

# Translating Scientific Results into Conservation Actions: New Roles, Challenges and Solutions for 21<sup>st</sup> Century Scientists

Earthwatch Institute 2007 Annual Principal  
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## Introduction

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**Earthwatch Institute** has a commitment to bridging the gap between scientists, communities, and the natural world and seeks to contribute real solutions on the ground to positively affect the grave environmental challenges of today and to create a healthy balance between the needs of communities and the needs of nature. In recognizing the challenge of producing relevant scientific solutions to current environmental problems, Earthwatch-sponsored scientists were invited to submit papers that contribute to this topic: **Translating Scientific Results into Conservation Actions**.

In conjunction with the **2007 Earthwatch Annual Principal Investigator Conference**, six contributors were selected to share their experiences to better understand how to design and implement scientific research that is both relevant to science and useful to promote sound conservation practices in collaboration with local communities. The following compendium includes all submitted papers and summarizes the workshop discussion.

In the last decade or so a significant shift has occurred in the natural sciences. Researchers realize, and many embrace, the fact that it is not enough to simply collect scientific data to answer specific questions and then publish results in the scientific literature. As educated and knowledgeable members of the world's community, we are vested with the responsibility of informing and stewarding the proper management of our natural resources for the benefit of future generations of humans and species.

This challenge entails a restructuring of how natural sciences are taught and interpreted, and adds new dimensions to the way data are collected and disseminated. Scientific publications are still the most significant personal contribution of scientists to their discipline of expertise, and are still very much the metric used by institutions to evaluate a scientist's professional and academic credentials. However, critical management decisions cannot be delayed for the weight of scientific evidence to be filtered through the usual professional channels. A more practical, outreach oriented and less academic approach needs to be developed to disseminate important scientific information that may be relevant to critical management decisions.

This approach can be uncomfortable to academics who appreciate the fact that science is built on the premise that there are no final answers to a specific issue, only hypotheses that get refuted or accepted with the lowest margin of error possible. And it is this margin of error that scientists critically evaluate when making statements about their findings, making sure that their conclusions are based on sufficient sample size, a sound sampling design, appropriate and tested sampling techniques, and the critical input of colleagues. This process takes time, often many years in the case of studies that involve complex natural systems with multiple variables. Often such variables cannot be controlled in a laboratory, making the interpretation of data difficult and the margin of error larger than desirable.

The need to translate scientific results into conservation actions often negates the steps that are usually considered desirable in the scientific process of inquiry. Environmental assessments and adaptive management plans often require fast turnaround, swift implementation, and both short and long-term monitoring to assess effectiveness. While this process may short circuit some steps that scientists would prefer were included, it has gained acceptance in the conservation science realm. It is critical that scientists continue to optimize this paradigm to achieve the best outcomes for all stakeholders. Lack of scientific input and participation in this process could lead to serious negative consequences for natural systems.

A new role and a new model for scientific inquiry are taking shape as a consequence of the need for concrete solutions to immediate and pressing environmental problems. Many in the scientific community have embraced this new challenge and are developing rapid assessment tools and environmental monitoring protocols that use the scientific method in a less stringent yet effective way to produce swifter results. A large body of literature and many journals are dedicated to the science of conservation, so I feel no need to elaborate.

However, scientific results are simply the first step to a much longer process. There has been quite a debate in the scientific community regarding who is responsible for the translation

of scientific outcomes to management or policy actions. Results lead to recommendations, and recommendations lead to plans for implementation that need to be carried through and evaluated for effectiveness. At what stage does the scientist hand off the process to a more appropriate implementer? Is the scientist also an advocate?

Does advocating for specific solutions negate the neutrality which is a characteristic of the scientific method to ensure unbiased judgment? On the other hand, isn't the scientist the most appropriate translator of results into recommendations by virtue of the fact that they can best explain the nuances of an issue and make a stronger case for the necessary action?

This debate will not be easily resolved soon and, frankly, there is little time to resolve it. The current environmental and social challenges are such that action is immediately required lest we have to witness the demise of our planet in the not too distant future. Many of us have rolled up our sleeves and accepted the challenges and opportunities that a new advocacy role poses to modern day scientists.

However, while scientists are shifting their perspective, few institutions have systemically changed to support this critical need. Scientific publications with high academic, but little applied value are typically still the currency of the scientific profession. In addition, grants for conservation work are small and hard to find, and salaries are often not adequate.

There is also another important dimension that is often ignored: it is not possible to isolate the cultural and the natural aspects of the environment. Ultimately, the Earth is a jigsaw puzzle of cultural and natural landscapes, delicately interconnected, constantly responding to shifts small and large, and deeply essential to the continuity of life on the planet.

Humans and their societies are an integral part of any ecosystem and the social and economic aspects of their presence cannot be separated from the other variables that affect the environment and shape it over time. Ultimately, a sustainable and balanced view of natural and cultural resources will only occur if responsibility for the management of these resources and the benefits they provide are shared equally by all stakeholders.

Scientists funded by Earthwatch Institute are grappling with all of these issues and pushing the frontiers on conservation science. They are individuals that have embraced these new challenges and have taken them one step further. Not only are they acting as environmental advocates and designing their research to respond to pressing environmental questions, but they have incorporated local stakeholders in many aspects of their research and education projects. They view this involvement, education, and outreach to local, national, and international communities as a critical component of their work.

Many of the projects Earthwatch Institute has funded through the years, have made critical contributions to the understanding of complex ecosystems with the specific goals of making long-lasting impacts on the design and implementation of management plans. These scientists and their projects also strive to empower worldwide audiences to participate in a direct and significant manner in the process of understanding, in the dissemination of information, and in the implementation of programs to the benefit of both communities and natural ecosystems.

In organizing a workshop entitled "Translating Scientific Results into Conservation Actions," I wanted to invite Earthwatch-funded scientists to share with one another the challenges and the rewards of working toward direct, on-the-ground contributions to a sustainable environment. I thought it important to highlight the contributions that some of the Earthwatch-funded programs are making in this area and to provide concrete examples of a variety of approaches. These Proceedings are the first attempt to capture some of the work being done by Earthwatch-sponsored scientists. The sample of projects presented here represents a small portion of the work that is currently being undertaken and only reflects the efforts of the individuals that generously submitted an abstract to the organizers. I envisioned this forum to be an opportunity to share some of the successes, and some of the challenges and opportunities, we face in pursuit of better ways of applying research findings to management actions. I sincerely hope this is the start of a continued discussion leading to new ideas, increased cooperation, and, ultimately, a better stewardship of our natural and human resources.

## Spanish Dolphins – From Science to Active Management

Ricardo Sagarmínaga van Buiten

Little was known of the cetacean and sea turtle populations in the Alboran Sea when the research vessel *Toftevaag* initiated its monitoring program there in 1992. The Alboran Sea is the only natural “gate” to the Mediterranean, and it is characterized by a unique and complex oceanography as well as an extraordinary biodiversity.

The first publications generated by our monitoring studies highlighted the relevance of this region for cetaceans and sea turtles, giving rise to an increase in scientific and public interest in the region. The R/V *Toftevaag* was visited by a National Geographic crew to produce *Keeper of the Planet* and BBC used the vessel to film parts of its documentary *Blue Planet*.

An important turning point was 1999, when Earthwatch Institute started funding *Spanish Dolphins*. The project became part of a Ministry of the Environment three-year program to design Marine Protected Areas (MPAs) and resulted in three new sites being proposed as “Sites of Community Interest (SCI)” under the framework of the European Union’s Habitat Directive, and in one international scale MPA (SPAMI) under the Barcelona Convention.

In order to ensure a follow-up to this important scientific effort, the Spanish Cetacean Society initiated an ambitious four-year, 3.5 million Euro, LIFE Nature project for the European Commission (LIFE02NAT/E/8610), in partnership with the central administration, regional governments, fishermen unions, and several universities.

The project’s aim was to develop management and conservation plans for cetaceans and sea turtles in the Alboran Sea, and actions at three levels, under the guidance of an international scientific committee, in order to establish a more solid management process.

The first level of this process focused on developing a robust scientific foundation for the management and conservation plans. This was necessary not only for the conservation goals established for the Alboran Sea, but also to provide Europe with solutions to the logistic and economic challenges of monitoring pelagic marine animals. Between 2002 and 2006, over



photo © Doug Peters

500 Earthwatch volunteers actively participated in a variety of tasks such as visual surveys, satellite tracking, photo identification, spatial modeling, acoustic experiments, and molecular analysis of stable isotopes. Highlights of this effort are the spatial analysis modeling developed by Principal Investigator (PI) Ana Cañadas as an innovative tool to monitor cetacean populations, and the satellite telemetry study carried out by PI Scott Eckert of the Wider Caribbean Sea Turtle Network (WIDECAST) identifying possible solutions to the problem of sea turtle bycatch, and the testing of bycatch mitigation measures directed by PI Ricardo Sagarmínaga under a contract with NOAA Fisheries.

