

Internet vis-a-vis marine biology

Vishwas Chavan

National Institute of Oceanography, Dona Paula, Goa 403 004, India

Internet is an amalgam of networks which reaches to more than 100 million people across the globe. The satellite-telecommunication based computer network web hosts information on every aspect of life. Marine biology related information too is being hosted on Internet by leading research organizations worldwide. Present paper reviews the marine biology related information available on Internet and Internet potentials for marine biologists from developing and underdeveloped nations is discussed.

Internet is a world-wide entity, that could be technically defined as a set of all interconnected IP (Internet Protocol) networks. These are the several thousand local, regional and global computer networks connected in real-time via the TCP/IP (Transmission Control Protocol/Internet Protocol) Internetworking Protocol suite.

This super entity provides the electronic home/office for leading-edge development, active discussions and information dissemination, and sets of relationships at span space and time. This amalgam of satellite-telecommunication based computer networks reaches to more than 90 million people across the globe and is growing with the rate of 10% per month. This number is expected to cross 120 million by the end of the year 1997.

Information resource tools and search engines provide various ways to access the vast amount of public information available across the Internet. Information on practically every aspect of life is available on Internet in the form of text, numeric, sketches, figures, audio-video, animation and even virtual reality. Though various search tools and engines, users are gaining access to a variety of information 'on net'. This includes software, tips, patents, environmental regulations and research papers. Needless to say vast amount of information related to marine biology is available on Internet.

Taxonomy of information sources on the Internet

Information is available in variety of forms. From a biologists point of view, it can be broadly grouped into following categories :

Computer mediated communication (e-mail, talk, Internet relay chat)

1) E-mail : Electronic mail, or e-mail, is the cornerstone of all that happens on the internet. It is a simple service that allows two people to send messages to each other in a near-real-time manner. With this basic feature of Internet, one can send same messages to lots of people, attach document or images, or can retrieve documents from other computers on the Internet by sending a command to a particular address. E-mail can also be used to retrieve documents from FTP Servers (FTP Mail) and for taking part in special interest group discussions such as listserver and USENET newsgroups.

2) Internet Relay Chat (IRC) : IRC is a program that lets you hold live keyboard conversation with people around the world. It's a lot like an international CB radio- it even uses 'channels'. IRC currently links host systems in 20 different countries, from Australia to Hong Kong to Israel.

3) Multi-user Dungeons (MUDs) : MUDs are multi-user Dungeons (or Multiple User Devices), and they were originally created so that Dungeons or Dragons player could role play in real-time with other players around the world. MUDs are no longer limited to dragon-slaying, though. There are even social MUDs where you can just sit and talk, with people around the world.

4) MOOs are "MUDs : Object-Oriented", and they are "text-based virtual reality adventures".

Directory services such as white pages etc.

The Internet is a huge jargon. It would have

been impossible to locate desired information sources without the help of yellow pages. There are more than 100 such directories available which enlists net-sources of information on every aspects of life. Some of the notable yellow pages are the Effs guide to the Internet, Yahoo Yellow Pages (<http://www.yahoo.com/>), Einet Galaxy (<http://www.einet.net/galaxy.html>), Whole Internet Catalog (<http://nearnet.gnn.com/wic>) etc.

Electronic books and journals

There are several hundred e-books and e-newsletter currently available on the Internet. Some are peer reviewed and some are fee based, but most are neither. They can be accessed by sending a subscription request via e-mail to the author or editor, or through gopher and web. A main archive is at the Cicnet gopher (nic.cic.net). Few notable amongst them are Aquatic Conservation Notes, Aquatic Survival, Environmental Resources Information Network (ERIN), Newsletter, Climate/Ecosystem Dynamics (CED), Conservation Ecology, Directory of Phycologists, LTER data Management Bulletin (DATABITS), The Scientist, STARNET Echinoderm Newsletter, Today's Aquarist etc. Contents of the major marine biology related journals such as *Aquatic Microbial Ecology*, *Disease of Aquatic Organisms*, *Marine Biology*, *Marine Ecology Progress Series*, *Oecologia* etc. are available through bionet (biosci-help@net.bio.net). Major publishing houses such as Academic Press (178 full text journals) Boline Publications, BIOSIS UK, BMJ Publications Group, Oxford University Press and Cambridge Scientific Abstracts also publish full text of their journals on Internet. *Indian Journal of Marine Sciences* (IJMS) is also available on Internet through BIOLINE WWW server (<http://www.bioline.com/ijms/welcome.html>).

