to how to listen in nature. Instead, Dunn's work is more of a personal introduction to some aspects of natural sound that he feels are most compelling and important for reintegrating humans with the world around us, as well as getting us back in tune with our own inner voices. Along the way he shares a number of insightful musings on sound, nature, and self.

After a brief preface and explanatory introduction, *Why Do Whales?* continues with 40 one- to two-page essays keyed to tracks on an accompanying 73-minute CD. The selections on the CD range from thunderstorms and insect calls to birdsongs and the sounds of human habitations, and were recorded around the world, though more than a quarter of the tracks are native to Dunn's home state of New Mexico.

Dunn begins with "Chama, New Mexico: Mountain Stream and Approaching Thunder" as an example of "something of a cliché. . .what many people think of when they think of the recorded sounds of nature." You hear running water, birdsong and insect calls, and the gentle rolling of far-off, approaching thunder. Listening to this feels like a dream of an idyllic afternoon in a shady forest near a stream, where life moves slowly and peacefully. The next track, "Venice Beach, California: Thunderstorm" comes as quite a shock, crashing in with heavy, immediate thunder and the sounds of people running for cover. The sounds are much closer to the listener, highlighting the violent aspects of the storm, and the presence of human voices yelling in the recording also makes it feel more real. Closing out the thunderstorm trilogy that opens the CD is "Les Moulins, Swiss Alps: Cows and Thunderstorm," where the comfortingly familiar notes of cowbells form a reassuring presence against the otherworldly power of a mountain storm.

Although I found every track on the CD and every essay in the book interesting and informative in one way or another, Dunn's speculations on and recordings of communications between different species struck me in particular. I have often wondered what crows think of the cats that watch them from apartment windowsills, or what house sparrows and starlings think of the pigeons feeding beside them in cities around the world. While Dunn's recordings can not prove one way or another what different species think of each other, they do show quite convincingly that different species are aware of each other.

On "Black Lakes, New Mexico: Frogs and Ravens," you first hear lapping water and rattling-bubbling calls of frogs; then you notice the rhythmic caws of a raven in the distance, and a flapping of approaching wings. As the raven passes over the lake, the frogs go silent in the face of their predator; after the "ha-ha" caws have receded into the distance, the frogs begin to sound off again. And "Sonoran Desert, Mexico: Mexican Wolves and Coyotes" captures a fascinating interaction between Mexican wolves on one side of a canyon and a pack of coyotes on the other; the two sides sound like they were having a hell of a good time doing call-and-response howling and yipping with each other. (As Dunn points out in his notes, the Mexican wolf has disappeared from the Sonoran desert, as it has from most of its former habitat; only time will tell if current reintroduction efforts will prove successful.)

Dunn's underwater recordings are also truly ear-opening. Most of us never get to hear what lies beneath the waves, but

Dunn gives us that chance. In addition to the better-known, but still eerily fascinating, calls of humpback whales, Dunn also presents recordings of underwater sounds off the Great Barrier Reef in Australia, which boil with hissing, flapping, and bubbling noises, as well as twittering and thumping; Geiger-counter-like tapping sounds made by walrus on deep-sea dives off the coast of Alaska; and a truly amazing collage of sounds produced by underwater insects in a pond in Mora, New Mexico, which range from a repetitious drone-buzz reminiscent of sounds made by terrestrial insects to noises like a radio tuning in and out. Dunn uses this last recording as an opportunity “to remind us that intelligence can reside in unlikely places.” Indeed, on one of his other albums, Dunn titled a track composed with underwater insect sounds “Chaos and the Emergent Mind of the Pond” because their beauty and complexity demonstrate perfectly the scientific concept of emergent properties: patterns arising from a complex process that appear to transcend the agents that produced them.

That observation brings me to one of the most rewarding aspects of *Why Do Whales?*: the many provocative speculations and insightful observations that Dunn weaves into his essays on the sound recordings. For instance, we learn how noise pollution from human sources like motorboats is disturbing and deafening many aquatic creatures such as manatees; some researchers believe these slow-moving mammals cannot hear approaching motorboats, and thus cannot avoid being scarred or killed by them. Another more recent example is the effect of new sonar the US Navy is developing to detect submarines; two recent tests of the system caused whales to beach themselves, yet at the end of March the National Marine Fisheries Service released the draft of a rule that would give the Navy a five-year exemption from the Marine Mammal Protection Act while it develops the sonar.

Dunn cites several other examples like this of how humans have so completely altered the sound environment that you can’t go anywhere on the planet—even miles beneath the ocean’s surface—without encountering human-caused noise. This is, of course, just part of a much larger pattern of human impact on the natural environment. As Dunn writes, “the important thing to understand is not only how humanity has radically altered the biosphere but the depth of responsibility we now carry for its future survival.”

But all is not yet lost. People can be a force for good as well as ill, protecting the remaining pristine wilderness areas, and restoring more degraded and urban landscapes. Opening our ears to the sounds of nature is one way to start along this path. And this meditative effort, in turn, will help revive our own spirits. To quote from Dunn once more: “through enlivening our ears and engaging in more attentive listening, we are drawn deeper into a resonance with life itself, a place of wonder where we might begin to ask questions like, why do whales and children sing?”

Dave Aftandilian is a graduate student in archaeology at the University of Chicago, working on a thesis about how perceptions of animals changed when precontact Illinoisans adopted agriculture. In addition to writing frequently about music and the environment, he is vice president and newsletter editor for *Nature in Legend and Story* [http://www2.h-net.msu.edu/~nilas/], a group dedicated to using stories expressed in a variety of media to explore human relationships to nature, and attempt to enrich those relationships.

This review was first published in the June 2001 issue of the University of Free Press and is reprinted here with permission from the author.

THE SOUNDS OF HARRIS AND LEWIS

Touring Exhibition of Sound Environments

By Andra McCartney

From 1999-2002, the Isles of Harris and Lewis, in northwest Scotland, have been the main areas of research for the UK-based *Touring Exhibition of Sound Environments (TESE).* This remarkable three-CD set and 50-page accompanying booklet documents and realises the activities carried out by soundscape researchers both local and imported. “Each place has its own particular soundscape which is interrelated to its inhabitants and their way of life. For example our dialects, politics, cultural traditions, religious beliefs, even our weather system, all contribute to the soundscape.” (CD booklet. p.1)

This project is local in its focus on listening to and recording the sounds of these island communities, and at the same time it is global in its concern for ways of life, politics, systems and forces in a larger sounding environment. Each CD has a different character. *The Machair Soundwalks*, CD 3, introduce the listener to the soundscape character of the region, through edited soundwalks across Ness Machair (Lewis) and Northton Machair (Harris). It was at this point that I wanted to locate the path of these walks on a map of the islands. The aerial photos on the CD cover give a beautiful medium-range representation of aspects of the landscape, but I kept wondering about the geographical relationship between Harris and Lewis. The CD booklet does not include a map with place-names, although I easily found one on the web, along with this description: Harris and Lewis are two islands joined by a narrow isthmus. Confusingly the name Harris applies to the southern island, and the southern part of the northern island. Harris turns into Lewis at roughly 58.03 degrees north. North of this the terrain tends to be more open moorland, while the south is mountainous. (http://www.edinburghbicycle.co.uk/routes/harris_lewis/route_harris_lewis.html)

The first soundwalk on CD 3, across Ness Machair in Lewis, is in conversation with Iain Gordon MacDonald, talking of Ness, social history and folklore, and with Chris Ryan pointing out species of flowers and birds. The second soundwalk is across Northton Machair, Harris, with Bill Lawson talking of that region’s histories. The booklet also contains some lovely photographs illustrating flora and fauna in the regions of Northton and Ness. I enjoyed this CD's introduction to the accents of residents and their recounting of natural and social histories that shaped this landscape.

CD 1 might seem archival because of its listing of sounds from "Cuckoo" to "Cal Mac old ferry and public safety announcement" (each with a separate CD Index number, although my CD player only showed a single track at 73:52, so I am not sure of the significance of this numbering). However, the sounds are recorded and edited in ways that suggest a narrative. For instance, at times I hear sheep shearing by hand and by electrical shears simultaneously, allowing me to compare their sounds. Peat cutting is followed by mechanical peat cutting, water sounds follow one another. My favourite parts of this CD are the songs, sung in Gaelic (hymns at the church and a man outside during sheep shearing), which seem so close to the ocean waves in their vocal ebb and flow, articulating an audible musical connection between the social history and the landscape of the Hebrides.

Finally, I turn to what is certainly for me the central CD of this project, CD 2, *Ness Sound Portrait and Sound Poetry*. The Sound Portrait section is the response of several residents to the question "How would you represent yourself and your place through sound?" Jayne MacLeod, Angus Morrison, Joan Morrison, Chris Barrowman and Kenny Don MacLean answered this question from flue wind to teeth-brushing and sea's edge. On this track, the listener is invited to approach these communities through a sonic portrait produced by residents who were given access to equipment and technical workshops through the project.

I return again and again to the middle of this CD, starting at 14:00. I hear sounds of someone gutting a herring and speaking in Gaelic, the language of some of my ancestors that I have never learned. From the booklet, Annie Mac Sween:

> I'm gutting herring... taking out the guts... I'll leave the head on, I'll clean out all this gore. It's full of blood, very unpleasant. Think of the poor women who spent the long winter and summer days cleaning the herring, filling the barrels with them. They'd be arranging them and making sure they were a good size. We're not used to the hard work these people had. They are our ancestors. They were very skilled in that sort of work, not like the mess I am making of this beautiful fish.

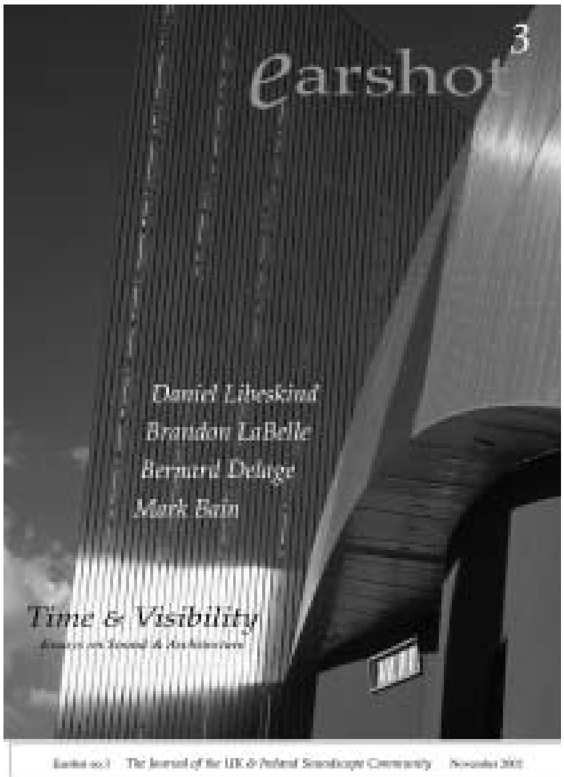
Then her cadence changes to that of a poem by Iain Chrichton Smith, *Do Mo Mhathai,* again in Gaelic. Finally I hear the same poem, *For My Mother,* in English. In it the sound of gutting herring echoes from the past, a sound of labour imbued "...with salt so coarse it stopped you from speaking and made your mouth bitter" (this line is spoken by Annie Mac Sween here). This sound is not romanticized but rather explored in relation to its historic resonance in this place, one of stoic endurance in the face of industrialised fishing practices. On this track, I hear many types of music, from popular music in the background to pipe music, melodian practice and guitar by the fire. I hear the weather through household flues and rain on window panes, I feel in touch with everyday lives. Tracks 2-16 on this CD are sound poetry and diaries by school children. Many of these are beautiful haiku. In addition, the booklet describes and documents the workshops and exercises done by Gregg Wagstaff with Mhari Gibson and her class. This section of the booklet is a rich source for educators, describing imaginative exercises to do with 8-12 year olds. The poetry produced by these students is beautiful, and the booklet includes many examples of their work.

I highly recommend this set of CDs, as a multi-faceted introduction to the sonic life of a Hebridean community through soundscape research. I find the range of approaches represented here to be remarkable, and the possibilities for community research to be exciting. It inspires me to develop some similar approaches, particularly in the area of community research, in soundscape work here in Montréal.

To order this CD & booklet set please contact:
tese@earminded.org
Price: £25 GBP + postage
£20 GBP for WFAE members.