The second level of this process integrated the scientific results of this effort into the national and international biodiversity conservation strategies and frameworks. Another major contribution of the project was its input into a process initiated by the Ministry of the Environment, whose staff solicited the Council of State for an analysis of maritime governance. Over 2,110 meetings were held during this process. The outcome is a series of urgent legislative, management, capacity building, and monitoring actions, such as sea turtle bycatch mitigation measures that could reduce loggerhead turtle death rates by over 85%, and the relocation of the Cabo de Gata I.M.O. Traffic Separation Scheme outside an important bottlenose dolphin foraging area.

But legislative and management actions cannot be easily enforced in the open sea. Here, the real decision makers are the mariners who are the ones that need to be convinced that these actions are beneficial to them and to the environment. And this is where the third level of

the process comes in: three historic vessels, touring the coast, have been used as meeting places and classrooms and their crews have been working with coastal communities, visiting schools, involving fishermen in research projects, and promoting alternative professional activities, because biodiversity conservation will only work if it is profitable.

The outcomes of these stakeholder involvement actions reaching out to fishermen, whale-watching operators, teachers, students, and others have been amazing. The results of these efforts have been presented by the Spanish Ministry to the OSPAR Commission (The Convention for the Protection of the Marine Environment of the North-East Atlantic) meeting in October 2006, and led to the Spanish Dolphin Project research team being selected to lead a “stakeholder involvement” working group in cooperation with the National Biodiversity Conservation Directorate General.

Now, at the outset of this LIFE project, *Spanish Dolphins* initiates the next phase of putting the more urgent measures into action in collaboration with the Spanish Fishery Ministry. For Earthwatch volunteers onboard the R/V *Toftevaag*, this will translate into new activities, focusing on three important current issues, such as the use and misuse by the fisheries of acoustic deterrent devices which are conflicting with dolphins’ hearing abilities, or testing new sea turtle bycatch mitigation measures, or collecting data to model cetacean distribution and abundance in order to map vulnerable or high risk areas. These efforts could lead to spatial or temporal closing of areas to potential threats such as military sonars (which cause strandings), fishing (the cause of bycatch and depredation), and navigation (which causes collisions with cetaceans and turtles).



Photo © Anlitak

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**Ricardo “Ric” Sagarminaga van Buiten** is the skipper of *Toftevaag*. Since studying biology at the University of Neuchatel (Switzerland), Ric has spent most of his time at sea sailing on conservationist campaigns onboard the Greenpeace ship *Sirius* and also as a sailing instructor on two classic sailing ships in Sweden. It was actually during his stay in Sweden that he discovered the world of restoration of old wooden ships and where the whole dream of *Alnitak* began. After gaining some wooden boat building experience working in specialized shipyards, he met Ana onboard the *Sirius*. Together in 1989, they found *Toftevaag* and reconverted her for her new mission as a research ship. At present, Ric is General Coordinator for the Spanish Cetacean Society, working mainly on the development of the management schemes of MPAs. He is in charge of the logistics of the Spanish Dolphins project, the navigation, the video filming, and the marine turtle research. As a complement to his Yacht Master Ticket, Ric holds a Swiss First Aid license, as well as a safety at sea and firefighting certificate.

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## A Cooperative Approach for Generating Robust Population Metrics for Whale Sharks *Rhincodon typus*

Bradley Norman and Jason Holmberg



photo © Brad Norman

Effective conservation policy for rare, migratory species such as the whale shark (*Rhincodon typus*) requires broad international participation to achieve statistically meaningful levels of standardized data collection and to ensure that local analyses are comparable between research stations. Previous studies of whale sharks at Ningaloo Marine Park (NMP) in Western Australia have sought to estimate total abundance (N) as a prime management metric (Taylor 1994; Meekan *et al.* 2006). However, site-specific abundance is of limited value in examining issues of regional interest to whale sharks. Attempts to quantify a catch-all “superpopulation” often overlook ecological parameters of importance, such as site fidelity and transience, that affect how abundance is estimated and how management policy can effectively conserve a migratory species. Similarly, attempts to model a population in isolation using closed models or with matrix methods based on poorly understood biological parameters may also ignore these influences. The resulting multi-year abundance estimates based on scarce data often include large standard errors and provide no dynamic from which to assess the health of local or regional populations and their own potential mixture of residents and transients.

Ningaloo Marine Park (NMP) in Western Australia is a reliable gathering point for whale sharks, with sightings reported each year between March and July. This annual aggregation is the focus of a comprehensive mark-recapture program started in 1995 that uses computer-assisted photo-identification (Arzoumanian *et al.* 2005) to model population dynamics and to generate meaningful statistics

for local conservation and management. The whale shark is assessed as *vulnerable* in the *IUCN Red List of Threatened Animals* (Norman 2000; <http://www.redlist.org/>), which is defined by a projected population decline of 20-50% over a ten-year or three-generation period, whichever is the longer. A twelve-year analysis at NMP has now shown this local population to be an aggregation of residents and transients demonstrating site fidelity. Population models for effective management and conservation must account for these behaviors to generate meaningful survivorship metrics, and accurate and timely reports of whale shark numbers are imperative to better establish the conservation status of this species and to justify management action where and when low survival rates are present.

Our study focuses on maximizing data collection by engaging ecotourists, scientists, and Earthwatch Institute volunteers to gather photographic mark-recapture data to estimate three broadly comparable metrics for whale sharks: apparent survival rate ( $\phi$ ), annual fluctuation in relative abundance ( $\lambda$ ), and the proportions of residents ( $\gamma$ ) and transients in the study population at NMP. Generating these parameters for local and regional marine and fisheries management is of vital importance to whale shark conservation, and their estimates can demonstrate the pressures on this poorly understood species at specific locations and can be used to correlate observations at other study areas through direct comparison. Subsequent analysis of these data can also help formulate improved conservation management decisions based on broader, multi-site observations, including the identification of areas of critical biological importance to the species that may require international participation to effectively manage and protect.

Establishing a network of research stations operating in a standardized manner is a complex task requiring a transparent and cooperative approach that must link and focus disparate local and international efforts for data collection, analysis, reporting, and action. In many locations, the individuals involved in each of these four steps are not directly linked. For example, ecotourism operators for whale sharks at NMP are ideally suited to collect photographic data through on-staff videographers and through

informative dive briefings that discuss how to photograph whale sharks for research purposes. However, the coordination, aggregation, and analysis of these data is commonly beyond the scope of their efforts. To facilitate a linkage between data collectors, population analysts, and management agencies, we created the ECOCEAN Whale Shark Photo-identification Library (<http://www.whaleshark.org>), which provides a simple, multi-lingual data collection interface for direct, standardized, and coordinated submission of photographic data to a centralized database. The ECOCEAN Library also provides a suite of software tools for photographic analysis, including dual pattern recognition algorithms for accurate identification, that enables quick and accurate processing of collected encounter data and directly exports it to popular statistical software packages, such as Program MARK and U-CARE. These tools are supported by on-site training in their use, a field manual to capture relevant processes, and an online forum to promote discussion and rapidly disseminate new discoveries and technique improvements. To make the entire process transparent, the ECOCEAN Library creates publicly visible, online records for all reported encounters to show the volume of data collected and the subsequent identifications made by analysts. A built-in email system automatically informs data contributors of identifications made with their assistance and updates them when their identified sharks are sighted again in the future by other contributors.

As an online research application, the ECOCEAN Library is a suitable platform for coordinating broad data collection and analysis for whale sharks. However, creating site-specific linkages between data contributors, population analysts, and management reporting agencies is most efficiently done by local stakeholders with knowledge of the individuals and agencies involved in a specific region. As a multi-user software tool with built-in, role-based security, the ECOCEAN Library supports international collaboration but promotes localized efforts to collect, analyze, and report whale shark data. Local stakeholders better understand site-specific parameters affecting data collection and can provide direct, consistent advocacy within related conservation, fishing, management, and tourism communities. This scalable approach allows for a completely local sense of ownership in research while providing a standardized methodology that ensures that local conservation efforts can benefit from and

contribute to a global understanding of whale shark ecology and population dynamics sustained by a host of independently managed field stations. Furthermore, through the mandatory, public display of all collected data in the ECOCEAN Library, local research efforts can directly obtain an understanding of observed whale shark ecology at other field stations, and the research community can avoid data “silos” that lock whale shark knowledge into small, proprietary collections of minimal benefit. Role-based security within the ECOCEAN Library ensures global access but limits who can modify and process contributed data to only an appropriate, local subset of users.

The work of Earthwatch Institute volunteers at NMP supports a broader approach to whale shark conservation that seeks to create a larger picture of whale shark ecology than has been previously attempted. While the results of these efforts are locally applicable and reported directly to NMP resource managers, they also underpin and assist a coordinated, multi-site study of the species. The translation of this research into conservation action is flexibly left to each field station where conservation efforts can be maximized using locally acceptable approaches informed by a global body of whale shark knowledge. Additionally, the transparent reporting and display of collected data from all field stations can inform larger conservation bodies, such as the IUCN, that can promote a needed international approach to conservation and protection for this rare, migratory species.