Library catalogs and virtual library

There are over 700 library catalogs in more than 60 countries available on the Internet. Many of these catalogs also have special databases. Catalog of particular interest to marine biologists include the EPA library, the university of California Library System (Melvyl) with over 10 million records, Harvard, Yale, the Library of Congress, University of Michigan, University of Washington, Illinet (the union catalog of Illinois) etc. These catalogs can be accessed by "telnet" if the address is known or through a gopher. Most gophers have a menu listing for "Library Catalogs" which allows geographical browsing or keyboard name searching for a particular catalog.

Virtual library is the recent but fast popularizing concept over the Internet. In Virtual Library information is categorized by subject. Under the category fish, information on aquariums, fish biology, aquatic environmentalism and sports fishing is covered (<http://www.actwin.com/WWWVL-Fish.html>). Bioscience as well as Biodiversity, Ecology and the Environment Virtual Library (<http://conbio.bio.uci.edu/link>) are also useful for marine biologists.

Databases

There are variety of databases covering bibliographic, reports, frequently asked questions (FAQ) etc. are available through telnet, gopher or WWW. Table 1 lists the marine biology related databases available over Internet. Some of these databases are freely accessible while some on payment or subscription.

Publicly accessible files (textual, numeric, image, software's etc.)

There are plethora of publicly available files of all types on the Internet. These files are obtainable

Table 1—Marine biology related databases available on Internet

Database Title/Content	Database site/address
Archie Carr Sea Turtle Bibliographic Database	telnet luis.nerdc.ufl.edu
British Columbia - Fisheries Technical Reports	gopher://freenet.victoria.bc.ca
CARL Uncover - 14000 journals, with 3 million citations	telnet database.carl.org
Crayfish Bibliography	gopher://nmnh.goph.si.edu/
Marine and Aquatic Sciences Serials Lists	gopher://scilibx.ucsc.edu
Neotropical Database of fish biodiversity	gopher://fowler.acnatsci.org/
North American Benthological Society (NABS)	gopher://gopher.nd.edu/
Ocean Network Information Centre (login : info)	telnet delocn.udel.edu
US National Fungus Collection (login : info)	telnet fungi.ars-grin.gov
Water Quality Data Directory	gopher://scilibx.ucsc.edu/

through 'ftp' (with "anonymous" login) and are indexed and searchable by a resource known as "archie". Many files are now also available through "gopher" and found with "veronica". They are also accessible through "WWW".

Specimen collection

Museum and laboratory specimen collections are often little used data repositories that contain a wealth of potential information. Automation of

these collections and global access through the Internet can greatly assist researchers. There are currently over 2 million plant and animal specimens on-line from variety of institutions. Virtual museums of California Academy Invertebrate Zoology & Geology, Cornell Fish Collection, Farlow Herbarium Diatom Catalog, Harvard Fish Type Catalog, Texas Natural History Collection of Fishes are accessible via gopher at huh.harvard.edu.