[Ed. Note: See also our Education issue of Soundscape—The Journal of Acoustic Ecology, *Volume Two, Number Two, p. 30, where Gregg Wagstaff writes about his soundscape work with a class of children on the island of Lewis—the same children that can be heard on the CDs.]*

Andra Mccartney is a sound artist who teaches Sound in Media for Communication Studies at Concordia University, Montreal, Quebec, Canada. http://andrasound.org



Earshot 3:

Earshot is available to non-UKSIC/WFAE members.
Contact: johndrever@moose.co.uk

Sounding Remoteness, Flinders Island.

By Ros Bandt

The Flinders Island community invited me to be artist in residence for the wind festival on their island in Bass Strait, situated midway between Australia and Tasmania at the roaring forties latitude. Known for its gale force winds and wild seas, passage over the sea in Bass Strait has always challenged sea and aircraft alike. The sea surrounds and divides it from the rest of Australia. It is remote, hard to get to.

One of the local residents, Phil Kelly, a former Sydney physicist had heard my Aeolian Harps in Mungo, an inland wilderness, played on the *Listening Room*, on ABC (Australian Broadcasting Corporation) FM Radio. I found myself with an invitation to create some kind of sound garden with the local community, which could be shared with the public over the weekend of the festival of wind, at the September Equinox. This was to be at the same time as the Olympics. No greater contrast could be found. A rocky ride in a noisy chartered small plane and I was there.

I met a fascinating bunch of creative people who manage to live alternately, almost untouched by capitalism. They live from their creativity, music, performance art, fishing, diving, environmental and land management schemes, and alternate power. They subsist, share and celebrate this island wilderness. Flinders Islanders have traditionally been traders and hunters and gatherers dealing in mutton—birds, seals, whales and blue topaz. Since white settlement, the greater eastern part of the island has been cultivated, cleared and is pastoral. Throughout the island, overpopulation of wild life is ever present in the carnage on the road; pottoroos, kangaroos, wombats, rabbits and birds. There are 800 people, five hundred cars, mostly wrecks. I felt in a time warp.

On the first trip, the sound team, consisting of about a dozen people, (including members of the band, RoadKill drummers), made an acoustic reconnaissance of the island's north west. A general brainstorm of sound sources, and acoustic sites took us to many sonic paradises, open unfettered sound spaces

Photos: Ross Bandt

where the voice of the wind, birds and sculptures seemed enlarged, with absolutely no competing sounds. Acoustic heaven. Magpies recorded on a rural property registered in the red on my DAT, with no bass to roll off. Usually you can never get close enough. How very present sound is on the island.

Several sonic explorations were made on shore and sea. One of the schoolteachers, Bruce Evans is an expert Jazz im proviser and kora maker. We lashed his locally made koras to the top of the cars as we drove around, ready-made portable Aeolian harps, and then onto the jetty structure at Whitemark. The sound of the sea and the just intonation of the wind singing the lute's strings merged into a beautiful music. Performers and instrument builders Jon Hizzard and the Scottish Ian Prescott performed live on the koras as I made a video piece. A workshop was held at Phil's farm where we made musical bows from the local teatree and bird scaring tape (plastic humming tape used by farmers in orchards and vineyards to scare birds off their vines). They could be played like whips or be wind-activated and would be suitable for installation over the sea. An old concrete water tank, high on a hill in this abandoned farm, became the acoustic chamber for a group improvisation on koras and saxophones. This was recorded digitally inside the tank. Original sound sculptures and instruments were designed, prototyped and made by individuals from the team. Phil Kelly's solar-powered, computer-controlled zither was finely tuned.

In another workshop, PVC pipes (plumbing/sewer pipes made from polyvinyl chloride) were cut and tuned so they could be used to capture, and modify underwater sounds by wedging them in deep granite slits in the coastline. Further on at the water's edge we attempted to listen and record the tidal cracks below the ocean line, pushing very long PVC tubes down into the rocky slits and placing field microphones down inside them to digitally record what we were hearing. The tide played rhythmic and polyphonic music of a type none of us had heard, the many tones and haunting resonant frequencies emerging from the subterranean watery depths. Capturing tidal tones from these age-old watery crevices was a new listening experience for most of us. The untouched ancient seascape made us very quiet.

We also went to the highest point on the island, complete with surround ocean views, but the humming of a generator to charge the new solar-powered mobile phone tower, to which many people were opposed, broke its splendour. Therein started a discussion about acoustic ecology on Flinders in general, including the loud sound of the wind propeller turbines generating electricity on the island. Nobody had heard of acoustic ecology, but they lived it.

On to Lillies beach for a swim. Approaching through the Aeolian casuar-

inas (native singing pines) and sandy tracks, we had to drive through Wybalenna, the so-called last place of aboriginal settlement, with the aboriginal graves placed outside the cemetery wall. The surrounding fields were alive with colourful iris and lilies, bulbs in full bloom, planted by early settlers. This ghostly beauty and quiet overtook us all. Lillies beach lay ahead, the mountains behind, and ancient round granite ledges playing the sea. Not a soul was to be seen. Private, pristine paradise is everywhere on the island. Heaps of strip paper seaweed had blown in from the west. I felt like I was suddenly in Polynesia. We laughed and rolled in these soft mounds. This was the place. We would install here for a weekend of sound made by the locals and the public. There was no other place like Lillies: an ancient antipodean paradise with a sad history, very Australian. We would celebrate it through a temple garden of sound suspended on sea and land and the sound would be activated by wind and water. Sound bows in hand, I swam the length of the old pier to test the listening distance and to design the intensity of sound needed. At high tide, some more resonant sounds would be needed to travel the distance to the listeners.

Some months later after planning, two days of workshops and phone calls and a couple of solar powered e-mails, we made the seashore into a sound garden. Hundreds of aeolian bows were planted in the sand and onto the old jetty, their songs free. The bird scare tape was tied into double and triple harps.

Wind Bows

The divers donned their wetsuits in the icy waters of the September Equinox. An enormous sound sculpture made from an upside down woven paperbark canoe, recycled from another performance but made by some of the same people, was built into a large sculptural form at the end of the pier. Elaborate wind chimes made from glass and brass bells were suspended on a bamboo and rope hammock and undertied with rust minnow fishing net. I had brought these materials from the mainland as exotic materials and general building necessities are hard to come by. There are few shops and everything has to be imported, at a price.

Sound Installation Lillies Beach, Flinders Island.

The coastline merged sea and shore, changing places every moment in sound and image. Wind harps littered the shore. The old discarded, weather-beaten pier vibrated again, not with boats but sonic vessels, suspended from this large sound sculpture, played by the tide. A large suspended bell was anchored to the hammock with a floating buoy, so the tide ebbing and flowing jostled the bell, sometimes rang it and constantly contributed to the kinetic movement of the entire piece.

Tidal elements, the sea played the bell.

The garden became built over the sea. People brought and installed sounding objects of their own, tuned cut Aeolian plastic bottle sculptures and portable kora and sounding pieces became the garden.

Phil's portable battery powered sound sculpture

Phil's portable battery powered sound sculpture lit up at night, the head of the carved anthropomorphic beast supporting a kora and electronics in its base. It was an instrument, sculpture and CD player in one. A large group of us built a beach living room and cooked soup for all. Digital recordings were made and from time to time Phil surprised us all with irrelevant sounds of cockerels and magpies coming out of his battery powered sound sculpture, loudly in the middle of the night. Musicians wandered up into the hills at the back and played long tones and riffs to each other, which filtered down onto the shore. The public came and went in their hundreds over the weekend; listening, watching, contributing, appreciating the wind and the sea, the dominant strains of existence on the island. Many stayed the night, reveling in the wisp of wind and tide and the sounds they brought to them. We had created a listening sanctuary.

No one could bear to take down the sculpture. A large round granite rock rather like an egg, was given to me by Jon Hizzard, a powerful organiser through the entire time, as well as an expert juggler and drummer. This stone now lives in Melbourne but I know I have to return it to the island some day. Phil gave me a paper nautilus shell, a transparent paper cradle built by the little octopus *Argonauta Nodosa* to hold her eggs. It is an acoustic form, replicating the ear's cochlea, and it is paper thin. It's as if the sea was made for listening, and of course it is. Phil had used a nautilus shell with a red LED inside on his sound sculpture so it would illuminate at night. The red glow was awesome on Lilies. I look forward to more sounds from this island paradise. Thank you to the people of Flinders Island for inviting me to help sound the island in a new way, and for a wonderful opportunity for us all to create collaboratively through our common expanded awareness of sound on Flinders Island.

Ros Bandt is an internationally acclaimed sound artist, composer and researcher. She interprets and sounds sites in unique ways, having created over 45 installations, and many radiophonic works worldwide. She is a pioneer of sound playgrounds, sound sculptures, interactive spatial music systems and sound installations. Her original compositions and writings on sound are published by EMI, Wergo, New Albion, Move Records and Fine Art Press. She is director of the *Australian Sound Design Project* at the University of Melbourne.

Five Years of Spirited Encounters

By Ray Gallon,
Steering Committee Member, Collectif Environnement Sonore(CES)

The Collectif Environnement Sonore (CES) was founded in 1996 to advance our work after the international acoustic ecology congress at Royaumont, France in 1997. It is conceived as an organisation without frontiers—based in Paris, but open to members from any part of the world—and without formal structure. This open structure has, by avoiding any kind of organisational or political distractions, allowed the CES to be very efficient.

Our principal activity over the last five years has been a series of meetings, under the direction of Pierre Mariétan, held every summer in the Swiss state of Valais, called the *Rencontres A.M.E.* ("Encounters A.M.E.–Architecture, Music Ecology." In a play on words, the letters "ame" also spell the French word for spirit or soul). The purpose of these meetings is to bring together people who work with the acoustic dimension, regardless of their professional discipline, to share their experiences and refine the work of describing the notion of a quality sound environment and defining criteria for it. The next step is to find the best means to apply the results of such research to urban, architectural and social practice. Each year, between 30 and 40 participants—experts and interested citizens—have joined us from at least eight countries on four continents as well as the local community. Each year the site is chosen to present a different façade of the sound environment of this region of the Swiss Alps.

The first two *Rencontres* were held in the village of Saillon (1998), a village perched on a promontory backed by upward-sloping vineyards, and facing the Rhone valley with its highways and mix of agriculture and industry; and the city of Sion (1999), a moderate-sized urban centre on the valley floor, whose main street completely covers the rivulet that runs through it. Participants were offered daily soundwalks and roundtables or presentations on subjects as varied as "The Time of Listening" (composer Pierre Mariétan), "Architecture and the city-inhabited sound space—mastering the elements of a composition" (architect Xavier Jaupitre), "The Horizons of Noise" (geographer Justin Winkler), "The Acoustic Dimension of Multimedia" (philosopher Roberto Barbanti), "The Social Role of the Artist" (sound artist Ray Gallon), and "Sound, Architecture and Health" (architect Mario Zoratto), to name just a few.

These sessions are complemented with evening concerts of music by musician participants and others whose work is informed by listening practice, and with explorations of the acoustic phenomena of the region (for example, a tour of different carillons in the area). The involvement of local groups and individuals is an important part of this activity.

In the third year, we realized that we had explored a lot of territory with the original format, but needed to move from exploration into practice. The *Rencontres* for the year 2000 were held in a tiny Alpine village, Chemin Dessus, overlooking the town of Martigny, the flood plane of the Rhone, and the Dranse valley. There, ensconced in an old-fashioned inn, a small group of people worked intensely on a series of listening exercises in order to truly hear the site—one which, being far from any urban centres, produces relatively little "noise" in itself, and thus allows us at one and the same time to hear distant, global sounds (from the valley floors, for example) and single signifying sounds which emerge easily in that environment.

Our work was done in three stages:
1) Listening to the site (various locations, different times of day...)
2) Analysis of the sonic data and work on how to represent this information (memory techniques, vocabulary, methodology...)
3) Exploring the problems of intervening in the sound environment (how to raise consciousness, what action to take, possible consequences...)

In our final synthesis, we worked together to identify signifying factors—a combination of objective and subjective criteria—that can be adopted in order to make this work concrete and realisable at social and political levels of society, and to raise general consciousness. An article, a first attempt at communicating our work, was published by philosopher Philippe Sers and Pierre Mariétan.

The results of this experience were encouraging enough that we decided to alternate formats—returning to the roundtable and presentation format in odd-numbered years, and retaining the workshop format for even numbered years. A local working group, l'Association A.M.E. was formally organised in Valais to facilitate the continuity of the *Rencontres*.