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**Brad Norman**, Project Leader and Biologist with the ECOCEAN Whale Shark Photo-identification Library, holds a Master of Philosophy degree in Marine Biology from Murdoch University in Perth, Australia. His main research interests are whale shark biology and physiology, sustainable ecotourism and conservation, and sustainable fisheries management. Brad began studying whale sharks at NMP in 1994 and has continued research both in Australia and abroad. Over his many years of work, he has established that the natural patterning on the skin of these sharks does not change over time and can be used to identify individuals. His studies previously focused on the biology of the whale shark and the sustainability of the associated ecotourism industry, while his present work extends to international conservation projects related to this species. In addition to developing acoustic and satellite tracking programs at Ningaloo and Christmas Island, Indian Ocean, Brad has discovered a new species of copepod living on the skin of whale sharks and also established the size at maturity of male whale sharks.



photo © ECOCEAN

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**Jason Holmberg** joined ECOCEAN in 2002 and has logged over 4,000 hours of development time on the ECOCEAN Whale Shark Photo-identification Library. As Project Architect, he has designed and implemented new tools to support digital pattern recognition for whale sharks. Using Jason's tools, the project has been able to categorize and manage a large amount of whale shark data and to identify individual animals from multiple photos taken by different researchers many years apart. Jason also undertook further field-testing of the project's methodology and technology in the Galapagos Islands in October 2004, Honduras in March 2005, and Australia in April 2005. He gave two talks at the International Whale Shark Conference in Perth, Australia in May 2005 and later that year accepted a Duke's Choice Award on behalf of the ECOCEAN team for innovative use of Java technology for whale shark data management and pattern recognition.

## Translating Scientific Results into Conservation Actions: Challenges and Opportunities from Jamaica and Belize

James Crabbe

### The projects

I currently run two Earthwatch projects—one on Jamaica's coral reefs (2001-present) and one as part of the new Conservation Research Initiative (CRI) in Belize (2006 was the first year).

Data on coral surface areas are collected with the help of Earthwatch volunteers using SCUBA, followed by digital image analysis and modelling. The Earthwatch teams' work, measuring over 2,500 corals over the years, shows that severe storms, which are increased in intensity by global climate change, play a key role in this loss of cover and biodiversity, and significantly lower growth and recruitment (Crabbe and Smith 2006; Crabbe *et al.* 2002, 2004).

In addition, Earthwatch volunteers have made possible the collection of coral colony DNA samples and their subsequent analysis using a new technique (Crabbe 2003), to show the effect of environmental and climatic change on the DNA of the algal cells (zooxanthellae) in the corals. We have, for the first time, shown that corals can contain more than one clade (sub-species) of zooxanthellae, where different clades show different responses to climatic variables (Carlin *et al.* 2006; Crabbe *et al.* 2007).

### The recommendations

We need to translate our research into reef restoration and protection.

i) While barriers could be constructed to mitigate the effects of high wave energy, they would be unsightly and expensive on their own. However, if they were combined with energy production devices, to harness wave and wind energy, then they could become financially attractive. We recommend that discussions take place with Industrial partners to investigate this approach.

ii) The question of the role of zooxanthellae in corals under different environmental conditions is controversial. The role of symbiont switching and symbiont shuffling is still under investigation, and may be species specific. We recommend that further research be undertaken in a variety of reef environments to enhance our understanding of this symbiosis, and how it may be harnessed.

iii) It is vital for communities to consider coral reefs as integral to land environments. Resorts and deforestation have major effects on mangroves and corals. We recommend that communities and governments be educated to consider a holistic environmental view when undertaking major land or marine policies. The environment needs to be seen as part of the solution, and not as part of the problem.



photo © James Crabbe

### The challenges

A major challenge the projects address in both Jamaica and Belize is to integrate scientific knowledge and conservation science into policy that directly benefits all the stakeholders, from governments to local fisherfolk and their families. Volunteers, both local and trans-national, can help key stakeholders (fisher communities, governments, economic partners) in realizing the opportunities in both Jamaica and Belize. There needs to be a more general awareness about the importance of the reef as well as increased awareness of the cause-effect relationship of storms-climate change and reef dynamics.

### Jamaica

Some models predict that in the Caribbean, a mere 1°C rise in water temperature could lead to the long-term bleaching (and death) of all of the region's coral reefs. The protective effects of the reef, both with regard to marine life and to the human populations that live in the coastal areas, may become compromised and under threat in future years. With climate change inducing sea level changes, rises in sea surface temperature, and increasing storms, there will be fewer massive corals around to help break up waves and act as retreats for marine life. We need to

know as soon as possible if such changes are happening in a particular area and what can be done to prevent them. The situation is not helped by overfishing and extensive resort development, with consequent reef degradation. While it has been possible to engage extensively in education on the island, with students of 5 years to adults, it has not been possible to engage with government or with Industry (the bauxite industry in particular). The environment is seen as part of the problem, not as part of the solution. This is because poverty and crime are seen as the key problems, and the government is not thinking about how the environment might help both those issues.



photo © James Crabbe

### **Belize**

In contrast to Jamaica, Belizean government organisations and NGOs recognise the need for managing marine resources in relation to the environment and the communities that rely on the reefs. The fishing industry contributes significantly to the Belize national economy, mostly from exports of lobster, conch, and shrimp. Our project contributes significantly to national priorities by providing key information on the role of climate variables in coral reef growth and recruitment, variables which themselves control the infrastructure for conch, lobster, shrimp, and snapper habitats. As part of the RI (Regional Initiative), we work closely with partners in the Toledo region of Belize—Toledo Institute for Development and the Environment (TIDE), Toledo Association for Sustainable Tourism and Empowerment (TASTE), the University of Belize, and other marine scientists as part of the Belize RI—in order to ensure that the whole of the RI is greater than the sum of its parts.

### **The future**

The different situations in Jamaica and in Belize highlight two challenges, one practical and one moral. The practical challenge is to provide the

local stakeholders with information at the appropriate level to demonstrate how certain actions—for example, “no-take” fishing zones—can help to achieve their aspirations. This intervention would need to address local economic and social concerns about the reefs, particularly their costs and benefits, and the range of options presently available. Belize is a good example of how this can work well, involving a RI. In Jamaica, because of the political situation, it has not really got off the ground, apart from the education side. We need direct links with the Jamaican government to show how environmental issues can help with poverty and crime, using examples from other countries, as well as our example in Belize. NGOs and local Industrialists need energizing with governmental and other support; not solely financial. We also need to engage with the ‘bad guys’ of politics and crime; without their support nothing will happen in the medium or long term.

The moral challenge is to reassess our own assumptions regarding people in developing countries and to acknowledge their rights and capacity for self-determination. We need to hold in greater esteem the diversity of social contributions that local people can make, and to maintain respect for a wider range of cultural values that can legitimately inform life choices about coral reef sustainability. This challenge comes into sharp focus with cultures with very different premises and linguistic backgrounds, such as the Bajau people in Indonesia (Crabbe, 2006). The role of indigenous communities in natural resource management is complex and easily oversimplified. Earthwatch can play a major part in facilitating this process by acting as a mediator with all stakeholders, nationally and internationally.

The questions “Whose aspirations? Whose achievements?” will continue to resonate in issues of sustainability and conservation. And we do not have much time. For people around the world who rely on coral reefs for their livelihoods, anthropogenic effects are degrading the local resource base at an alarming rate.

*Time past and time future  
Allow but a little consciousness*  
– T. S. Elliot, “Little Gidding,” *The Four Quartets*

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He is Editor of the journal *Computational Biology and Chemistry*, and on the editorial boards of three other journals. He is Chairman of the Trustee Directors of a charity for Access Ability and Communications Technology (AACT), a member of the College of Experts of the UK Medical Research Council, a member of the Advisory Board of the Coral Reef Research Unit at the University of Essex, and a former member of the Peer Review College of the UK Engineering and Physical Sciences Research Council. He is currently on the Executive Committee of the UK Deans of Science, has been a member of the Council of the Biochemical Society, an Academic Auditor with the QAA, and a member of the Research Boards of the EU and of the Big Lottery Fund. He has made several classical records, one of which won an award, and has worked with BBC TV and Radio, and on the science and art programme of the Wellcome Trust. His research specialities include computational biology, coral reefs, and proteins and enzymes in health and disease. He is also a PADI Assistant Instructor and Master SCUBA Diver, having made over 430 logged research dives since 2000.

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## Marine Conservation as a Common Goal: The Benefits of Communication between Marine Biologists and Artisanal Fishermen

Joan Gonzalvo Villegas

In 1991 the Tethys Research Institute started a project around the island of Kalamos, Greece. Initially, this was meant to be a long-term study on the ecology and behaviour of short-beaked common dolphins, *Delphinus delphis*, in the eastern Ionian Sea, a Mediterranean hotspot. However, research documented the sharp decline of the local common dolphin community, to the point that today only a few animals can be seen. Bottlenose dolphins, *Tursiops truncatus*, living in the same area appear to have relatively stable trends, but their numbers are small.

In 2001, Tethys started a parallel study in the Amvrakikos Gulf, a semi-closed sea stretching over about 35 km and covering an area of approximately 400 km<sup>2</sup>. There, bottlenose dolphins are the only cetaceans encountered. A recent population estimate showed that about 150 dolphins live in the Gulf. These dolphins seem to be members of a resident community and their behaviour and ecology is remarkably different compared to that of bottlenose dolphins living around Kalamos. Research by Tethys is now documenting how dolphin communities in both areas interact with their environment and how human activities—particularly fisheries and pollution—affect their conservation status.