Table 2 - Internet listservers, newsgroups related to marine biology

Listserv/News group address	Content/Topic
Listservers	
aqua-l@vm.uoguelph.edu	aquaculture and aquariums
aquarium@emuvml.cc.emory.edu	discussion of home fish aquariums
biodiv-l@bdt.ftpt.ansp.br	biodiversity networks
brine-l@uga.cc.uga.edu	brine shrimp discussion list
coastnet@uriacc.uri.edu	coastal management conference
crust-l@sivm.si.edu	crustacean biology
cturtle@nervm.nerdc.ufl.edu	sear turtle biology and conservation list
cyano-tox@gream.csi.forth.gr	toxic cyanobacteria
deepsea@uvvm.uvic.ca	deep sea and vent news
diatom-l@ubvm.ucs.indiana.edu	research on diatom algae
ecs-news@mailbase.ac.uk	euopean cetacean society news
fish-ecology@biome.bio.ns.ca	fish and fisheries ecology
fisheries@biome.bio.ns.ca	fisheries management
fish-junior@searn.sunset.se	marine sciences and children/youth
frog-net@rana.usc.edu	amphibian researcher mailing list
herp-l@xtal200.harvard.edu	herpatology mailing list
iamslic@ucsd.edu	marine science library
icam-l@irmafao01.bitnet	integrated coastal area management
mar-facil.ac.dal.ca	marine facilities and aquaria, etc.
marine-l@cgc.ns.ca	marine studies/shipboard education list
marine-tech@mailbase.ac.uk	marine technology in the UK
marmam@uvvm.uvic.ca	marine mammal research and conservation
marine-l@vm.uoguelph.ca	marine studies/shipboard training
molluska@uvvm.uvic.ca	molluscan taxonomy
oceantech@ucsd.edu	ocean technology forum at SIO
listserv@utcvvm.utc.edu	sharks and cartilaginous fish discussion
star@matrix.bchs.uh.edu	echinoderm newsletter
wildnet@access.usask.ca	fish and wildlife biology
Usenet Newsgroups	
bionet.biology.computational	comp. & math applications in biology
bionet.biology.tropical	tropical biology and ecology
bionet.jobs	job opportunities in biology
bionet.journals.contents	biological journals table of contents
bionet.photosynthesis	photosynthesis research
bionet.population-bio	population biology
bionet.sci-resources	information about funding agencies
bionet.software	software for biology
bit.listserv.biosph-l	biosphere, ecology discussion list
bit.listserv.ethology	ethology
sci.bio.ecology	ecology research (ESA)

Electronic newsgroups, listservers, conferences

There are thousands of conferences on a variety of topics from the scholarly to the personal. Topics or questions can be posted for discussion or answers. Bitnet and most Internet Conferences are known as "Listservs" and can be automatically subscribed by sending a specific command to the listserv address. Some Internet conferences require subscription request be directed to individual moderators via e-mail. Usenet conferences are generally known as "Newsgroups". Instead of subscribing to them, they are read with "news-readers" or through your local gopher. Table 2 lists the Internet listservers and newsgroups related marine biology.

Internet tools

The Internet is like one's basement. There's a lot of good stuff down there, but it's such a cluttered mess one can't find anything. However, there are two factors that make the Internet more appealing than basement. Firstly, you never have to

clean the Internet, and secondly, there are lots of nifty tools available to help you find what you're looking for on the net.

1. Telnet: A program that allows Internet "nodes" to login and access program and data on another Internet node. In other words it is the standard TCP/IP remote login protocol.

2. Archie: Archie is an Internet program accessible through telnet and e-mail services. Archie is used to help locate data on the Internet through user specified criteria. In a simpler terminology archie is the finder tool.

3. File Transfer Protocol: FTP is an immensely popular program (protocol) for transferring files between Internet nodes. This is also called as "Anonymous FTP" and is accessible through e-mail (FTP Mail).

4. Gophers : Gopher is a hierarchical browsing program to help netters navigate their way through various Internet resources. By using a gopher the user does not need to use command (eg. Telnet, FTP) or know specific addresses for resources. It is