The last two years have followed this pattern. In 2001, based in Vissoie, Val d'Annivieres, we offered a series of debates and presentations on the type of listening one is apt to develop from the practice of a given discipline: a musician's listening (composers Robin Minard and Peter Streiff); an architect's listening (architects Jean-Pierre Giuliani and Mario Zoratto); a cultural mediator's listening (cultural mediators Janete El Haouii and Hoël Corvest); an acoustic researcher's listening (acoustician Jean-Marie Rapin); a sociologist's listening (sociologist Gabriel Bender). These were accompanied by additional roundtables, debates and presentations.

The 2002 edition was based in the town of Les Haudères, the geological point where the European and African tectonic plates meet. A vocal workshop explored the relationship between the naked voice and three different architectural volumes. This collaboration between Pierre Mariétan, Franziska Baumann, Laurence Revey and Brigitte Schildknecht (based on work begun the previous year in concert) was recorded, and a 35" CD produced. A second workshop continued the type of listening experience we applied at Chemin Dessus, but this time emphasising the differences between the way the ear hears and the way the microphone hears. Eight sites in the region were chosen for intensive listening. Each listening period was also recorded, and at the end, we compared our perceptual differences between these two listening situations—also coloured by memory and its quirks. Our objective was not to remember specific sounds, but to find ways of qualifying how the sounds were expressed in the given acoustic environment where we found ourselves. All of us found it quite difficult to move from the simple identification of what we heard to the more complex task of understanding how the sound reverberates and resonates in acoustic space. As usual, the sessions were accompanied by concerts and related explorations of the territory.

Future plans for the *Rencontres A.M.E.* include publishing and diversifying our sites. A first contact has been made that could lead to a book of proceedings for the first five years, with selected proceedings from the Royaumont conference included.

The CES steering committee also agreed that the *Rencontres* should move around: odd numbered years will now feature two events—the major session of roundtables and presentations will be held in a different place each year, with a small, music-based workshop maintaining continuity in Valais. Even numbered years will see the intensive workshops returning to our Swiss base in the Rhone valley. The 2003 Rencontres A.M.E. are planned for Sion and Barcelona. The Barcelona sessions feature a Radio workshop (radio as element in, and actor on, the sound environment; the role of internet radio, digital broadcasting, environmental radio...) and our first exploration of a dense, urban metropolis. Dates and details will follow as plans develop. The Sion workshops will take place August 18-24 with the theme *Composition Musicale Composition Architecturale* (musical composition architectural composition).

The 2004 *Rencontres* are programmed in conjunction with the Association Suisse de Musiciens, the official Swiss musical organisation, September 1-5, 2004.

Members of the CES steering committee: Roberto Barbanti (Italy/France), Michael Fahres (Holland/Germany) Ray Gallon (Spain/France/Canada), Pierre Mariétan (France/Switzerland), Hoël Corvest (France), Janete El Haouii (Brazil), Ryu Maruyama (Japan).

Ray Gallon is a Canadian sound artist and radio producer (CBC, NPR, WDR, France Culture...) and former programme manager of WNYC-FM, New York Public Radio. He is a co-founder of the CES. He currently teaches sound and multimedia at the Université Paul Valéry in Montpellier, France and shares his time between Montpellier and Barcelona, Spain.

The Nature of Sound at Biscayne National Park

The text which follows is from the Biscayne National Park web site www.nps.gov/bisc/ and has been written to encourage visitors to listen attentively to the aquatic world into which they will venture. Hopefully this will encourage them to turn off the motors of their boats with which they enter this park. Reprinted here with permission.

There is some effort underway in America's national parks to recognize the value of the soundscape as well as the majestic visual beauty of wilderness lands. The following describes the soundscape experience visitors may have while exploring the water based environment of Biscayne National Park.

Biscayne National Park is located about 35 miles from the Miami International Airport at Convoy Point, Florida. It is a wonderful place to visit. The mangrove shoreline, crystal clear waters, emerald isles, and living coral reefs attract nearly 500,000 visitors a year. Most of these visitors enter the park by private boat. They fish, cruise, and enjoy the waters of the park. They picnic and camp on the islands. And with snorkel or dive tanks, they explore the exciting kaleidoscope of life that is the living coral reefs.

When you visit Biscayne National Park, you enter a world of memorable sights. When you listen, you enter a world of inspirational sounds.

Think about what you want to see on your visit, and imagine what you hope to hear too. Search for special sound environments, just as you might seek an outstanding view. Although they may not be marked on a map, soundscapes are great points of interest.

During your park visit, you can walk on a nature trail at Elliott Key sheltered by silent green leaves, or find a place where a sense of history still whispers in the wind. At Boca Chita Key as well as other park areas, you may encounter the fluttering of shorebirds wings as they land on the beach, lapping water on the fossilized coral shorelines, or encounter a thunderstorm.

At the Dante Fascell Visitor Center, you can walk along the mangrove fringe shoreline, where you may hear the occasional slap of a grouper's tail, a snort of a manatee, and the call of an osprey. While snorkeling or SCUBA diving on the reef visitors can enjoy the sounds of parrot fish feeding on coral, and the sound of shrimp clicking their claws together. Many other natural intermittent sounds can be heard in the park that can inspire visitors with a sense of peace and tranquility.

Soon you will discover that complete park experiences feature both sights and sounds.

Soundscapes are acoustic (pertaining to sound) environments. People experience soundscapes by hearing, rather than by seeing. Soundscapes may include both mechanical and natural sounds. They may vary in their character from day to night, and from season to season.

Natural Soundscapes are park resources that may include the sound created by wind, flowing water, crashing waves, mammals, birds, insects, and other biological and physical components.

Natural Ambient Sound Levels are the natural soundscape conditions that exist in a park in the absence of any human-produced noise. This is sometimes referred to as natural quiet.

National parks include a symphony of natural sounds that is a rich natural resource important to ecological communities.

In the wild, sound is a matter of life and death. Birds, insects, mammals, and amphibians rely on complex communication networks to live and reproduce. In habitats where wildlife vocalizations signify mating calls, danger from predators, or territorial claims, hearing these sounds is essential to animal survival.

Research in bio-acoustics (bio = life, acoustics = sound) is an important tool for defining the health of natural habitats. Scientists can discern details about animal populations and behavior by recording sounds in the wild. Such bio-acoustical recordings are used in a variety of ways, including bird censuses, bat echolocation studies, and marine mammal surveys.

MonteVideo Soundscapes

By Hans Ulrich Werner

The CD edition of contemporary new music in Uruguay carries a provocative image by Uruguayan painter Joaquin Torres Garcia: it shows the inversion of Eurocentric geograpy, where north and south are upside down. We in the North, where most soundscape activities take place, are down South in this view. Normally the Southern hemisphere is an exotic landscape for new sounds, a place to visit, to become aware of lacking environmental sensitivity and to record unique sonic events. The image seems to be both a bitter and satirical icon—and reflecting emancipatory motion and energy, even for a still underdeveloped country like Uruguay.

The Montevideo Soundscape Project reflects both dimensions—a strong interest in innovative communication and deep contemplative listening ability to understand your own world through the ear. Composer, Tonmeister and Music Director Daniel Maggiolo is certainly the key in this sonic motion. His keywords are the idea of dialectical change and of interaction between musician and every-day listener, especially well portrayed in his excellent works for tape and musicians. Daniel, musical Marxist for many years, is very interested in technology and new methods of sonic processing, but always sensitive to the connection between our compositional tools and the industrial, dominant civilization from where they come.

Through his ambitions in electroacoustic composition he found his way to the soundscape concept and applies it to the sonic landscape of his own country. In his teaching, researching and composing he emphasizes a collective approach, challenging the people in their ability to listen and to design new sounds, as well as aiming to enhance their talents and potential. Especially in our soundwalks through the city and towards the broad Rio de la Plata I liked the strong collective experience and the de-coding process.

Life in Montevideo seems to have its own 'Art of Pausing,' overlaid and enforced by the strong dynamics of traffic. Many longitudinal streets are loud and dense, the crossroads are more silent, even rural. A walk around the block turns into a composition of loud and quiet sound, with floating dimensions of space, sound walls and listening islands. I learned much from the poetic, soft spoken and deep words listeners of all camps of life found for their experience through the ears.

People here seem to live a contemplative culture, always carrying a small gourd with mate tea along with them, always ready to refill, to share and to communicate in their daily life. Walking along they cut through the heavy traffic, meet the nasal sound of vendors and blind people, a sound to be reheard in the strong collective singing of murga music during carnival and in the new *Canto Uruguay* by Jaime Roos. In his best songs he expresses acoustical identity and a deep connection to the 'poetic' place in the city and culture. 'Life is hard and the night is dark'—but sound and song mean the acceptance of suffering, not its nostalgia. People seem to sing and dance to survive.

The musical soundscape in this country goes far beyond the proverbial tango or spontaneous choir rehearsals in the streets—into new music, fusion and a devoted sense for the Afro-American, Afro-Latin tradition. Writer and journalist Eduardo Galeano writes, that drums—like fairy tales and dreams—sound through the night. And like the night they are dangerous, deserve caution and often they are guilty, he says. The Candombe drumming, one of the most vivid and surviving expressions of slave music, is perhaps the strongest image for a social soundscape within the metropolis. Music, drumming, a polycentric motion, a collective wandering along the urban streets, an undulating energy field of people that seem to assure themselves: 'we are still here'. Soundscape walks are called a subversive experience and these Candombre walks certainly are, with their additional iconicity of motion, fire, sound and symbol. They are a symbol for the fact that a minority of people in this country are ready to turn the Nordic picture upside down, and with small means and greatest listening gifts do their best in promoting its culture and country. The Montevideo soundscape is a time axis, turning forward and backward at the same time. Many layers of the past and options for the future are audible simultaneously. Daniel Maggiolo symbolizes this in one of the best compositions for drums and electronic tape—both a deep physical experience of sound and rhythm, and a reflected connection of the human ear and body into the world wide electronic cultures of the future.

Escuchar el paisaje sonoro es otro camino para transitar la vida. Pero de lo que se trata es de cambiar la vida. To listen to the soundscape is another pathway through one's life. But mostly the point is to change life.

Hans Ulrich Werner. Sound designer at the Studio für Klangdesign, Westdeutscher Rundfunk (WDR), Cologne, Germany, author and composer of audiofilms (Hörfilmen) and city-soundcape-images (Stadtklangbildern) of Lisbon, Madrid, La Palma, Stockholm, Vancouver, Chicago, Cologne and Montevideo. Publications: *Soundscapes* 1992, *SoundscapeDesign* 1997, *SoundscapeDialog* 2003.

Soundscape Research in Uruguay

By Daniel Maggiolo

Introduction

Ecology does not seem to be an important issue in Uruguay, and acoustic ecology seems to be even less important. I would even say that for most people in Uruguay acoustic ecology is not an issue at all. The soundscape is a given fact and nothing can be done about it. It is not even worth talking about.

Since nothing can be done, nothing is indeed being done. For instance, too many Uruguayans open the doors of their car before turning the alarm off. One of the main goals of our project is to increase people's awareness of the soundscape as a relevant topic, indeed to help them in understanding themselves as both consumers and producers of the soundscape as it is.

Ecology, at least as I conceive it, is not just about preserving the environment, but rather about the responsibility that human beings have in their interaction with the environment. A constant dialectic exchange occurs between human beings and nature. Human beings necessarily transform nature, causing it to react, and that in turn leads to transformations in human beings. Increasing awareness about the fact that our actions inevitably have consequences on nature and on ourselves, is a good starting point.

Soundscape Research in Montevideo

The idea of starting a research project of the Uruguay soundscape grew out of my own interest in sound and its qualities as raw material for my electroacoustic compositions. My experience of living in a pretty noisy neighborhood that can turn quiet on Sundays or holidays, led me to think about the role sound plays in determining the quality of our lives.

The project began in 2000 and was based in the Electroacoustic Music Studio (eMe) at the State University's Music School. A working team was created, where students can participate in the project.

The project builds on the fact that human beings have a double dialectic relationship to reality, both a functional and an aesthetic one. From the functional point of view, soundscape is a source of important information that people could use for improving the quality of their lives. From the aesthetic point of view, soundscape could and should be enjoyed.

We have defined this first phase of the project as a learning phase: getting to know the real nature of the soundscape of the city we inhabit. That is, learning to listen; also, learning how to work and be in dialogue with other people in order to increase their awareness of the soundscape, its quality, and consequences.