I first joined the Tethys team in 1999. In 2004 Giovanni Bearzi, President of Tethys and co-principal investigator of the Earthwatch Institute expedition, suggested that I move to a village on the coast of the Amvrakikos Gulf and I settled there to start a year-round study of local dolphins. My decision to move from my home town of Barcelona, Spain, to the village of Vonitsa, Greece, was a difficult one. However, I soon realized that this could open the door to significant developments, which were unlikely to occur as long as we operated as “visitors.” Soon after I settled there, a friendly relationship developed with the local community, especially with artisanal fishermen.

Since the beginning, local fishermen were curious about the presence of biologists from abroad and started inquiring about our work. When we told them about our interest in dolphins, comments were ironic and sometimes slightly aggressive. Some fishermen claimed that dolphins had to be all killed because of their habits of damaging and depredating fishing gear. However, in the end, even those attitudes

evolved towards a genuine appreciation of our work. Fishermen started to ask questions about the methods we use, our past experiences in this field, our findings and, at a more personal level, they wanted to know the reasons and motivations that led me to choose this profession and way of life.

Establishing a good personal relationship with them and listening to their different opinions on the problems they face, offered insight that would be difficult to obtain otherwise. While sitting at seaside bars drinking our “café frappé” (ice coffee, a favourite refreshing beverage in Greece), they told me about ever-decreasing landings caused by human impact, illegal fishing taking place in the area, and the actual hardships of dolphin-fisheries interactions.

Their interest in collaborating became even clearer when fishermen started to report dolphin sighting or stranding events. Fishermen who had found a dead animal offered the possibility of taking us there with their own boat. They even waited patiently under heavy rain while we were measuring the animal and taking photos.



Barba-Yannis setting his trammel net and repairing it at the port of Vonitsa. Photo courtesy of Joan Gonzalvo Villegas.

An understanding of the factors threatening the Amvrakikos Gulf is somewhat complicated as a variety of problems—including chemical pollution, eutrophication, and illegal fishing—are contributing to ecosystem damage. Still, local fishermen have come to a good understanding just out of their own experience, without knowing about the conclusions of many scientific articles focusing on this area. Many fishermen, for instance, do not think twice when asked about the problems of the Gulf. And—surprise—the main problems do not include dolphins. Fishermen maintain that the progressive reduction of the narrow channel that links the Gulf to the open sea (resulting from a project to enlarge the port of Preveza) has had a major impact on water balance and the ecosystem. Water exchange was reduced and this contributed to increasing eutrophication. Changes in freshwater input from rivers due to hydroelectric and other dams also added to the problem. Another serious problem reported by local fishermen is that of illegal trawling (a fishing method that has been forbidden in the Gulf since 1975) - reportedly one of the main factors behind the steady decline of fish captures.

The local fishing community also shows signs of the phenomenon known as “shifting baselines,” described by fishery scientist Daniel Pauly in 1995. As one generation replaces another, people's perceptions of what is natural change to the extent that they no longer believe historical anecdotes of past abundance or size

of species. The environment changes dramatically, but due to loss of information and memories across generations most people do not realize the extent of change. Therefore, recording fishermen's present and past experiences represents an important opportunity to document the history of the Gulf's ecosystem.

For instance, young fishermen admit that a few years ago their catches of sardines, red mullets, and shrimps were much larger. Old fishermen tell an even more interesting story. Barba Yannis, who is 74 (the prefix “barba” is used in Greece to express respect for the elder), and Barba Mihalis, 75, have been fishing in the Amvrakikos Gulf for more than 50 years. Both of them recall a time when large tuna were frequent in the Gulf, and tell stories of amazing biodiversity and plentiful catches. Younger fishermen, on the contrary, have never seen a single tuna in the Gulf.

At dusk, while walking along the sea side of Vonitsa with the dolphins seen just a few hours earlier still on my mind, I watch the silhouette of Barba Yannis setting his nets while hand-rowing his *kaiki* in the magnificent sunset. Not so long ago, this was a common sight in the Mediterranean. Today, artisanal fishermen are yet another “species” struggling to survive in an ecosystem that has been depleted by commercial and illegal fishing. I again realize that Barba Yannis, Barba Mihalis, and their sustainable fishing means deserve to be protected as much as the dolphins.



**Joan Gonzalvo Villegas**, born in Barcelona, Spain, in 1972, is a Catalan biologist who is a member of GRUMM, a group for the study and conservation of marine mammals at the University of Barcelona. As a GRUMM collaborator, Joan has been involved in a project funded by the Spanish Ministry for the Environment, focusing on interactions between bottlenose dolphins and fisheries, and in another EU-funded project to assess bottlenose dolphin population size and conservation needs with the final goal of producing an Action Plan for the conservation of this species. Both projects have been conducted in the Balearic Islands. He is experienced in developing public awareness campaigns addressing the problems faced by cetaceans in the Mediterranean as well as in cetacean research methods. Joan works in the Amvrakikos Gulf in the context of his ongoing Ph.D. program at the University of Barcelona, Spain. He has been collaborating with the Tethys Research Institute since 1999, regularly participating in cetacean research done in Greece. Joan is a professional swimming teacher with experience with disabled children and has lived for several years in London, where earned his degree in Animal Biology. Joan can speak English, Catalan, Spanish, Italian and some modern Greek. From March 2006 Joan has been settled in Vonitsa and is committed to full-time, year-round research in the Amvrakikos Gulf. He is in charge of all the logistic work and coordinates all teams of Earthwatch volunteers.

## Successive Incremental Increases in the Conservation Status of Milman Island Turtle Rookery as a Direct Result of Research Outcomes

Ian Bell

Broad scale vessel-based surveys of the north Queensland coast and islands by Limpus (1980) and Limpus and Fleay (1983) initially identified Milman Island (11° 19.05'S, 143° 00.13'E) as a regionally significant green turtle, *Eretmochelys imbricata*, nesting rookery. Subsequent island-based research by Loop *et al.* (1995), Dobbs *et al.* (1999) and Limpus and Miller *et al.* (2000) confirmed this initial finding. While year round nesting ( $\bar{X}$ : 1-7 turtles per week) has been recorded, a peak in nesting density occurs during the austral summer. During the past 10 years, average annual *E. imbricata* nesting densities of 203 (R: 93-365, SD 88.8, N=10) have been recorded over the peak nesting period. The island is remote, lying close to the northern extremity of the Great Barrier Reef World Heritage Area.

Prior to 1975, Milman Island reef flat formed part of the Queensland coastal waters tenure with little to no conservation status afforded to the island or associated reef. The *Great Barrier Reef Marine Park Act* was passed in 1975 and the waters surrounding Milman Island were, in association with the whole of the Great Barrier Reef (GBR), gazetted as part of an all encompassing Great Barrier Reef Marine Park (GBRMP) under federal legislation. This new legislation required zoning plans to be developed that clearly required protection of the area's biodiversity whilst providing for reasonable use.

Consequently, over the last 30 years a range of management tools including zoning plans, permits, education, and management plans have been applied to regulate access and to control and mitigate impacts associated with human use of the GBRMP. Zoning is basically a spatial planning tool that acts like a town planning scheme.

In 1981, a zoning plan was prepared for the far northern section of the GBRMP. As a direct result of earlier turtle research, Milman Island was initially gazetted a Marine National Park 'B' Zone, which essentially provided for appreciation and enjoyment of the area in its relatively undisturbed state (Figure 1). This was a "look but no-take" zone, in which all forms of extraction (including fishing) were prohibited. It did not however preclude people, including commercial fishers from entering or anchoring at

the island. Additionally, zoning arrangements only extended to waters around the island and to 500m seaward of the reef edge, with the land area above high tide not becoming National Park until 1989.

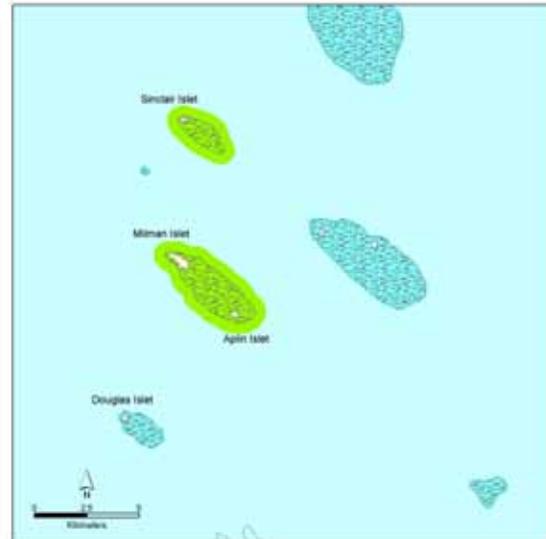


Figure 1. Milman and associated islands-pre rezoning.