Table 3 - Marine biology oriented gopher sites

Gopher Title/Content	Address
Aquanaut	gopher.opal.com
Australian Oceanographic Data Center	dir.ic.ac.au
Bedford Institute of Oceanography	biome.bio.dfo.ca
Biodiversity and Biological Collections at Harvard	huh.harvard.edu
Cicnet, Centre for the Great Lakes	nic.cic.net
Ciesin, Global Ecology and the Environment	gopher.ciesin.org
EcoGopher at University of Virginia	ecosys.drdr.virginia.edu
Ecological Data Exchange at Yale	gopher.yale.edu
Econet	icg.org
Envirogopher	envirolink.hss.cmu.edu
Galveston Bay Bibliography	tamug.tamu.edu
Great Lakes Info Network	gopher.great-lakes.net
Harvard Gray Herbarium Index of New World Plants	huh.harvard.edu
IUBio Biology Archive, Indiana University	fly.bio.indiana.edu
Long Term Ecological Research (LTER) Network	lternet.edu
Marine Biological Lab, Woods Hole	crane.mbl.edu
National Oceanographic Data Center, NODC	gopher.nodc.noaa.gov
NABS Bibliographies in Aquatic and Benthic Biology	gopher.nd.edu
NEODAT Fish Biodiversity Gopher	fowler.acnatsci.org
NOAA - Environmental Information	gopher.esdim.noaa.gov
NOAA - Great Lakes Environmental Research Lab	gopher.glerl.noaa.gov
Scripps Institution of Oceanography	sio.ucsd.edu
Smithsonian Institution's Natural History Gopher	nmnhgoph.si.edu
Universities Water Information Network	gopher.c-wr.siu.edu
Univ. of California, InfoSlug, lots of biology, ecology etc.	scilibx.ucsc.edu
Uni. of Santa Barbara, Marine Biology Laboratory	ucsbuxa.ucsb.edu
University of Colorado	gopher.colorado.edu
Virginia Institute of Marine Sciences	gopher.vims.edu
Woods Hole Oceanographic Institution	gopher.whoi.edu

tremendously popular program and there are now thousands of gopher servers around the world. To search particular resources of gopher around the world - use a resource known as "veronica" (there is also an adaptation of it known as "BOING" - Bio-Oriented Internet Gopher). Some of the marine biology oriented gopher sites are listed in Table 3.

5. Wide Area Information Servers (WAIS): WAIS is a powerful search tool that is used to keyword search a particular information resource which can range from a newsgroup archive to a text or image database. There are over 600 different individual WAIS sources or databases with more added each month. Table 4 lists the sources accessible from a public WAIS site sunsite.unc.edu via telnet or gopher.

6. World Wide Web (WWW): WWW is another tool for navigating the Internet. It is based on "hypertext" and references. Characterized by its more intuitive ease-of-use and powerful paradigm for representing links related information. Table 5 lists few of the marine biology related WWW sites.

Finding topics on the Internet

There are a number of tools available for finding topics on the Internet. Veronica search through the volume of information provided by Gopher information servers. Jughead search for topics in gopherspace. Subject Trees present resources in gopherspace by subject matter. Web search, Telnet search and List search are the programs to search through WWW, Hytelnet and Listservs and Usenet Newsgroups respectively.

There are few search engines available on the WWW. Infoseek Net Search, CUI World Wide Web Catalog, Yahoo search engine, Global Network Academy Meta-Library and Aliweb are the list-based WWW engines which help in locating the information servers. Spider based WWW engines such as WebCrawler, OpenText, RBSE and JumpStation II searches full text web documents. Other catalogs such as Lycos, EINET Galaxy are also used for locating desired information servers. Software's could be searched through engines like Archiplex, The Language, The Free List Compilers, The Free Database List, Nexor's Mac Software Catalog, Iconix WWW Power Page, SoftInfo Search Page.

People on the net could be located by searches at WhoWhere Search, Netfind gateway, Finger