Documentation and Analysis

We are making recordings of different soundscapes in our country, in order to develop an archive of this sound environment. Potentially it would show future generations what the soundscape of this community was like at the beginning of the 21st century. It also provides a good foundation for future research on this topic.

In addition we are concerned about devising a proper methodology for soundscape analysis, the results of which would allow us to make the best decisions and take the most appropriate steps in each particular case.

Quantitative analysis, such as is usually carried out in the field of noise abatement, is just one part of it. However, the sound with the greatest sound pressure level is

Photos: Alejandro Flain

Though it is actually a river, we Uruguayans name it the sea. It makes out the essence of Montevideo, and it shapes the soundscape of the city significantly. In frame 1 of the sequence: Hans-Ulrich Werner with Laura Robales and Leonardo Fiorelli, members of the Soundscape Working Group Montevideo, plus some unknown bystanders.

Photos: Alejandro Flain

On Sunday evenings the Candombre-drums go to different locations in Montevideo. People create their parade into their own ritual and walk and dance with them.

not always the most annoying one, and possibly not even the most damaging one.

Based upon the dialectics between functionality and aesthetics, sound quality is something that also needs to be considered in researching the relationship between human beings and sound environment. Revealing the dialectic relationship between qualitative and quantitative analysis seems to provide us with a good methodological foundation for researching the soundscape.

Special attention is paid also to the dialectics (once again) of individual and collective perception of environmental sounds, as well as to their meaning—both to individual and communally shared meaning—considering the context in which they are produced and perceived.

Soundwalking Montevideo

Invited by the Uruguayan University's School of Music and the Goethe Institute, German composer and sound designer Hans-Ulrich Werner held a workshop in Montevideo in November 2001. The workshop sought to establish a balance between theoretical approaches, listening, and practical activities.

Many soundwalks were conducted as part of the workshop and participants found out the relevance of that practice. They were able to (re)discover the sounds of their city, the different rhythms, silence, and even its (unexpected) birds. "Surprise" was a common word heard during the discussions on these soundwalks.

In a concert held at the Goethe Institute, we had the opportunity of talking on the phone with Hildegard Westerkamp—whose presence was felt in all activities through Werner's comments and indications. Upon defining her concept of acoustic ecology, she introduced us to her work *Gently Penetrating beneath the sounding surfaces of another place,* played afterwards at the concert.

During the soundwalks carried out the following day participants concluded that, having listened to Westerkamp's piece and her comments, made them think differently about the sounds of their own city. It lead them to pay attention and listen to the soundscape and its particular sounds in a very different way. This is an example of how music—sound art, in general—can contribute to the development of a different level of consciousness, which, of course, should always be one of the purposes of art.

Ecology and the Third World

One final remark (or question) about ecology. Can ecological thought and practice be developed in our underdeveloped countries? Better said, will the rich and developed countries (i.e. the ruling economical power system) allow ecological thought and practice to be developed in underdeveloped countries?

Globalization is but a new term for an ancient reality, in which some countries (the wealthy and developed ones) think they have the right (they surely have the power) to decide what is best for the rest of the countries, assigning different roles to the different regions of the world.

We are seen mainly as a cheap labour force and as suppliers of raw materials. Ecological thought, but particularly ecological practice, makes processes more expensive, standing against the interest of the ruling economical system, and therefore is unlikely to be tolerated in the current global system.

In this regard, developing people's awareness of, and commitment to, their civil rights—including those related to sound—become increasingly important, and represent a step forward to achieve and grant these rights.

More information about the Uruguayan Soundscape Project can be found at: http://www.eumus.edu.uy/ps/

Daniel Maggiolo is a composer and musician/Tonmeister, as well as a faculty member and researcher at the School of Music, Universidad de la República in Montevideo, Uruguay. Currently he is leading the research project on the Uruguayan soundscape, described above.

The sound of the tambores (candombre-drums) is perhaps one of the most characteristic sounds of Montevideo. It happens always in the streets, and its increasing occurence during the last decade has made it into an outstanding soundmark in Montevideo's acoustic environment.

Eyes Closed: An Aesthetics of the Unseen

By Justin Winkler

From August 18 to 23, 2002 the third Summer School *Eyes Closed*, took place in Siikaniemi Hollola (Finland), organized by the International Institute of Applied Aesthetics (IIAA) at Lahti Polytechnic with Tero Hyvärinen, chairman of the Finnish Society for Acoustic Ecology (FSAE). Participants and teachers were from Finland, the UK, Austria, Switzerland, Russia, USA, Australia, and China. As varied as their origins were, they represented the scientific and artistic disciplines, giving the workshops the quality they needed in order to fulfil what the title of the course promised: aesthetics of the unseen.

Arnold Berleant, a scholar with an international reputation for his innovative environmental aesthetics, led the way into the thematic field, giving the vast number of questions and approaches a sound frame. The issue was to broaden philosophical aesthetic concepts—which so far had focussed exclusively on the visual—without throwing out the baby with the bathwater and condemning the visual. This is a delicate search for a delicate balance, because the active co-operation of the senses and a critical stance are required.

The contributions from teachers and other participants were bringing in the entire spectrum, from painting and visual appreciation, through sound, smell and kinaesthetics, to semiotics. The concepts and methods of Soundscape Studies were introduced by Helmi Järviluoma. Justin Winkler presented an approach to dynamic environmental phenomena derived from the soundwalk concept. Soundscape Studies proved strong with respect to empirical procedures but-— compared to the advanced theoretical concepts presented by all participants — relatively weak in the theoretical field.

A "darkness experience" organized by Matti Vilkka from Lahti Polytechnic consisted of an evening spent in complete darkness. It "showed" in an impressive way how deprivation of the visual can lead to both disarray and enrichment. The presence of people, recognised through their voices only, created different scales of space, and even postures of individuals seemed different from their light-day appearance. It proved how sound experience is akin to touch experience, a fact highlighted by Lévinas fifty years ago, well known to blind people but also intuitively known to all soundscape artists.

Thanks to the IIAA's courage to give this summer school the thematic opening beyond the visual, a philosophical programme emerged with high relevance for the future not only to Soundscape Studies, but to all fields dealing with the non-visual realm. It can be characterized by an attitude of engagement, as opposed to one of distancing or disinterestedness—an attitude urgently needed in the world of the 21st century.

The IIAA's upcoming activities are well worth consulting at: http://www.lpt.fi/io/

Justin Winkler is teaching human geography, landscape aesthetics and environmental phenomenology at Basel University, Switzerland. He has been involved in soundscape field studies.

Scandinavian Sound News

By Henrik Karlsson

The Music Museum in Stockholm just opened a new exhibition, called *The Sounds of Work—Songs, Music, Muzak,* financed by a governmental project aimed at preserving memories and artefacts from the age of industrialization. Here you can watch an early promotion movie for muzak; try to vacuum-clean a piece of oriental carpet while listening to various musical genres in a head-set, to find out which one is most "functional"; open up small boxes with recorded sounds and guess to which professions they belong (a hairdresser, a dentist etc.); and discover the effects of sounds and noise on work through a variety of playful devices. And long before the age of mobile phones, animal horns were used as signalling instruments—cow herding girls had a number of set tunes, meaning for example: "We have found a lost cow—come and fetch it!"

From Copenhagen, Denmark

Like in Hamburg, Brussels and Zurich, authorities in Copenhagen found that muzak can be used not only to invite people but also to deter a certain "clientele". The Central Railway Station had a problem with drug dealers and addicts occupying one of the main entrances. Police raids had no effects; the dealers were back in no time. But after setting up a muzak system, playing waltzes, brass band music and classical medleys (in copyright-free synthesizer recordings) the place became as clean as ever. The musical genres were deliberately chosen to frighten off younger people. Only one slight anxiety remains: that the new muzak will attract retired people instead and make them stay at the entrance for too long, reports the Copenhagen daily Urban.

From Gothenburg, Sweden

Audiologist Kim Kähäri successfully defended her doctoral thesis in otolaryngology at the Gothenburg University, named *The Influence of Music on Hearing. A Study of Classical and Rock/Jazz Musicians* (2002), based on tone audiometry and questionnaires conducted with 279 musicians. Readers interested in her findings can contact the author directly by e-mail: kim.kahari@niwl.se. Another two doctoral theses, on urban soundscapes and landscape architecture respectively, are expected to follow in March of next year: one by architects Björn Hellström (Noise Design) and the other by Per Hedfors (Sight Soundscape. Landscape architecture in the Light of Sound).

Henrik Karlsson is assistant professor in musicology at the University of Gothenburg. He was the research secretary at the Royal Swedish Academy of Music until 2001 and founded the Sound Council as a network for Swedish soundscape interests.

Quiet Places: Protecting our Natural Soundscape

Summary Report | Lecture and Roundtable
Building Partnerships | October 6/7, 2002

Background

In an effort to emphasize the importance of protecting quiet places and in building partnerships, the National Park Service (NPS) along with the Nature Sounds Society (NSS) and the California Library of Natural Sounds at the Oakland Museum of California, held a public lecture and environmental roundtable discussion around the topic of natural sounds protection and preservation. The lecture was held in the museum's James Moore Theater on Sunday October 6, 2002. The title was *Quiet Places: Protecting our Natural Soundscapes—An Afternoon with Bernie Krause and Marv Jensen*. The environmental roundtable discussion among the NPS, NSS and ten additional land management and environmental organizations was held Monday, October 7, 2002 at the NPS Regional Office.

Natural Quiet Lecture

Bernie Krause is an internationally recognized nature sounds recordist and author. He opened the lecture using a very effective combination of actual sounds from a wide variety of natural soundscapes, sonograms that illustrated the different "niches" into which the various sounds fell, and readings from his book, *Wild Soundscapes: Discovering the Voices of the Natural World*. Marv Jensen, manager of the National Park Service Soundscape Program Center, followed Bernie with a briefing on the mission of the center. Marv shared many stories from his experiences in several national parks including Yellowstone, Glacier Bay, and Sequoia and Kings Canyon. Marv also reminisced about what he had seen and heard when hiking through the canyons that were subsequently flooded by the Glen Canyon dam.

Natural Quiet Roundtable

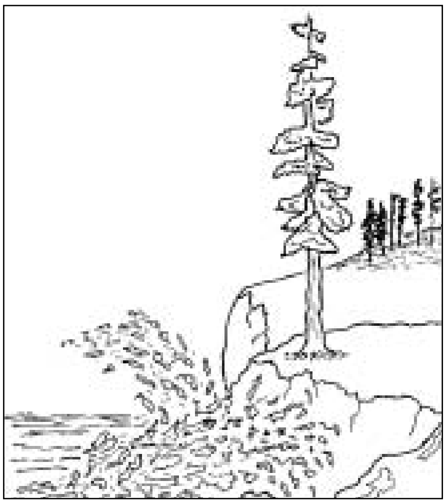
Monday, October 7, Marv and Bernie participated in a facilitated "Natural Quiet Roundtable" at the NPS Pacific West Regional Office. A group of twenty dedicated individuals participated representing twelve land management and environmental organizations involved with soundscape preservation. Organizations represented included the National Park Service, Nature Sounds Society, California Library of Natural Sounds, Sierra Club, Blue Water Network, Point Reyes Bird Observatory, U. S. Forest Service Pacific West Region, Audubon Society, Wild Sanctuary, Quiet Down America, Public Employees for Environmental Responsibility/Center for Sierra Nevada Conservation, and an Independent Radio and Television Producer.

Natural Quiet as a Resource

The mission of the National Park Service is to "conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." The National Park Service in its 2001 Management Policies took a major step and for the first time designated natural soundscapes as natural resources, which offers them full protection under the Organic Act, the founding legislation of the National Park Service. As stated in their Mission Statement the Nature Sounds Society (NSS) is "a worldwide, non-profit organization dedicated to the preservation, appreciation, and creative use of natural sounds. The Society promotes education on technological, scientific, and aesthetic aspects of nature sounds and the conservation of natural soundscapes." The NPS and NSS mission statements encompass the basic ideals of those who attended the roundtable.

Outcomes

The desired outcomes of the roundtable were threefold: 1) People from diverse organizations understand more fully the range of resources directed at natural soundscape preservation; 2) Participants identify areas of mutual interest and gaps regarding natural soundscapes preservation; and 3) Participants identify



areas where coordinated action can amplify the effectiveness of activities to increase/improve the resources of natural soundscapes.