Between 1999 and 2003, the federal government's Great Barrier Reef Marine Park Authority undertook a complex planning and consultative program to develop new zoning for the entire Marine Park. The program's primary aim was to better protect the GBR's range of biodiversity, by increasing the extent of "no-take" areas, ensuring they included representative examples of all different habitat types and areas of high biological significance. Whilst increasing the protection of biodiversity, a further aim was to minimise negative and maximise positive impacts on the existing users of the Marine Park. It is believed both aims were achieved by incorporating a comprehensive program of scientific input, community involvement, and innovation (Fernandes *et al.* 2005).

During the GBR-wide re-zoning process, important marine turtle nesting sites were specifically examined to ensure "no take" areas included 100% of known turtle nesting sites with a high to very high priority ranking for each species. The ten year Milman Island data set provided a comprehensive understanding the

island's marine turtle nesting population biology, and the nesting dynamics of surrounding islands (Limpus and Miller 2000). Data were also available which concluded that, while Milman Island was the primary nesting site, turtles moved extensively within a nesting season between adjacent islands to nest. These data underpinned an argument to increase the area of Marine National Park "B" zone to encompass waters of the three islands adjacent to Milman Island. Data clearly supported the case for a declaration of a preservation zone within 500 meters of Milman Island.

A preservation zone (or pink zone in Figure 2) is a "no-go" area for the general public. A person must not enter a pink zone unless they have special permission and extractive activities are strictly prohibited. Research may occur in a pink zone, but only if the research is relevant to, and a priority for, management and cannot be conducted elsewhere. Re-zoning of Milman Island to a preservation zone now affords the area the highest conservation status level possible within the Marine Park.

Incremental increases in higher levels of conservation zones surrounding Milman and adjacent islands over time would not have been feasible without a comprehensive understanding of the nesting biology of the turtles using the island. Given the cryptic life history displayed by marine turtles, only long term research can provide this understanding.

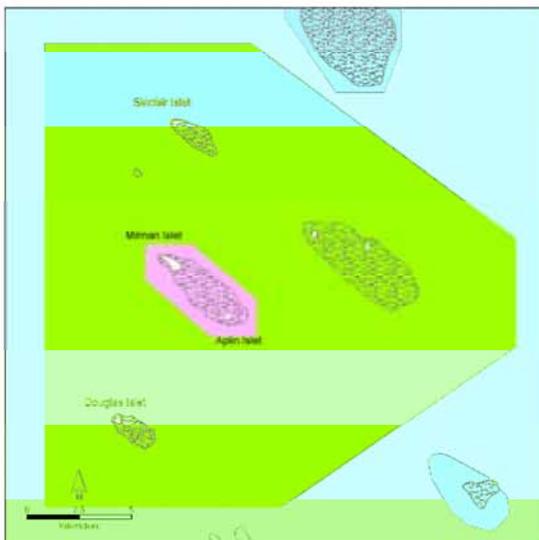


Fig. 2. Milman and associated islands-post rezoning.

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Photo © Ian Bell

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## Values, Health and Sustainable Management of the Chuuk (Truk) Lagoon Submerged World War II Sites

Bill Jeffery

Chuuk (Truk) Lagoon is home to about 50,000 indigenous Pacific Islanders known as Chuukese. They are part of the Federated States of Micronesia (FSM); Yap, Pohnpei and Kosrae being the other three states. The FSM is made up of hundreds of small islands for a total land mass of 270 square miles within a jurisdiction of 1,158,310 square miles of the western Pacific.

During World War II, Truk was a major base for the Japanese, equivalent to America's Pearl Harbor in strategic importance. The Japanese Navy used the deep water and natural fortifications of Chuuk Lagoon to shelter its Combined Naval Fleet and to supply its advanced military bases such as Rabaul, with ships, aircraft, and personnel. Beginning in February 1944, the USA launched an aircraft carrier attack, larger and more intense than the Japanese attack of Pearl Harbor and, until the war's end, they dropped over 6,000 tons of bombs on Chuuk. They also sunk/damaged about 114 ships and over 400 aircraft in and around Chuuk Lagoon.

Today, about 50 shipwrecks and 12 aircraft located in the lagoon form the backbone for the Chuuk tourism industry—in fact Chuuk's only major industry. World renowned underwater photographer Al Giddings described the submerged military sites as “one of the great undersea wonders of the world” and, equally famous for her marine biological work, Dr Sylvia Earle stated in the 1976 edition of the National Geographic magazine (in collaboration with Al Giddings) that the shipwrecks are “the world's largest of artificial reefs and they offer invaluable clues to the growth rates and patterns of the abundant marine life that congregate around them.”

Tourists from many different countries visit Chuuk to dive these sites. The natural flora and fauna that has built up around these sites and the war wrecks and remains provide a unique natural and cultural heritage seascape that is unparalleled elsewhere. The Chuukese government and part of the Chuukese community rely on the economic returns from tourism. However, the number of tourists visiting Chuuk has gone from a peak of 9,834 in 1996 (66% of all tourists visiting the FSM) to 2,770 (20% of all FSM tourists) in 2002.

To the Japanese, the submerged military sites are the final resting places of many of the 4,000 Japanese killed during World War II in Chuuk, of which some have been recovered and have been provided with the appropriate funeral rites. Japanese war veterans and relatives visit Chuuk every year on February 17<sup>th</sup> to pay their respects to those who died. The Chuukese tourism industry based on these war graves is tolerated by some Japanese but not greatly liked. There is obviously a need for a sensitive and inclusive approach to the management of the sites.



Figure 1 – CoPI Dr Ian MacLeod and July 2006 Earthwatch volunteer Neil Glickstein drilling a hole in the wing of the *Emily* flying boat in preparation for measuring the corrosion potential of the aluminium. Photo courtesy of Bill Jeffery.

Two other major issues surround the submerged sites. Many of the ships contain bombs/sea mines/general munitions that some Chuukese recover and use to make small ‘dynamite bombs’ to kill fish inhabiting the ships and the surrounding barrier reef. These explosions also kill all other animals in the general area. Although the practice is illegal, attempts to stop it are proving difficult and the shipwrecks and reefs are greatly suffering. Fish are a traditional staple in Chuuk and good money can be made selling fish at the many market stalls. With 33% of Chuukese below the poverty line, there is a big incentive to collect fish in this way although this practice is known to be dangerous and to have fatal consequences to some fishers and those trying to control it.

Another issue with similarly grave environmental consequences is the leakage of oil and gasoline from the shipwrecks. Since 1944, a number of

small oil slicks have been found on many of the shipwrecks. Findings from the first corrosion survey to be carried out on the shipwrecks in 2002 by Dr Ian Macleod, suggested that some of the shipwrecks may start to collapse in the next 10-15 years. If those shipwrecks contained large quantities of oil, as it is possible, their disintegration could release oil on a massive scale.



Figure 2 - November 2006 Earthwatch volunteer Steve Hubble inspecting some of the damaged area on the upper part of the bridge of the *Fujikawa Maru*. Photo courtesy of Bill Jeffery.

### Project aims and methods

A major goal of this project is to provide Chuuk, FSM, USA, and Japanese governments and communities with an assessment of the natural and cultural assets found at the sites and with a strategy to manage them in a sustainable manner. It is contended that the submerged sites hold little historic, archaeological or scientific value to most Chuukese who are more interested in their economic value—from tourism and fishing revenues. These communities would therefore be more interested in preserving the sites from corrosion as compared to knowing how a shipwreck was built. Although the archaeological and cultural value of the sites should not be ignored, they would be better appreciated by the Chuukese if paired with their economic concerns and the sustainability of their alternate uses of the sites.

The project seeks to study all aspects of the sites, from the impact of dynamite fishing, of divers and of poor mooring practices, to their biological diversity and the cultural heritage they represent. Any sign of potential or existing oil leaks need to be reported, and the impacts these leaks may be having on the health of the shipwrecks and the surrounding environment need to be assessed. Interesting comparative data could be generated by comparing lesser

known or newly discovered shipwrecks with frequently dived shipwrecks and natural reefs. The project is a collaboration among marine ecologists, corrosion specialists, and maritime archaeologists working closely with Chuuk government employees, the commercial diving industry, and sections of the Chuukese community to look at these sites in a holistic way.

The project commenced in July 2006 with four teams of six Earthwatch volunteers working for a period of two weeks each under the supervision of three principal investigators and field team leaders. The aim of the first year was to establish a good working relationship with the Chuuk government agencies responsible for the management of submerged natural and cultural sites, the Chuuk Historic Preservation Office and the Chuuk Department of Marine Resources. Two personnel from each agency were allocated to work on the project and the Chuuk Department of Marine Resources made one boat available for the project.

With over 50 shipwrecks and a dozen aircraft located in water depths up to 70 metres, it was necessary to select sites, firstly within the 20 m depth limit as per Earthwatch policy and secondly those that would be useful in illustrating some of the issues presented.