Table 4—Sources accessible through sunsite.unc.edu WAIS server

- Biology Journal Contents #239
- Biosci (Usenet Bionet Newsgroups) #240
- Coastal #271
- DOE Climate Data #76
- Environment Newsgroups, #350
- Global Change Data Directory, #83
- Invertebrate Paleontology Database, #106
- NOAA Environmental Services, #127
- NOAA National Environmental Referral Services, #128
- The Scientist, #562
- Smithsonian Pictures, #530
- USDA CRIS (Current Research Information Service), #575
- U.S. Fish & Wildlife Service (Region 9), #197
- Water Quality Database, #590

gateway at Digital CRL, Ph gateway, UFN Search (X.500 directory) and FOUR11 directory services. Location of a desired publication could be searched at Rik Harris Abstracts Index, The Unified CS TR Index, Computer Science TR Archive Sites, OO Bibliography, Gopher Catalog of Electronic Texts. Update on News or Frequently Asked Questions (FAQ) can be located by using search engines such as WAIS FAQ at Utrecht University, HTTP FAQ Search, Gopher FAQ Search, Search.news.announce.conferences, Search Today's usenet news and Zippo News Service. Documents can be searched at Big Dummy Search, NCSA Docfinder, CUI Computer Science Library, BSD/386 Hypertext Man Pages etc. Apart from these other search engines such as Hacker's Jargon, Acronym Search, Say, American recordings, WIRED Archive and Sherlock could be used to locate the desired information.

Internet and Third World

Developing and under-developed nations, where most of the available marine living resources are still remaining unexplored, have great potential to flood Internet with the information and data on the subject which can prove helpful in understanding the marine biodiversity, aquatic processes etc. However, reach of Internet in these nations is still in primitive stages. Much of the information in the form of databases/databanks is still available via off-line modes such as prints, floppies and CDROMs. These need to be hosted on the net to ensure wider dissemination. Most of the research

Table 5 - Marine biology related WWW sites

WWW titles/contents	Address/ Site
Aquanaut -scuba related information	http://www.opal.com/aquanaut
Australian Environmental Resources Information Network	http://kaos/erin/gov.au/erin/html
Australian National University Biodiversity	http://life.anu.edu.au/biodiversity.html
Bio-Journal	http://www.bio.net/bio-journals.html
CYAMUS Regional group of IAMSLIC	http://www.riv.nl/totem
Institute of Oceanographic Sciences, Deacon La	http://wocomms.nwo.ac.uk/pub /www/welcome/html
NMFS	http://kingfish.ssp.nmfs.gov/homepage.html
NOAA	http://www.noaa.gov/
NOAA, Environmental Info. Services	http://www.esdim.noaa.gov/
Oceanic, Ocean Information Center	http://diu.cms.udel.edu/
Pacific Regional Aquaculture Information Services for Education	http://www2.hawaii.edu/uhib2/aqua/
The Oceanography Society's Distributed Ocean Data System	http://lake.mit.edu/jgofs/index
Rosentile School of Marine and Atmospheric Sciences	http://www.rsmas.miami.edu/
Scripps Institute of Oceanography	http://sio.ucsd.edu
Scripps Institute of Oceanography Library	http://orpheus.ucsd.edu/sio/
Sea WIFS project	http://seawifs.gsfc.nasa.gov/seawifs.html
Sea World	http://www.bev.net/education/seworld
Unidata Program	http://unidata.ucar.edu/
University of Hawaii, School of Ocean & Earth Sciences and Technology	http://www.soest/hawaii.edu/
US Fish & Wildlife Services - Div of Law Enforcement	http://ash.lab.rl.fws.gov/
US National Oceanographic Data Center	http://nodc.noaa.gov
WhaleNet	http://whale.simmons.edu
Whale watching Web	http://www.physics.helsinki.fi/whale/
Woods Hole Oceanographic Institute	http://www.whoi.edu/

organizations and individual workers are deprived of basic Internet tool - an e-mail. It is essential to ensure speedy Internet connectivity to these individuals/organizations whose data/information once available over Internet would help in better understanding of ocean processes etc. In case of India, once the proposed Indian National Oceanographic Internet Server (at the National Institute of Oceanography, Goa) starts operating variety of information related to oceanography from and around India would be made available.

Vast amount of marine biology related information is available over Internet which if accessible would be of immense help to biological oceanographer. Information available over Internet is mostly from the developed countries. Efforts have to be made to publish the data/information generated in developing and under-developed nations. In order to ensure wider dissemination and usage of data/information, reach to Internet needs to be assured in developing and under-developed nations of the world.