Issues

During the roundtable we identified key issues for further discussions, which clustered around two main themes: 1. Education/Outreach/Partnering and 2. Science/Analysis/Methodology. Each group outlined a variety of desired outcomes and means of getting there. Members of the groups volunteered for one or more assignments each, and agreed to try to accomplish those tasks by the time the group meets again, in about six months.

Future

As a result of the roundtable the seeds of a Natural Quiet Coalition have been sown and sparks of long term support have been ignited in all those who were present. There are now a number of individuals and groups who are ready, willing and able to assist the National Park Service and each other in efforts to preserve natural soundscapes as a resource unimparied for the enjoyment of future generations. In six months another roundtable will be convened where we hope to have an even larger group from which to take action.

The Delhi Sound Scene

By Veena Sharma

November, 2002. As the festival of Diwali approaches the auditory hackles begin to gear up for an onslaught which even for Delhiites, with their sound sensations deadened by decibel encroachment, is far more than they can stand. That which was earlier a festival of lights and joy has now, at least in some cities in the north of India, turned into a noise filled event, vying to jar the ears with sounds meant to drive one to exasperation and annoyance.

Sound, which has been described by the classical Indian texts as the route to the highest truth, has now become a medium for deadening responses. Shrill, high-pitched horns fixed into trucks and buses pressed with impunity, loudspeakers blaring out 'religious' music or harangues, have become a part of life. Rather than attract, they deaden responses. People walk through the melee of sound like zombies. A screeching horn pressed next to a person's ear evokes no response. And when somehow attention is drawn, they seem surprised that it is them that were being addressed.

Noise calls for further noise in an attempt to attract attention. Perhaps that is why at Diwali time people vie with each other in trying to use crackers that are more deafening than others—to attract attention or to prove "I can create greater noise than you can." The Delhi Noise Pollution Committee has found that there is an increase to 125 decibels at Diwali which is very much above tolerable limits and can cause deafness.

It was timely for Toxic Links, an organization dedicated to raising issues of pollution, to hold a discussion on noise pollution. Mohanan of the acoustics section of the National Physical Laboratory said that noise was the least understood pollutant in India. It was seen as a transient thing and its effects were not recognized. That is why it has been a low governmental priority and it was only in 1986 that general legislation with regard to noise was passed. He described noise as 'unwanted' sound, sound 'without value' or 'undesired' by the recipient, or one that was 'distracting or harmful'.

Noise was sometimes countered by noise—noise against noise—by using another frequency of the same level to reverse that level, he said. And that any Delhiite is well acquainted with.

All civilizations traditionally have held a healthy sound environment to be of special value. The Romans, for example did not allow wheeled traffic after a certain time in the day. The Chinese placed the reason for the Great Flood on too much noise which they believed disturbed the gods.

In the era of over consumption and desensitization sound has taken diabolical proportions. In Delhi the ambient noise level does not fall below 55 dB. At traffic intersections, of which there are many, it goes up to 95-100 dB(A). Though the level of noise has not increased its horizontal spread has. As a result, areas which were earlier comparatively quiet now carry the same noise levels. Noise has become synonymous with consumption and affluence and people do not seem to recognize its impact on their lives. Cars with high-powered speakers go blaring through quiet residential areas.

That which allows one to turn inwards and to experience the Truth behind all has now become a tool for causing irritability, annoyance and neurogenic stress. Diwali, the Festival of Lights, has become more akin to a festival of flights which compels many to take shelter in areas where there is some sound sanity.

Sensitization to sound is important and it calls for various methods to be adopted. Perhaps those involved with 'sound' concerns will begin to take note of areas in which certain methodologies need be adopted, in order to tackle this problem.

Photo: Hildigard Westerkamp

Marigolds and candles for Diwali—visual quiet near main road.

Veena Sharma worked as the head of the Swahili Service in the External Services Division of All India Radio from 1989 to 2001. She has been a regular visiting faculty member at WICE, the International Centre for Excellence at Wageningen, Holland, where she has been exploring the philosophy of leisure and the nature of the leisure experience as seen through the study of Vedanta. She has participated in soundscape workshops in New Delhi since 1992 and in 1998 she collaborated in the sound installation *Nada—An Experience in Sound* at the Indira Gandhi National Centre for the Arts, New Delhi.

Sound Bites

Making Madrid Acoustically Gentler
The last thing first time visitors would expect when visiting this Spanish city known for its history, architecture, and culture is the loudness of the soundscape. Given the warm climate and long hours of outside street activity speaking loudly is a necessity when wanting to be heard. This behavior continues throughout the night both inside and outside making Madrid a bit high on the vocal decibel scale. City hall has initiated a public service *SSSHH. Control your noise campaign to quiet the city.* It began September 13 and will last through 2003. Mime artists with fingers raised to their lips roam busy areas of the city reminding people to be quieter. Posters, news releases, and a web site provide citizens with tips such as wear slippers, don't slam doors, honking, and stop yelling. Source: *The Associated Press*

Humpback Whales Change Tune to Attract Mates
Male humpback whales off the East Coast of Australia have been singing a different song in recent years. Researchers speculate that they gave up their old tune in favor of one they learned from a group of visiting Indian Ocean humpbacks, all to attract females.

According to Michael Noad, a whale researcher at the Marine Mammal Research Center at Sydney University, between 1995 and 1998, scientists analyzed more than 1,000 hours of humpback songs and the recordings contained a surprise. "By the end of 1997, the old song was virtually extinct. It had just about disappeared completely. And in 1998 when we came back to record again, there was nothing but a new song. It had taken over completely." Source: *CNN*

How Golden is Silence?
Lawyers for the John Cage Trust have settled a lawsuit over Rocker Mike Batt's composition, *A One Minute Silence.* The composition which is exactly one minute of quiet, it was argued, is similar in concept to Cages 1952 silent composition *4'33"*. Batt agreed to pay an undisclosed six-figure sum to the John Cage Trust. Batt noted, "We are... making this gesture of a payment to the John Cage Trust in recognition of my own personal respect for John Cage and in recognition of his brave and sometimes outrageous approach to artistic experimentation." Batt credited his piece to Batt/Cage on Classical Graffiti, the latest album by The Planets. Source: *globeandmail.com*

Tuning Into the Sounds of the Sea
Our oceans are often loud with the sound of volcanoes, earthquakes, whales, and other creatures of the deep. A hydrophone array, dedicated to civilian research of the health of marine life, is located off the Monterey Bay near San Francisco, California. This former military listening post provides scientists with the opportunity to study the migration of blue whales up and down the Pacific Coast. Marine biologist hear a variety of sounds in addition to the whales. Landslides and even suspected calving of Antarctic ice can be heard thousands of miles away on the other side of the ocean. Also heard is the increasing human noise of ship engines and submarines. Source: *CNN*

Feeling the Music
Some individuals attending a Liverpool concert were asked to take note of the emotions they experience while listening to an inaudible music performance in the British city's Anglican cathedral. The experiment was part of the work of a group of scientists and musicians, who studied the effect of infrasound vibrations at a frequency too low for human hearing. The idea is that low frequency music provides an emotional stimulus, something organists have often used when the music soars. The scientists hope to analyze the collected responses and see how it works and how long the effect lasts. An ultra-low-frequency loudspeaker inside a 12-metre long, 30-centimetre diameter pipe was used. The device transmitted vibrations at various moments in the 50-minute recital by Russian pianist Evgenia Chudinovich. No results have yet been reported. Source: *London AFP*.

Ocean Racket
If you ever thought of an ocean swim as a quiet escape, think again. Today, oceans are noisier than a motorcycle without a muffler. Boat propellers, deep-sea drills, and sonar—sound waves that ships bounce off ocean floors to map them—often blast sounds as loud as 170 decibels. That's 10,000 times louder than the most deafening rock concert. And that's set off alarm bells for scientists concerned about undersea life. They worry that exploding ocean noise may confuse and even kill animals that use sound to find food and mates.

"Marine mammals like dolphins and whales use sound like humans use sight," says Roger Gentry, oceanographer (ocean scientist) for the National Marine Fisheries Service in Silver Spring, Maryland. "If they can't hear, they could die." Whales, for example, communicate within their own group or pod through sounds as high as 20,000 hertz—the same frequency as most of today's ocean racket.

Also, sound travels four times faster in water than in air: 1,230 meters per second versus 340 meters per second, because water molecules are packed tighter than air molecules. So underwater sound travels longer distances before it diminishes. A dolphin swimming along the California coast may be able to hear deep-sea drilling 7,000 miles (11,300 kilometers) away off the China coast! Researchers have no concrete data on how ocean noise pollution will impact sea life. But they do know such noise is definitely not music to fish ears! Source: *Miguel Vilar Science World, Oct. 4, 1999, http://www.findarticles.com.*

Bush Administration Allows Snowmobiles in National Parks
The Bush administration has reversed a ban on snowmobiles in Yellowstone and Grand Teton National Parks, despite widespread support for the measure and 10 years of research detailing the negative impact from the machines on the health of the parks and their employees.

"The administration has argued that an outright ban is not needed and new technologies can protect the parks. This is in contradiction to the US Park Service decision that snowmobile use was inappropriate for the national parks. The Bush plan will impose daily limits on snowmobiles in the parks and on part of the highway that connects the two."

The ban, slated to go into effect this year, was challenged by the snowmobiling industry right from the start. In contrast The National Park Service received some 360,000 comments during the comment period, a record number for a park service rule. "More than 80 percent of respondents favored the ban on snowmobiles, a figure that advocates believe exposes the administration's indifference to the public's view on the issue." Source: *Environment News Service (ENS)*

Software Enables Deaf to use Cell Phones
Israel's largest mobile phone operator Cellcom and Israeli start-up SpeechView have launched a worldwide patented software that will allow the deaf and hard of hearing to communicate through mobile phones. The product LipCcell is a software installed in the user's computer and connected with a cable to a cell phone. When the deaf user gets a call, the software translates the voice on the other side of the line into a three dimensional animated face on the computer, whose lips move in real time synch with the voice allowing the receiver to lip read. Eventually the software will work with personal assistant technology. The kits, including a CD for basic training and cable, will cost $125. Source: *Reuters*

Acoustic Right-of-Way?
A recent acoustic-ecology listserv discussion noted that a Newfoundland, Canada Highway Traffic Act indicates that a horse-drawn vehicle has superior rights to the shared acoustic space when overtaking a slower moving motor vehicle—i.e. the motor vehicle must yield the acoustic space to the horse-drawn vehicle, by making no "avoidable noise" as it passes. Specifically, the law notes that...**138. (1)** Where a traction engine is met or overtaken on a

highway by a vehicle drawn by an animal or by a person astride a horse, the operator of the engine shall, where practicable, draw to the right and give the vehicle or person astride a horse at least 1/2 of the highway and, if requested by the other driver or person astride the horse, shall stop and remain stationary until the vehicle or person astride the horse has passed and shall, if so requested, help the driver or person astride the horse to pass.**138. (2)** The operator or the person in charge of an engine referred to in subsection (1) shall see that it makes no avoidable noise by whistling or otherwise when an animal is passing or is near or is about to pass the engine on a highway. Source: *http://www.gov.nf.ca/HOA/statutes/h03.htm#138*

Testing of Navy High-Frequency Sonar Blocked

A United States federal judge has temporarily blocked the Navy from deploying a new high-frequency sonar system amid concern it could endanger whales and other marine animals. The lawsuit brought by the Natural Resources Defense Council as well as other environmental organizations had requested the court to stop US Navy training with the sonar system which may harm whales and other marine mammals. The sonar system being used is able to send signals as loud as 215 decibels hundreds of miles through the sea. The objective is that these sound waves can help detect enemy submarines at some distance. The Judge did ask the military and environmental groups to work on a plan that would meet the needs of the environment and military concerns. For full story see:
http://www.wired.com/news/ebiz/0,1272,56149,00.html

Conversing with the Animals

A US$139.00 device, the Bowlingual, is now being marketed to those interested in understanding their dog's barking. The technology is based on 2,000 voiceprints from nearly a thousand dogs. The utterances are, it seems, fairly universal and allows for some interpretation of animal needs. The science behind interspecies communication uses some of the same techniques that have allowed human voice recognition to become a valuable application. Researchers at the Institute of Technology and Biosystems Engineering in Braunschweig, Germany, have recently been able to decipher, with about 90 percent accuracy, what cows mean when they moo: hunger, thirst, need for milking and so on. Full application of the technology is about five years away. Actual uses are still being explored. Source: *New York Times.*

Excessive Noise Impairs Children's Learning

Cornell University environmental psychologist Gary Evans and his European colleagues have concluded that excessive noise such as jet aircraft flying overhead has a direct effect on children's reading ability and long-term memory. A study of German schoolchildren was conducted which compared children living near airports who went to quieter areas and children who went from a quiet environment to a busy one.