So far the project has accomplished:

- The development of a good working relationship with the Chuuk government, agency directors and their employees, and the completion of preliminary reports (verbal and written) to these agencies.
- The discovery of a rare coral species, *Acropora pichoni*, on some of the shipwrecks.
- The initial assessment of the relationship between corrosion and the natural biota (Figure 1).
- The documentation of a less frequently dived site: a gun-boat not recorded in any historical documents.
- The discovery of a new site not dived at all which will provide a unique opportunity to compare sites impacted by divers with an undisturbed site.
- The implementation of monitoring of the most frequently dived site, *Fujikawa Maru*, found to have a different corrosion mechanism than other sites (Figure 2).
- The comparison of some natural reefs with submerged military sites with the discovery that natural reefs are heavily impacted by dynamite fishers.

Some training/capacity building of Chuukese agency staff has commenced with the likelihood of involving college students in the future. A number of oral history projects are also earmarked to begin in the future, including collecting oral histories from Chuukese World War II survivors, an investigation of why there has been a drop-off in tourism, and the history

of the Chuukese dive guide system and what information they can provide about the changes in the health of the submerged military sites. The project will also consider, and possibly respond to, broader socio-environmental issues that are of a concern to the Chuukese such as climate change.

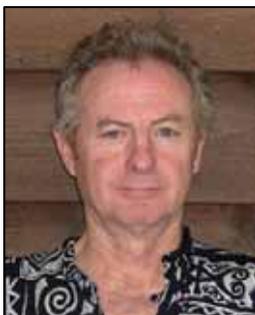


Photo © Bill Jeffery

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From 2001-2006, **Bill Jeffery** was employed as a contract maritime archaeologist with the Federated States of Micronesia Historic Preservation Office and he has initiated projects in Chuuk, Yap, and Pohnpei. From 1981 to 2001, Bill worked as the Principal Maritime Officer with Heritage South Australia, Department of Environment and Heritage, where he was responsible for formulating and implementing an Historic Shipwrecks Program. His work in maritime archaeology has included sites in New Zealand, China, Finland, Sri Lanka, and Hong Kong. He has written a number of articles and reports on maritime archaeology sites and issues. Currently, Bill is a Ph.D. candidate in maritime archaeology at James Cook University in Queensland, Australia, and is the Principal Investigator in an Earthwatch funded project being implemented in Chuuk. He is also a sessional lecturer in maritime archaeology at undergraduate and post graduate level and has carried out maritime archaeology training programs for the benefit of Historic Preservation Office staff from throughout Micronesia.

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## The Disposition of Water Resources of Arid Area with Special Reference to the Alxa Plateau, Inner Mongolia

Wei-Zu Gu and Jia-Ju Lu

The study area of the Earthwatch-funded project entitled *Inner Mongolia's Lost Water*, is the area geomorphologically known as the Ejina - Badain Jaran Depression, a part of the Alxa Plateau, which also encompasses the Ejina Basin of the Gobi, the Gurinai grassland, the Wendu Gaolei lowland, and the Badain Jaran Shamo (dune desert) with an area of about 80,000km<sup>2</sup>. The Black River flows northward into the west part of the study area flowing into lakes (Figure 1a and 1b). This is an arid plateau with annual mean precipitation of about 50mm. Desertification in this area is caused from both natural and anthropogenic impacts, often superimposed by impacts from climate change. Anthropogenic impacts took a turn for the worse near one of the Black River's terminal lakes, the Gaxun Nur, with area of 267km<sup>2</sup> drying up during the 1960s. Data collected with the help of 289 Earthwatch volunteers since 1997, consisting of general observations of the desertification processes, hydrometric observations of the water cycle, groundwater monitoring to identify recharge sources and water sampling to conduct environmental isotope and hydrochemistry analysis, identified two main issues; water resources are naturally wasted because of the natural cycle in this endoreic basin and the basin faces a high risk of damage to water resources and to the environment from a proposed river regulation project. The reason for these issues is mainly that natural water cycles in an endoreic basin are different than in other natural environments. Endoreic basins amount to 34.8% of the land area in China and most of them are arid.

### Wasted water resources

In the Wendu lowland, 19 out of a large number of fresh springs are monitored biannually. Their discharge ranges between 0.1 and 3.3 L/s with small annual variations for a total of approximately  $37.2 \times 10^4$  m<sup>3</sup> per year. In the Gurinai grassland, the fresh spring Ktaohe forms a swamp at ground level with stable height and  $\delta 2H$  ranged from -52‰ (1998) to -50‰ (2005), which is indicative of a stable recharge. This spring water just flows away and becomes a wasted water resource. In the Shamo, we monitored 13 out of hundreds of springs and calculated their discharge at between 0.2 and 8.7 L/s, for a total of  $137.3 \times 10^4$  m<sup>3</sup> per year. In contrast to the grasslands, this spring water is partially used up

to maintain the lake level. The rest is a wasted water resource.

The nomadic Gobi and Shamo peoples have a population of about 0.2 per km<sup>2</sup> and the wasted water described above could be used to grow plants with economic and environmental benefits such as sequestering atmospheric carbon. Two thousand km<sup>2</sup> of plantation will sequester about half a million tons of carbon (Issar 2004).



Figure. 1a - Location of study area

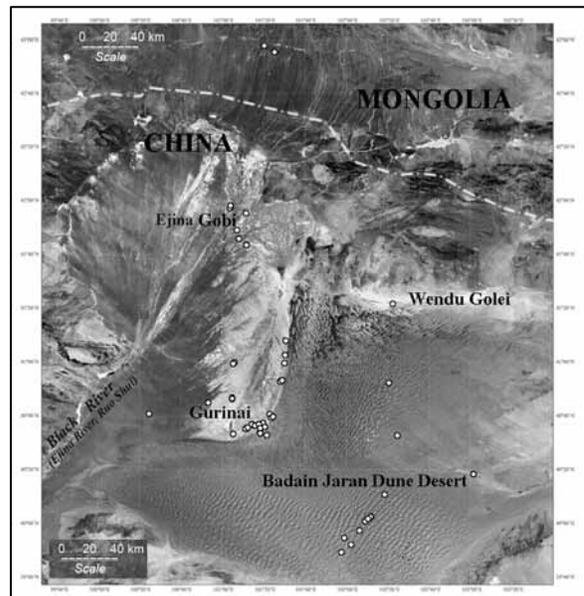


Figure 1b - Geomorphology of study area, main sampling sites are shown by circles



It also shows that water is necessary to support it. But where does the water in megadunes come from? Data on vadose water content profiles in megadunes (Hatch *et al.* 2004) have refuted the view that it comes from groundwater recharged afar (Sheng Cheng *et al.* 2004). Data on diurnal variation in air temperature and humidity suggest it may come from air itself (Zai-Sheng 2006). The megadunes are at up to 1,700m altitude, and act as a natural but incomplete vortex engine by catching water vapour from the atmosphere: Air Well. The possibility of this phenomenon occurring in such an arid area is worth exploring with more detailed studies of the megadunes.

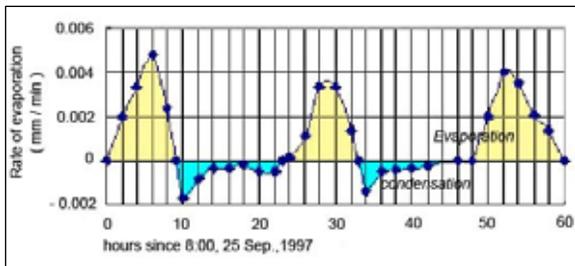


photo © Peter Seiler

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## Ecological Monitoring as a Tool for Conservation Management: An Initial Impression for the Mulanje Mountain Forest Reserve

David A.N. Nangoma

### Introduction

Located between latitudes 15°50' - 16°03' South and longitudes 35°30' – 35°47' East in Malawi, the Mulanje Mountain Forest Reserve (MMFR) sits at an altitude of about 680m above sea level, reaching a height of 3,000m. This is a very important ecological zone, currently enjoying the status of Global Biosphere Reserve under UNESCO. Its challenge is that it is completely surrounded by communities with high levels of poverty, most of them deriving their livelihoods from subsistence farming on less than 0.1 ha of land. Harvesting and sale of forest products supplement the people's income and livelihood sources to a significant degree. Population densities around the mountain vary from place to place, and provide insight for the conservation of the MMFR.

### Background

Initiatives to conserve the MMFR started in early 2001 through funding from the UN Global Environmental Facility (GEF) following pleas to conserve the unique biodiversity of the massif, particularly the Mulanje Cedar. The Mulanje Mountain Conservation Trust (MMCT), in partnership with the Forestry Department, implements programmes collaboratively aimed at protecting and conserving the forest whilst ensuring that sustainable benefits accrue to the communities surrounding the reserve. Of particular importance is an effort to provide research-based information that promotes well informed forest management decisions for the managers and resource users through an Ecological Monitoring Programme (EMP). The EMP runs a series of study plots that address a number of forest and biodiversity related issues aimed at monitoring the ecological health status of the forest, amongst which are disturbance transects situated around the reserve (Figure 1).

### The disturbance transects

The rationale for establishing the belt transects in 2004 was to assess the levels of resource utilization in areas of woodland and forest. It aims to assess levels of pole and tree cutting.

### Results and discussion

Involving at least five people to collect data, this method uses three transect lines of 250m length, running parallel to each other and spaced 50m apart forming a transect belt. Results are here given of four sites—Michesi,

Fort Lister, Kambenje and Likhubula—which are sites situated near a farming village, inside a protected area but near an urban area; near a forestry village and near a District Forestry Office, respectively (Figure 2).