The researchers analyzed data on 326 children (average age, 10) living near two sites in Munich: near the old airport, which was scheduled to close, and near the new airport site. The children were assessed three times: six months before the old airport closed and the new one opened, and one year and two years after the airport opening. "Noise exposure is consistently linked to reading deficits and may interfere with speech perception and long-term memory in primary school children," says Evans. "But it wasn't until we had this unprecedented opportunity to study children near the simultaneous opening and closing of the new and former Munich airports that we could actually find stronger evidence for a causal relation." The study, the first of its kind to examine the effects of airport noise on reading, memory, attention and speech perception in children, is published in *Psychological Science* (Vol. 13, No. 5, Sept. 2002). Source: *Cornell University news release, October 7, 2002.*

B.C. Harbour Seals Learn Killer Whale Lingo

Researchers from the Fisheries Department, Vancouver Aquarium, and Slater University of St. Andrews have discovered that West Coast harbour seals have a special life-saving skill—they have learned how to eavesdrop on killer whale calls. Harbour seals are the most common prey taken in the waters off the B.C. coast by transient killer whales.

"Two kinds of killer whales live in the waters off the B.C. coast—resident killer whales, which eat only fish, and transient killer whales, which prey on marine mammals. Researchers played calls of resident and transient orcas underwater. Local harbour seals scattered after hearing the mammal-eaters calls, but didn't flinch at recordings of fish-eating whales. The research also found the seals were able to recognize the calls of Alaskan fish-eating orcas, even though those whales remain in waters 600 kilometres to the north." Source: *Canadian Press Fri. Nov. 15 2002*

Banning Cell Phones in Movie Theaters .

A New York city council member wants to outlaw the use of cell phones in movie theaters. If the law becomes effective in December individuals talking in movie theaters or other places of public performance may result in a $50.00 fine. The ordinance is intended to provide a means for ending loud conversations while others are trying to watch a film. Councilman Philip Reed notes that, "I have witnessed people sit in the theater and dial their friends and give them a blow-by-blow description of what is happening." The cell phone industry argues that any ordinance is too much of an intrusion by the government into an area that should be ruled by common sense. The question of who would be responsible for enforcing the regulation is one yet to be answered. Source: Internet news report.

Sound Underwater

In a sound installation event by Trimpin a brilliantly glowing grand piano was floating on Lake Union, in Seattle, September 21, 2002. The piano continuously played itself, using a hydrophone to translate the audio signals into a midi score, creating a piano concerto of Nature vs. Human technology. As humans, we are unaware to what sound levels the habitat under water is exposed—motorboats, sonar signals and other technologies continuously interfere with marine life. The event showed the environmental impact of sound pollution on our marine inhabitants, using music as a metaphor. Source: printed information from artist.

Sound Journals

These Sound Journals were originally written as part of an assignment for Acoustic Dimensions of Communication, CMNS 259, at Simon Fraser University, Burnaby, B.C., Canada. This course is available both as a regular course taught on campus by Norbert Ruebsaat as well as through Distance Education www.sfu.ca/cde/courses/cmns/cmns259.htm taught by Robert MacNevin.


Photo: Hildegard Westerkamp

Underwater
by Edmund Ma

When I was 6 years old, I was diagnosed with asthma. To treat this condition I was in hospital for 2 weeks inside a plastic shell, being fed oxygen I believe. Actually, I'm not entirely sure what or how this process helped but it did cure my asthma so it would never again be life threatening. I recall running and having a difficult time breathing. My heart rate would increase and all I could remember after being chased by a dog and finally escaping by hopping a fence, was the sound of my lungs struggling to gasp for air and my heart beating. It would drain all sounds out of the acoustic space. It was as if I was under water.

By age 8, I was swimming regularly and we used to have contests to see who could sit at the bottom of the pool longest and I would usually win. It was because I was surrounded by water that I truly realized my biological rhythms. I think it was also a mental process: I was so focused on being calm and slowing down my heart rate that all I could hear was my heart beat and in the background the lo-fi hum of water in my ears.

Crescent Beach, British Columbia
by David Hicks

A cloudy Sunday, but the sun is beginning to show. I'm sitting flush against a newly dumped wall of boulders, which serves as a dike. The sea is in front of me about 10 feet ahead, with a pebble beach between and the tide is high. The constant background noise is that of small waves, cresting in white foam, curling like avatars of larger swells—starting as a hiss, then bursting into a momentary liquid crash as they break. This sound is made more complex by the micro-geography of this spot: the broken waves rush over a small bar of pebbles and broken shells, which bang against one another, rolling with the wave, making a sound like glass shards—a very delicate, tinkling music. The water rushes over this bar and fills a small lagoon no bigger than a puddle, creating gentler pulse waves on its surface, which themselves lap against the beach proper, in a slower rhythm than that of the crashing swells. Only every third wave or so has enough force to push over the entire bar, and push into this lagoon. All of this sound is amplified by the rock wall: it blocks out the sound of people on the walkway behind and above it, which I am accustomed to hearing in this spot—over all, it feels like a very private, very comforting space. But then an airplane flies overhead, and I am struck by the changes this brings: suddenly, the immediate, cloistered space of this little zone expands. The overflying plane provides a vertical background noise, which stretches the acoustic space upwards, placing a distant boundary on this space which previously had been so closely bounded. Almost as if in response to the plane, some crows begin cawing from a tree behind the wall: they are a natural part of this soundscape, and always have been. But I know through long association that they are fighting over a garbage can on the walkway. People, garbage, crows. These birds have an immediate and demanding call which asserts their presence, and as natural as they are, their disputations seem to puncture the little world of singing pebbles and waves. I figure I'll move on down the beach, to a less trodden spot, to compare the differences in location on the beach.

Degenerated Island Regenerated
by Brett Ziegler

Each summer I spend a couple of weeks working at a camp on Anvil Island in Howe Sound near Vancouver. This camp fills a large portion of the island, and is sonically reasonably isolated from others living on the island. The 200-person camp is powered by a large diesel generator, which is turned off at night. Although the generator is quite loud (around 65-70 dBA), we are usually nearly a mile away from it, and our ears adapt to it. Every night the generator is shut off, I make sure to be outside, on my back, in near silence. The experience of a rich natural soundscape breaking forth from beneath the silenced drone is phenomenal. The ocean provides faint periodic gestures, a myriad of trees begins to stir, and you can literally hear the meadow as it draws moisture from the earth. Distant animals cry, and a variety of insects begin their song. There is competition between sounds even at this level, as some specific sounds begin to become indistinguishable—each being masked by others. It's an aural microcosm for our urban soundscape, and it reminds me that harmony can be found in the city, too.

Resources

WEB SITES

Atlas of the Oceans
http:// www.oceansatlas.org/index.jsp

This online publication is the culmination of more than two years of collaboration between the UN and numerous scientific institutions, including the National Geographic Society, the Census of Marine Life and the Food and Agriculture Organization. The Atlas features 14 global maps, links to hundreds of other related sites, and more than 2,000 documents on 900 subjects ranging from climate change to poisonous algae. The Atlas is an information system designed for use by policy makers who need to become familiar with ocean issues and by scientists, students and resource managers who need access to underlying data bases and approaches to sustainability.

Acoustic Ecology Project
University of British Columbia,
Vancouver, Canada
http://www.cs.ubc.ca/~kvdoel/acel/
Contact: acoustic-ecology@cs.ubc.ca.

Understanding Listening: The goal of the present research team is to understand how humans of all ages, who have either normal or impaired hearing, listen in the realistic situations they encounter in everyday life. We aim to incorporate new knowledge about how people process auditory information into a more general cognitive science model that accounts for how multi-modal sensory inputs (auditory, visual) are coordinated during information processing and how sensory and motor processing are coordinated during perception and production of sound...

Acoustic Ecology is a term that captures our new conceptual approach to human auditory information processing. It builds on traditional disciplinary research foundations, with the key novel feature being that our interdisciplinary research reinstates the listener in the listening environment. Specifically, our approach combines traditional disciplinary research focussing on listeners (e.g. audiology, linguistics, neuroscience, otolaryngology, and psychology) with research focussing on the physical environments (room design, computer science, engineering) and the social situations (anthropology, education, and linguistics)

The project has three research areas, each with several subareas to examine these interlocking issues: The psychology of listening, synthesis of complex environmental and human sounds, and ethnographies of acoustic ecology.
Source: *website*.

Centre for Acoustic Ecology Research (CAER)
University of Calgary, Alberta, Canada
http://commons.ucalgary.ca/~sanchez/caer/

The Centre for Acoustic Ecology Research (CAER) maintains an interactive online database of literature in Acoustic Ecology and its component science of Sound Cognition (psychoacoustics). The Centre's purpose is to provide a system for streamlining interdisciplinary literature searches in an extended bibliographic field, spanning several component disciplines. By so doing, we seek to facilitate the work of researchers, practitioners, and enthusiasts in this field. CAER's website is in the first stages of development.

AcousticEcology.org
http://www.AcousticEcology.org/
Contact info
AcousticEcology.org
Attn: Jim Cummings
45 Cougar Canyon
Santa Fe, NM 87508
ph 505-466-1879 fax 505-466-4930

AcousticEcology.org is a networking and resource information project begun by EarthEar founder Jim Cummings. EarthEar's emphasis is on the art of soundscape production, and is a network of individuals who release CDs that are creative interpretations of the sounding world. AcousticEcology.org involves a network of organizations and individuals who are engaged with the actual, living soundscapes of the world as they are directly experienced.

Early discussions of this site and its possible directions have involved academics, activists, and recordists, as well as active members of the World Forum for Acoustic Ecology, the leading organization in the field. The goal of AcousticEcology.org is to provide a central clearinghouse for accessing existing organizations, learning more about sound-related initiatives and environmental issues, and providing an integrated context for learning more about human and natural sound making.

AcousticEcology.org provides access to academic research, public policy advocates, and articles and essays about sound and listening. We hope that these diverse threads of information and passion will be of service to policy makers, the media, and interested individuals. Please be in touch with any comments or feedback you may have.

The Australian Sound Design Project
http://www.sounddesign.unimelb.edu.au

Provides a data base and exhibition spaces of some 40 Australian Sound Designers over 27 sites. The Gallery section under the names has photos, audio and descriptions of works. This is an ongoing research project and has important research tools and interesting papers and links.

The Public Cause Network
http://www.thepubliccause.net/LoudSONAR s.html

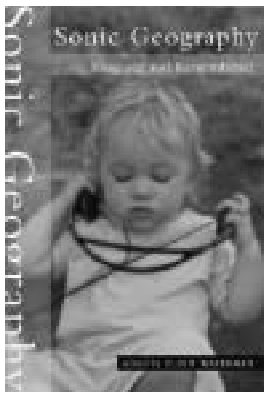
This is The Public Cause Network's comprehensive and detailed resource on SONARs and sonic devices, and the harm that they can cause to marine life.

BOOKS

Among Whales (Book and CD)
By Roger Payne
Hardcover: 431 pages
Publisher: Scribner
ISBN: 0684802104; (April 1999)

Among Whales combines a study of natural history and environmental concerns with an enthusiasm about whales. With over 30 years of research, Roger Payne, presents an informative introduction to topics such as: the social and mating behavior of whales, their migration patterns, and—of interest to acoustic-ecologists—whale bioacoustics. The book's appendix provides a good introduction to undersea acoustics. (Information edited from web sources).

Sonic Geography Imagined and Remembered
Ed. Ellen Waterman
Penumbra Press 2002
PO Box 940, Manotick, Ontario, Canada, K4M 1A8
Tel: +1 613-692-5590
Fax: +1 613-692-5589
http://www.penumbrapress.ca
ISBN: 1-894131-34-7
CAN$25.00



These are the proceedings from the *Sound Escape* conference at Trent University in Peterborough, Ontario, Canada, in 2000. The book contains essays on acoustic ecology and culture by Helmi Järviluoma, Brigido Galvan, Nigel Frayne, Keiko Torigoe, Doug Harvey, Bart Plantenga, John Wynne, Lydia Zielinska, Gayle Young and Hildegard Westerkamp

The Soundscape of Modernity:
Architectural Acoustics and the Culture of Listening in America, 1900-1933
Author: Emily Thompson
MIT Press 2002
The MIT Press Bookstore

Kendall Square
292 Main Street, Cambridge, MA 02142, USA
http://www.upenn.edu/pennnews/releases/2002/Q2/soundscapes.html

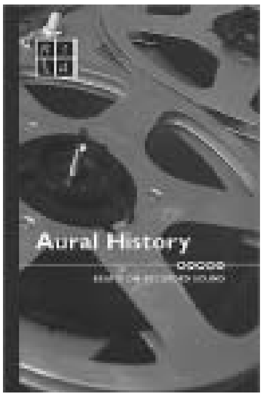
Since the turn of the last century we have changed the way we listen to the world. This change has been brought about through the development of tools which have extended our ability to listen over great distances, record and delay acoustic messages, and amplify sound making activities.

Technology has also brought about a major change in the soundscape of modern life. Machines dominate our environment from the hum of air conditioner units to the constant drone of freeway traffic.

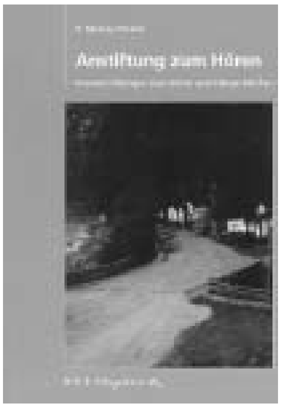
Thompson explores the dramatic changes to the soundscape as a result of technological developments. She explores the role of the acoustician in shaping sound by shaping the architectural environment and sheds light on the underlying cultural values and beliefs that shaped the development of acoustical engineering and sound manipulation in early 20th century America. Thompson is an assistant professor of history and sociology of science at Pennsylvania State University.

With the publication of this book Alex Van Oss reports on the nature and history of acoustics at:
http://www.npr.org/ramfiles/wesat/20020914.wesat.17.ram (RealAudio).

Aural History—Essays on Recorded Sound
Editor: Andy Linehan
ISBN 0 7123 4741 0
Price: £40.00
Order by phone from The British Library Bookshop with payment by Access, Visa and American Express.
Tel: +44 (0)20 7412 7735



This collection of essays presents a stimulating review of current professional issues for sound and audio-visual archivists and other custodians of time-based media. The book pays particular attention to the variety of institutional holdings and collections, as well as to the numerous and innovative ways in which sound recordings are being used in the academic and creative spheres. It includes an accompanying CD of sound examples.
Source: *Playback, Bulletin of the British Library NSA, No. 27, Summer, 2002.*



Anstiftung zum Hören (in German)
Hundert Übungen zum Hören und Klänge Machen
R. Murray Schafer
Translation: Klaus Wittig
Publisher: Justin Winkler
Available from:
HBS Nepomuk, Postfach, CH-5001 Aarau, Switzerland
Fax: +41 (0) 62 824 27 14
E-Mail: email@hbs-nepomuk.ch
Web: http://www.hbs-nepomuk.ch
Best.-Nr.: MN 714
ISBN 3 907117-1 4-X
CHF 32.- / 21.- (?)

This is a translation into German of R. Murray Schafer's *A Sound Education, 100 Exercises in Listening and Sound-Making.* For our German readers here is a short description:

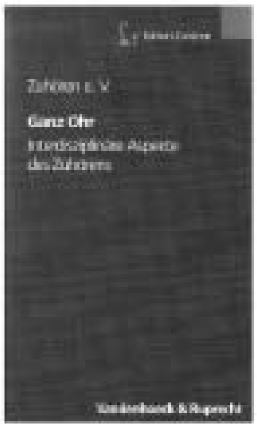
Unsere klangliche Umwelt hat sich in den vergangenen Jahrzehnten grundlegend gewandelt und verändert sich weiter in rasendem Tempo. Auf dem Gebiet der Erforschung dieser akustischen Umwelt ist R. Murray Schafer der Pionier: Zentrales Element seiner Arbeit ist der Soundwalk, der Hörparcours. Er erschliesst alltägliche Situationen und Erfahrungen auf neue Art und Weise und führt so zum bewussten Hören: sei es in der Grossstadt oder auf dem Dorf, im Einkaufscenter oder im Garten-Restaurant, auf einer Bootsfahrt oder bei einer Wanderung im Gebirge. Die Anstiftung zum Hören enthält hundert Übungen.

Sie richten sich ebenso an die Bürger, die ihrer Alltagsumgebung als kompetent Hörende begegnen wollen, wie an die Wissenschaftler, die Soundscape Studies betreiben, wie an Kinder und Jugendliche, die aus den mannigfachen Sinnesumwelten neue Energien gewinnen. Das Hören kann niemandem abgenommen werden. Von dieser Erkenntnis ausgehend gelingt es dem Autor ausgezeichnet, zu einem bewussten, differenzierten und kritisch reflektierenden Hören anzustiften.

Ganz Ohr (in German)
Interdisziplinäre Aspekte des Zuhörens
Published by Zuhören e. V.
Göttingen. Vandenhoeck & Ruprecht, 2002
(Edition Zuhören; Bd. 1)
ISBN 3-525-48000-8
http: //www.vandenhoeck-ruprecht.de

Soeben ist eine Sammlung von Beiträgen erschienen, die auf das grosse, von FKL-Mitglied Sabine Breitsameter organisierte Symposium *Ganz Ohr* in Kassel 1997 zurückgeht. Ganz Ohr sein heisst, sich aufmerksam zuhörend einzulassen, sich Zeit zu nehmen für das gesprochene Wort, den gestalteten Klang, eine Lesung, einen Gesprächspartner, damit eine kritische Auseinandersetzung zum Verstehen führt, damit Höranwendung mit Freude daran geübt wird.

Zuhören können ist eine unentbehrliche Voraussetzung für jede sprachgebundene Kommunikation und bei Musik Bedingung für eine qualifizierte Rezeption. So unverzichtbar das Zuhören für den gesellschaftlichen und politischen Diskurs ist, so wenig ist bisher darüber bekannt. Dieser Band versammelt grundlegende Beiträge zu den verschiedenen Aspekten des Zuhörens—so aus der Kulturpsychologie, der Zeitökologie, den Soundscape Studies, der Kulturwissenschaft.



Overtone Singing—Physics and Metaphysics of Harmonics in East and West
(Book and CD)
By Mark van Tongeren
Paperback (ISBN 90-807163-2-4)
Hardcover (ISBN 90-807163-1-6)
Publisher: Fusica
De Wittenkade 97-III
1052 AG Amsterdam
Netherlands
Tel/Fax: +31 (0)20-681 69 06
http://www.fusica.nl
email: office@fusica.nl

Mark van Tongeren is a singer and ethnomusicologist who provides a unique insight into the universal aspects of sound and vibration. Grounded in a decade long study of Asian music he draws upon various fieldwork experiences, interviews with Eastern and Western musicians in addition to the work of numerous scholars. He presents a multi-disciplinary vision on sound that runs from World and contemporary music to the science of acoustics and perception, to music philosophy and the spiritual dimensions of music. Written in a non-technical style, this book and accompanying audio CD is an indispensable guide to musicians and music lovers seeking a deeper understanding of the nature of sound.

The music CD contains a survey of different techniques of overtone singing in East and West and forms a complete anthology of Turco-Mongol styles of overtone singing. (Information edited from publisher and distributor sources)

COMPACT DISCS

Songs Across The Pacific
by Pacific Whale Foundation
Ocean Store at store@pacificwhale.org

Researchers use hydrophones and digital recording technology to explore the undersea world of the humpback whale.

Antarctica
by Douglas Quin
Wild Sanctuary Series
Miramar Recordings,
Seattle, Washington, USA
www.miramarupx.com
www.earthear.com

Field recordings by Douglas Quin in the Antarctic, a location known as the wildest place on earth. "The listener experiences the other-worldly voices of Leopard and Weddell seals and the creak and groan of glaciers." Using hydrophones, Quin has been able to capture the acoustic beauty of this frozen wilderness and the creatures that call it home.

Ocean Dreams
by Bernie Krause
Wild Sanctuary
www.earthear.com

Krause uses the studio to edit and compose his field recordings into soundscape experiences. He is able on this disc to provide the listener with the experience of the seashore by combining foreground sound with ambient sound background recordings.

Call of the Ocean
by Andrew Skeoch and Sarah Koschack
Listening Earth
www.earthear.com

This disc includes fourteen tracks of various lengths that provide the listener with a variety of soundscape experiences from tide pools, rock shores, to shoreboards.

Thalasa: Seashore Soundscapes
by Geoff Sample
www.earthear.com

Sample explores the Scottish seaside on this disc and takes the listener to a variety of coastlines, birds, mudflats, waves, and harbour ambiences.

The Song of the Waves
by Jean-Luc Hérelle Sittelle
www.earthear.com

This unusual disc provides the listener with the experience of an approaching and passing storm along the shoreline. The power of the surf is detailed as it grows increasingly rougher.

Ocean Flows
by Rik Rue
Tall Poppies
www.earthear.com

Rue explores the subtle sounds along the edge of the surf including small wavelets and tide-pools. Created from field recordings Rue has used the technology of the studio to create an overlay of sounds to highlight this micro world of sound.

Quiet Surf
by Jonathon Storm
EarthTunes
www.earthear.com

This recording was made on the Olympic Penisula of Washington State, USA, where the beaches along the Pacific ocean are far from heavy human foot traffic. Long period waves on sandy beaches enhanced with large driftwood from the North-West forests provide a unique soundscape experience for the listener.

Soundscapes of Uppsala—Ljudbilder från Uppsala
by Per Hedfors
http://www.lpul.slu.se/personal/phedfors/ph soundscapes.htm
Order at: miljotorget@uppsala.se

The city of Uppsala is explored through a series of recordings arranged as if on a soundwalk. Featured soundmarks include: The Cathedral, Skytteanum Archway, pedestrians, Linnaeus Garden, the railway station, the harbour, Skarholmen, Håga Mound, Eklundshof, Jackdaws, Gunilla Bell, and other acoustic features of this old Swedish city.

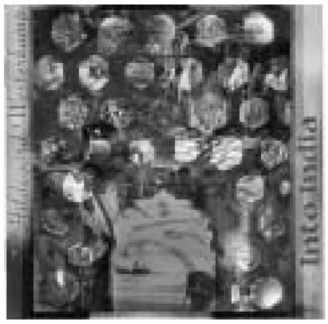
Radio Expeditions: Oceans of Life
by National Geographic and National Public Radio
NPR Educational Products: USA.
303-414-2843

This disc explores the rich variety of life in the mostly unseen, unheard and unexpected world that covers 70 percent of the planet. A rich palette of sounds provides a context for the exploration of issues related to the survival and demise of underwater life.

Into India
A Composer's Journey
by Hildegard Westerkamp
earsay productions
#308 - 720 Sixth Street
New Westminster, BC, V3L 3C5, Canada
Fax: +1 604-524-9356
Web: http://www.earsay.com

The highly anticipated *Into India* project was developed over a ten year period. "All sounds for these compositions," Westerkamp explains, "were recorded during my travels in India in the 1990s. They form the language with which I speak, of a relationship, of a love, that I developed for this initially very foreign place."

Exploring the contrasts and intensity which India presents to the visitor, "the relentless confrontation... the extremes between beauty and filth, glittering wealth and devastating poverty," *Into India* reveals Westerkamp at the height of her compositional and philosophical powers. These works have captured "the extraordinary intensity of daily living on the one hand and the inner radiance, focus, and stillness on the other hand that emanate from deep within the culture and its people..." The earsay productions label focuses on gutsy, beautifully crafted, new music ranging from soundscape and electroacoustic to instrumental composition and improvisation. Source: *publicity flyer*



CD-ROM

Antarctic Waves
Produced by British Arctic Survey and Braunarts
Funded by the National Endowment for Science, Technology and the Arts, UK
Free distribution to UK secondary schools-PC and Mac compatible
www.antarcticwaves.com

Polar researchers have collaborated with artists and designers to produce a CD-Rom that allows kids to investigate the science of the White Continent while at the same time experiment with sound. The disc explores five different branches of Antarctic research: ocean life, glaciers, astronomy, albatrosses and a strange phenomenon called whistlers, which are faint echoes of Northern Hemisphere thunderstorms.