All sites show that communities living nearby gain access to resources of the forests, especially in form of wood for timber and energy (firewood). The large percentage (>80%) of saplings of DBH less than 10cm is indicative of forests that are largely coppicing or regenerating after much cutting. There is generally a noticeable trend of further tree (>10DBH) decline in all the sites, with Michesi being more affected and the other three sites, which are relatively near forestry establishments, remaining with relatively good stocks of standing trees (12%, 11% and 11% respectively). It is also evident that communities use other resources such as ropes derived from saplings that have not reached pole size, especially of *Brachystegia species*. This has implications on the regeneration of the Miombo woodlands.

The complete absence of natural falls of trees in all the sites indicates greater reliance of the villagers on wood as a source of energy. Not only does this pose a challenge to the regenerating forests, but also brings a dimension of the alternative energy sources for the communities, as well as the general ecological balance of the forests.

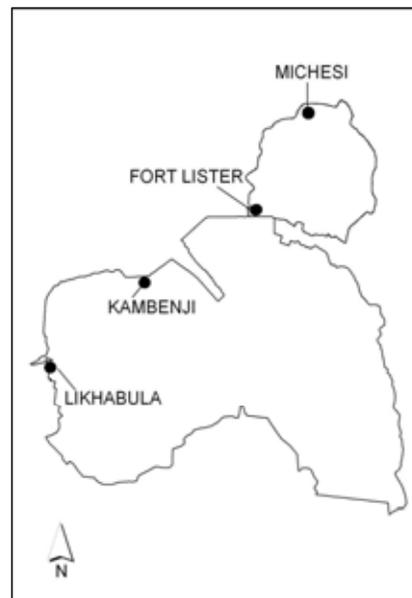


Figure 1 - Study plots

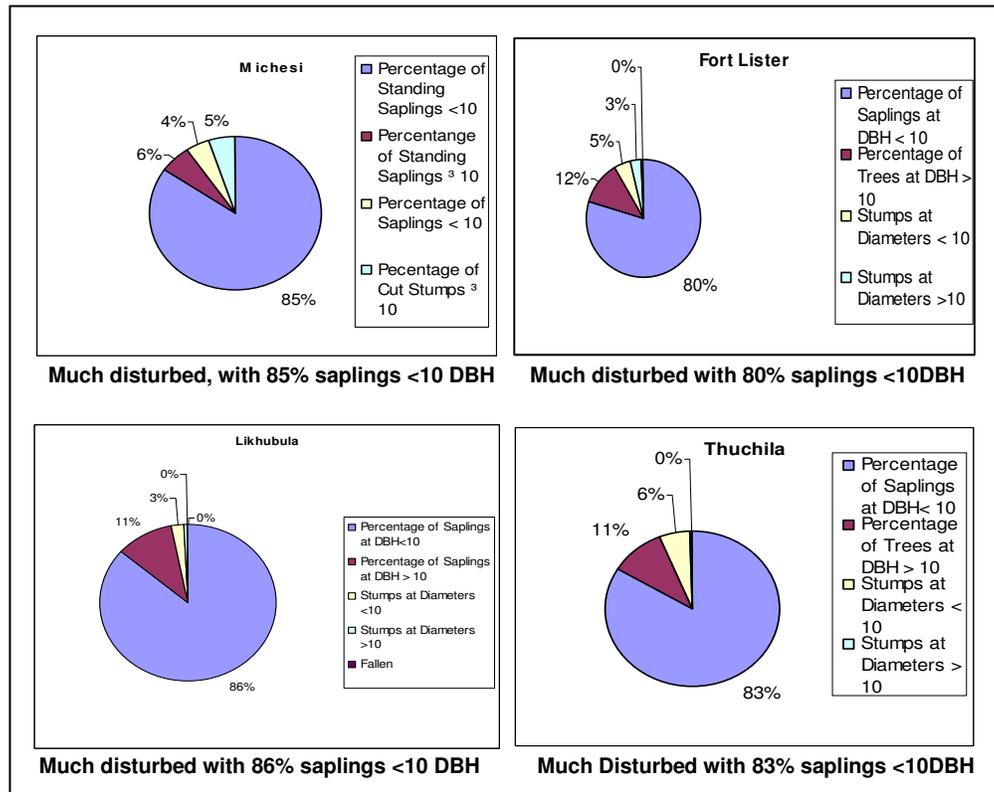


Figure 2 - Charts representing levels of forest disturbance due to resource use

With this initial (year two) information, appropriate management interventions can be initiated in order to protect the Miombo woodlands and forests, especially interventions that involve communities who interface with the forest reserve. The development and coming into effect of the Mkhumba Border Zone Livelihoods project is one positive intervention that has come into play and its positive

contributions towards addressing problems of further forest resource degradation can be replicated elsewhere around the MMFR.

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Photo © David Nangoma

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## Two Steps Removed: The Value of Tangential Research in Finding Novel Solutions to Common Problems

D.J. Metcalfe, M.G. Bradford, A.J. Dennis, A.J. Ford, B.D. Hardesty, G.N. Harrington, D. Jones, A.T. McKeown, H.T. Murphy and D.A. Westcott

Invasive plant species (weeds) are a threat in many environments today, and huge efforts and resources are expended in attempts to remove infestations where they occur. However, a problem for many managers is that weed infestations only become apparent when the plants have reached sufficient size or abundance that they are noticeable. For many species, particularly herbs and shrubs, this occurs only when the plants are reproducing and spreading new seed. This paper documents our collaboration with Earthwatch to better understand seed dispersal processes in tropical rainforests in order to refine our understanding of forest dynamics, the ecosystem services provided by key groups of animals in achieving seed movement, and how an unintended bonus from our work has been a development in approaches taken to control weed spread.

For the majority of plants, seed dispersal provides the only means of movement about the landscape. Consequently an enormous amount of evolutionary effort has been expended on ensuring that seeds are adequately dispersed away from the parent tree (Grubb *et al.* 1998). In tropical rainforests the great majority of woody plant species have evolved to be dispersed by animals, primarily vertebrates (Jordano 1992). The flip side of this association is that for many animals, especially birds, fruits and seeds provide a vital part of their diet. These associations can be hugely complicated; in the tropical rainforests of northern Queensland nearly 2,000 species of plants are dispersed by 65 animal species (cf. Dennis and Westcott 2006). Earthwatch teams have helped us since 2000 to try and make sense of who disperses what, and how many viable seeds are moved how far from the parent plant. The collected data have been used to develop predictive seed shadow models, based upon what animals move what proportion of seeds where within a landscape. The project has evolved over time, but has resulted in a unique insight into the impacts that different groups of animals have on plants with particular fruit types. We are currently refining our understanding by incorporating environmental context into the models, so that we can see how a fruiting tree's proximity to a fragment edge, or a ridge top, or a stream, might influence the movement pattern of the animals visiting it and the consequent seed shadow produced (Figure 1).

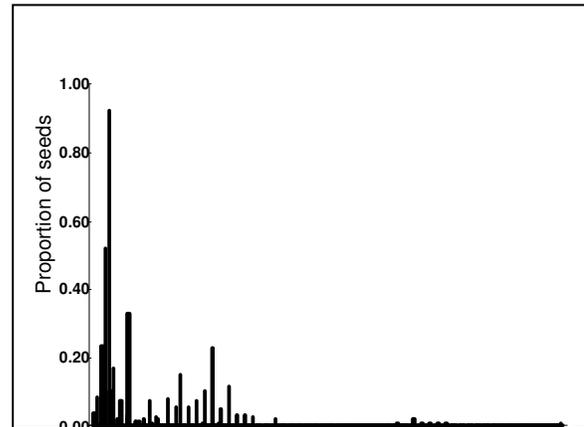


Figure 1 - Estimated complete dispersal curve for a small-seeded species such as *Miconia calvescens*, with several different functional groups of dispersers visiting the tree. Most seeds are deposited within 250m of the parent, but a considerable number are distributed up to 500m away, and a small but significant number exceed 1000m, defining a large search area for land managers looking for seedlings of this important weed.

From a logistical perspective, Earthwatch Institute has found us teams of motivated volunteers who have provided the huge labour force that would make such an undertaking possible. For example, we have logged 3,034 hours watching fruiting trees to see which species visit, how long they stay, and how many fruits they eat. We have timed the passage of over 31,000 individual seeds, and spent 5,065 hours radio tracking resulting in 10,245 positional fixes. This effort has been expended in an attempt to better understand dispersal processes, the dispersal services provided by different groups of animals in different landscape contexts, and the longer term effects of habitat fragmentation. We have been able to answer these specific questions, and, as a further step, use the answers to provide managers with information on which to base landscape rehabilitation decisions. However, the most significant conservation benefit from our research to date has been two steps removed from the initial concept. We were approached by Queensland Department of Natural Resources (QDNR) weed eradication teams to see if we could build predictive dispersal models for highly invasive and nationally significant weeds to aid their search for seedlings around newly identified infestations. We had no data on weeds, but using our rainforest data and our approach to modelling dispersal in order to

generate seed shadows, we have been able to assign species such as pond apple (*Annona glabra* L.) and miconia (*Miconia calvescens* D.C.) to plant functional groups based on fruit and seed morphology, and predict seed shadows based on the most likely disperser animals and their movements. These predictive seed shadows have been used to revise search patterns for seedlings after new adults are found, increasing search efficiency and efficacy at finding all potential offspring before they reach reproductive maturity themselves. This work is now part of an ongoing collaboration with QDNR to refine our models and their search pattern based on incorporating current findings and model developments.