Real data collected by polar scientists, such as underwater audio recordings, have been digitised to produce a set of component notes that can be arranged by children into a fantastic array of musical styles.

SOUND ARCHIVES

New Additions to Sound Collection

The British Library's National Sound Archive (NSA) just received as a bequest the late Bill Sinclair's 700 tapes of sounds of Scottish highland and wetland wildlife. It also received an important collection from the International Fund for Animal Welfare of hydrophone recordings of seals, whales and dolphins made by scientists on board the research vessel 'Son of the Whale'. Published acquisitions included donations of CDs from Nashvert Productions in France of the sounds of volcanoes, icebergs and caves. For more information go to: http://www.bl.uk/nsa Source: *Playback, Bulletin of the British Library NSA, No. 28, Winter 2002.*

Announcements

Acoustic Ecology: An International Symposium
Presented by the World Forum for Acoustic Ecology (WFAE)
Hosted by the Australian Forum for Acoustic Ecology (AFAE) and the Victorian College of the Arts, and participating partners.
March 19-23, 2003.
Melbourne, Australia
Web: http://www.afae.org.au

Presenting a unique event that brings together the full range of issues and disciplines within the field of acoustic ecology: the relationship between living organisms and the sonic environment. The symposium will include, invited presentations, limited paper sessions, workshops and forums, sound installations, soundwalks, and social events. (For more details see p. 4)

Symposium Klangumwelt: schon gehört?—Chi ha suonato? L'ambiente!"
Forum Klanglandschaft
March 15, 2003
Meran, Italy
Information: Albert Mayr
<timedesign@technet.it
Web: www.rol3.com/vereine/klanglandschaft

To date the programme of the Symposium consists of Papers Presentations (by Günther Olias, Germany, Justin Winkler, Switzerland, Giuseppe Anzani, Italy, Anke Haun, Switzerland, Elita Maule, Italy, Emilia Restiglian, Italy); Pedagogical Projects Presentations (by Marta Galvagni, Francesca Righi, Angela Casotti of the Conservatorio di Bolzano, Italy); Workshops (with Antonello Colimberti, Italy, Hannes Heyne, Germany); Sound Installations (by Francesco Michi and Luca Miti, Italy); Audiovisual Documentations (by Giuseppe Anzani and Alfredo Bigogno, Italy); plus Round Table Discussion, an Action (by Luca Miti), and a Concert of Soundscape Compositions.

Open Ears—Festival of Music and Sound
May 7-11, 2003
Kitchener, Ontario, Canada
http://www.openears.ca

Celebrating the art of listening with concerts, multimedia performances, electroacoustics, sound installations, and a symposium.

Soundscape Design as a Grass-Roots Movement:
Soundscape Association of Japan (SAJ)
Annual symposium of SAJ
May 24, 2003
Hirano Osaka, Japan
Contact: Atsushi Nishimura:
atsusi@yo.rim.or.jp
Web: http://www.omoroide.com/soundscape

This symposium is part of a series of projects to celebrate the 10th anniversary of the SAJ. A keynote report will focus on the Hirano Soundscape Museum (HSM), that was established in 1998 and has been run as part of a non-profit society, the "Hirano People's Network for Community Development." The museum is tiny and has been managed entirely by volunteers. However, this case, in which concrete activities are based in the grass roots of daily life soundscapes, could prove to be a very important example.

In the symposium, the keynote address will report about the activities of the HSM and a sound bazaar will take place in close co-operation with the people's network. The bazaar will consist of a lot of workshops, exhibitions, concerts and so on. The aim of the symposium does not focus only on soundscape but also on more comprehensive experiences in daily life. Our purpose is to give visitors some understanding of the attraction that we feel in our ordinary activities of community development. We have considered that this attraction may arise from the voluntary nature of our activities and that 'voluntarism' in that context is one of the most important concepts of soundscape design, in which any individual citizen can participate.

NYRIS 8—Nordic Youth Research Symposium 2003
Theme: Youth—Voice and Noise
June 11-14, 2003
Conference Secretariat Centre for Youth Research
Roskilde University
P.O.Box 260 Building P10
DK-4000 Roskilde, Denmark
E-Mail: nyri@ruc.dk
Tel. +45 4674 2300 · Fax +45 4674 3070
Web: http://www.cefu.dk/kalender/konferencer

The 8th Nordic Youth Research Symposium (NYRIS) is organised by the community of youth researchers in Denmark and the Danish Centre for Youth Research (CeFU).

On the one hand the theme relates to the general idea of young adults as representing a voice of the future: a wanted voice in democracy....On the other hand, while trying to enhance participation, many societal institutions are struggling to maintain control and rely upon well-established lines of structures and power relations, in which young adults often become noise rather than voice. Thus youth is considered the root of both moral decay AND change and innovation.

Youth research reflects on and participates in such discourses and sometimes goes beyond them. It gives channels of expression to the diversity amongst youth, to silent youth and it strives to make cacophonic noises intelligible for untrained ears and asks what the value of youth life is for young people themselves. Youth research is not only about youth. It is an arena for understanding ongoing social and cultural changes and spotting the problems and possibilities of the future.

The Danish Centre for Youth Research (CeFU) is a research unit at Roskilde University in Denmark. The purpose of the Centre is to examine and portray the ways in which young people form part of society and its institutions and to gather existing knowledge of the education selected by the young, their media habits, the crimes they commit, their ethnicity, health, political opinions etc.

First International Congress of Music Therapy, Medicine and Consultancy
Organisers: Institute for Musictherapy, University for Music and Theatre, Hamburg; International Society for Music and Medicine (ISMM)
June 24-28, 2003
Congress Centrum
Hamburg, Germany
Web: http://www.musik-und-gesundsein.de

Conference Goal: Perspectives, insight and definitions of music in practice, research and training for therapy, medicine and consultancy professions, coaching and supervision.

Music medicine as a science means the use of medio-functional music in order to support and supplement orthodox medical concepts of treatment in Prevention, Therapy and Rehabilitation. Practice research, for instance the use of music in pain therapy, music in the operating theatre, music for treatment of stress illnesses, music in geriatrics provide more and more evidence regarding the use of music as a health factor for individuals as well as groups of patients. The congress also aims to demonstrate increasing co-operation of music therapy and music medicine, thus moving towards a possible reunification. (Source: excerpt from congress brochure)

Call for Papers
The second Congress CATH hosted by the AHRB Centre for Cultural Analysis, Theory and History, University of Leeds, UK
July 11-13, 2003.
Deadline for paper and panel proposals: February 28, 2003.
Guidelines are available at:
www.leeds.ac.uk/cath/congress/2003/

The theme for this year is Warp: Woof, Aurality/ Textuality/ Musicality. Papers and sessions are invited on topics such as: New music theories, new musical objects, theorising through music and noise. Extra-diegesis: sound and the moving image. Installation and sonic art. Radio. Philosophy of rhythm: musical morphologies as modes of experience, memory, thought and novel perception. Acoustic cartographs: local music cultures, dissemination. Considering historical soundscapes. Grain, interpretation, accent, translation, voice. Acoustical technologies, reproduction. Media.

The warp and the woof is the opening of a field. Shifting from structuralism to post-structuralism, from system to speaking subject, from work to text: this puts into play new possibilities for thinking about sound, music, noise and listening, about the structure of audition, and about the listening, responding subject. Nietzsche diagnosed post-Socratic philosophy as fundamentally and constitutively unmusical, however the theory of the text signals the closure of that era. There opens a series of deconstructions of the voice in philosophy and in the metaphysics of everyday life, and of attempts to change the object of analysis itself, sparking genealogies of disciplinary power, desire and lines of flight. Although the writers evoked here (Kristeva, Barthes, Derrida, Foucault, Deleuze) only rarely themselves evoke those of the Frankfurt School, writers slightly out of phase in nation and period, nevertheless these writings in their reflections on language, technology, subjectivity and power weave a field for thinking musically.

WORLD FORUM FOR ACOUSTIC ECOLOGY
MEMBERSHIP INFORMATION

JOIN OR RENEW NOW! PLEASE CHOOSE THE APPROPRIATE AFFILIATE BELOW.

As a member of an Affiliate Organization you will automatically become a member of the WFAE. If you are not near a convenient Affiliate Organization, or if you relocate frequently, you can join the WFAE directly as an Affiliated Individual. Financial members of the WFAE receive a subscription to *Soundscape—The Journal of Acoustic Ecology*. A Membership Form and a sample article from *Soundscape* are available for download in PDF format on the WFAE website: http://www.wfae.net

DONATIONS ARE WELCOME

Additional donations (in CDN $ and US $, to the below WFAE address) will be gratefully accepted. Donations will be used toward the production costs for *Soundscape*, and to help subsidize those who cannot afford membership, or who come from countries with disadvantageous exchange rates.

Australian Forum for Acoustic Ecology (AFAE)
Individual fee: A$40 — Institutional fee: A$95
Please send a cheque or money order in Australian Funds to:

Australian Forum for Acoustic Ecology (AFAE)
P.O. Box 268, Fairfield, Victoria
3078, Australia

Canadian Association for Sound Ecology (CASE)
Association Canadienne pour l'Écologie Sonore (ACÉS)
Individual: Cdn $35 — Student/Étudiant: Cdn $20 (with a copy of your current student ID). Please send a cheque or money order in Canadian funds to:

Canadian Association for Sound Ecology (CASE)
Association Canadienne pour l'Écologie Sonore (ACÉS)
c/o Musicworks
401 Richmond Street West, Suite 361, Toronto, ON
M5V 3A8, Canada

UK and Ireland Soundscape Community (UKISC)
Individual fee: £20 GBP — Institution: £50 GBP
Concessions: £10 GBP
Cheques should be made payable to the UK and Ireland Soundscape Community and sent to:

John Levack Drever
Flat 1, 17 Queens Crescent,
Exeter, Devon
EX4 6AY, UK
E-mail: johndrever@MOOSE.CO.UK

Suomen Akustisen Ekologian Seura
(Finnish Society for Acoustic Ecology—FSAE)
Individual fee: 120 FIM — Student fee: 80 FIM. Please pay to the bank account in Finnish Funds: Osuuspankki 571113-218325

Suomen Akustisen Ekologian Seura
c/o FT Helmi Järviluoma
Musiikkitiede, Turun yliopisto
20014 Turku,Finland

Forum Klanglandschaft (FKL)
Austria, Germany, Italy, Switzerland

FEES:	Normal	Studierende	Gönner	Institutionen
EURO	27	17	50	60
CHF	40	25	75	85

Austria: CA Creditanstalt, 6218 2061 531, BLZ 11000, lautend auf "FKL"
Germany: Mittelbrandenburgische Sparkasse Potsdam, 350 300 4032, BLZ 160 500 00
Italy: Conto corrente postale nr. 100 075 08 Firenze, intestato a Albert Mayr, con l'indicazione della causale "iscrizione al FKL/WFAE"
Switzerland: Postcheckkonto 40-551632-1

Japanese Association for Sound Ecology (JASE)
Individual fee 2,000 yen/year
NOTE: the JASE fee should be paid with and in addition to the annual fee of 6,000 yen for the Soundscape Association of Japan (SAJ) by postal transfer.
Postal transfer number:00110-6-612064

Japanese Association for Sound Ecology (JASE)
c/o Keiko Torigoe
University of the Sacred Heart
4-3-1, Hiro-o, Shibuya-ku, Tokyo,150-8938, Japan

WFAE Affiliated Individual Membership
Regular: US $35 - Students: US $20
(with a copy of your current student ID).

WFAE Associate Membership
Regular: US $75 - or as negotiated depending on size of organisation.
Please send US cheques, international money orders, or travellers cheques made out to the WFAE. Do not send drafts, as bank charges are very high! Mail to:

World Forum for Acoustic Ecology (WFAE)
Membership Secretary
P.O. Box 268, Fairfield, Victoria, 3078, Australia

NON-MEMBER SUBSCRIPTIONS TO SOUNDSCAPE NOW AVAILABLE!

(Each subscription includes 2 copies per year including postage)
1 year library or institution paper copy subscription = US $50
1 year individual paper copy subscription = US $25 • Single copy purchase: US $15.00
Available from the WFAE address above.

The sound of the sea, the curve
of a horizon, wind in leaves,
the cry of a bird leave
manifold impressions in us.

And suddenly, without our
wishing it at all, one of these
memories spills from us and
finds expression in musical
language...

I want to sing my interior
landscape with the simple
artlessness of a child.

Claude Debussy
[Source: unknown]