The message from our Earthwatch collaboration is that the involvement of motivated volunteers with scientists can make apparently impossible tasks feasible and that targeted scientific questions can inform conservation management. Also, that dialogue with the managers themselves can hugely increase the value and application of research findings

through providing a different perspective on how data can be used, or to bring different problems to the attention of scientists, with ultimate benefit to the landscape and natural biota which it supports.

### Acknowledgements

This work would have been impossible without the willing support of more than 20 Earthwatch expeditions. All work has been conducted under permits from the Queensland Environmental Protection Agency and the CSIRO Animal Ethics Committee.

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Photo © David Westcott

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*Dr. Daniel Metcalfe is a plant and community ecologist with more than a passing interest in ecophysiology and taxonomy. He obtained a B.Sc. in Botany from the University of Bristol, UK, writing a dissertation on diurnal migrations in photosynthetic flagellates, which he naturally followed up with a Ph.D. from the University of Cambridge for work carried out on the dynamics of understory plant species in the rainforests of South East Asia. He spent three happy years in Atherton working on root competition, sapling growth strategies, and factors influencing seed size, and after seven years as a Senior Lecturer in Ecology at the University of Brighton, UK, he accepted the offer to return to CSIRO as a researcher in 2004. This time he is working primarily on landscape ecology and plant biogeography.*

## Looking Towards a “Bridge” in China’s Mountain Area

Dong Feng



Photo © Nicole Like

Translating scientific results into conservation actions—I believe that is a very good question for us. In fact, in my motherland, China, we also discuss the same problem seriously. I want to listen to other PIs’ great ideas and I also want to share my own ideas with them.

In my opinion, there are several ways to solve the problem. But we should choose different methods for different situations. Sometimes we can send brochures or even TV shows to publicize our research result to the residents. Sometimes we can invite officers from the government to attend our meetings and try to make them understand the meaning of environmental conservation. Sometimes we can advise local companies to help them increase their environmental stewardship.

We may encounter some unexpected problems. Common people can just sense the short-term profit, and the benefit of conservation action often takes a long time. In China, government officers are ambitious and if they want to be promoted, accelerating economic development is the best way to do this. Under this situation, it is not strange to see people abandon conservation action and its long-term advantages.

In this way, things can become complex and awkward. How to solve the problem becomes an economic question. We should try our best to solve it. I believe if we want to have the greatest effect on the policy-makers, the first step is to try to get them to recognize the real value of our research, which makes the public recognize the importance of conservation. We will give them

some advice and help them understand the balance between short-term benefit and long-term benefit.

Take our expedition, *Walking through China’s Past*, for example. This expedition works in the mountainous Zhejiang Province of China—a place most visitors yearn to return to after they have visited. There are many old bridges with tipped roofs, lichen-covered stone-built traditional netlike roads, and many centuries-old buildings established for extended families. We believe all the bridges and old roads have excellent stories which can show us the local history and culture.

As a mountain area, Taishun County remains relatively unscathed by China’s recent explosive commercial development. There are too many mountains and it is too hard for the local people to build factories or workshops. Agricultural development meets with the same problem. Meanwhile, population growth doesn’t stop, which makes the problem worse. But Taishun County has its own advantages: Clouds change fast over the green peaks, beautiful birds sing engaging songs in the forest, and rivers flow through hills and farmland. Old roads are connected by famous and uniquely crafted bridges, which are historical treasures for architecture and historical geography. The old roads linked the local markets and led the way to the main valleys and tiny hill villages. Follow these old roads and we may enter the residents’ houses which have not changed, just like walking through time.

After our first team expedition, local government became aware that developing tourism may be the best choice for local economy development. Taishun County has its own wonderful landscape and longstanding history. Its bridges and old buildings are the keys to opening the historical gate. We see a mountain area from an earlier time. We can learn from the wisdom of the local people at that time and see how their knowledge has shaped us. Local government recognizes that it has another chance to introduce Taishun County to the world. They are also publicizing the advantage of conservation. More and more people have realized that long-term profit fits their needs better—local people earn money from the tourism and they welcome this new “smokeless” industry very much.

We hope our project will encourage people in Taishun and elsewhere to think about their own connection to local history and to pave the way for the protection and further study of these cultural assets by local government and scholars.

History is a play, geography is the stage. Our research gives the wonderful landscape a

colorful cultural background and shows local people and the government the possibility of tourism development. In short, we are trying to find a “bridge” to connect conservation action and economic development.



Photo © Dong Feng

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## Approaches to Conservation through Cultural Influence

Jin Feng, Anrong Dang, Jiang Lu and Yanfeng Liu

Successful environmental conservation depends on the conscience of a society that determines people's attitudes toward life and the environment. In our research project that studies cultural traditions in the small Chinese mountain village of Dang Jia Shan, we discovered the beauty of a very simple lifestyle that respects nature and treasures the limited resources at the villagers' disposal. The villagers live in cave dwellings that can be seen as the most elegant solutions to sustainable design in almost every aspect of this contemporary concept. The cave dwellings are energy-efficient and have a positive environmental impact. The villagers are most efficient recyclers: When a shirt is worn out, it is made into shoes; when the shoes are worn out, they are made into shoulder pads; and when the shoulder pads are worn, they go back to the environment and become nutrients.

Such a healthy and sustainable lifestyle, however, is in great danger of being phased out under the pressure of rapid economic development and ideological changes in the name of social progress, or modernization. With the young people in the village being attracted to the booming urban centers, a much more wasteful way of life has taken root in the village. New architectural styles based on urban models have been adopted to replace the traditional cliff cave dwellings. The new houses are free-standing buildings away from the cliffs. They are much less energy-efficient and use more land. Modern building materials, which have more negative environmental impacts, are extensively used. It is not hard to calculate how much more fossil fuel is needed to heat the new houses in the winter and to produce the new building materials such as brick, ceramic tile, steel, and cement.



The traditional cave dwellings in the village of Dang Jia Shan. Photo courtesy of Anrong Dang.

### Challenges

When we first started the project, we focused on the conservation of the village cultural traditions and their relation to a specific government policy of reforestation. The more we learned about the village, the more we felt that the conservation of its cultural traditions is closely related to environmental conservation. The shifting of lifestyles toward a more modern model based on the developed world puts tremendous pressure on the local environment. Therefore, we believe that environmental conservation depends on the building of a culture of sustainable development. We have found *Chinese Village Traditions* to be very inspirational in this regard, and have thus found a new meaning to our project.

Our fieldwork documented a wide-spread negative attitude toward the traditional lifestyle among villagers and government officials. They see the traditional lifestyle, symbolized by the cave dwellings, as “backwards” in the context of social and technological progress, while the non-traditional urban style housing becomes the most fashionable and desirable model. Since the village we are studying is a typical rural community, this attitude reverberates in other rural areas of the less developed regions of China. If the more than one billion people in China are striving to realize a “dream life” inspired by the wasteful lifestyles of some developed countries, the scale of the negative impact on the environment is far beyond the specific policies concerning the village. We felt it was imperative to work on this influential ideology and reshape the peoples’ dream if we hope to win against unsustainable progress, and we believe our project has a potential to produce impacts that go beyond the village of Dang Jia Shan and make contributions to the global environmental conservation effort. This is, however, a great challenge that needs to be answered by using all possible channels to divulge our values and to summon all the powers of persuasion.

### Approaches

First, we are using the power of science. In contemporary China, science is venerated. The scientific approach is seen as the only valid approach to decision-making. Policies are expected to have a scientific basis. Therefore, we collected measurable scientific data about the thermal performance of different housing types in order to produce convincing

comparative data and demonstrate how much energy could be saved by continuing to use traditional cliff cave dwellings. This type of comparative study can be expanded to cover the entire loess plateau in northwest China to calculate the tremendous amount of fuel that would be required for heating and cooling if all the population currently inhabiting cave dwellings in the region move into modern style housing. The scientific approach and accurate numbers have strong persuasive power to influence not only the policy toward cave dwelling preservation, but also public opinion about the traditional lifestyle by promoting the idea that traditional housing can be a scientifically proven solution to modern energy-efficiency issues.

Second, we used the power of economy. Economic development has first priority in China. Anything that has the potential to promote economic development gets immediate attention in the country. Because an increased energy consumption has great economic implications, our advocacy for traditional cave dwellings may no longer fall on deaf ears as it has in the past efforts of other Chinese scholars. In presenting our project to the local community, we introduced the possibility of developing cultural tourism that could bring economic benefits to the local community. We also proposed the founding of a park to preserve the unique natural landscape of the loess plateau while attracting tourists to this area.

Third, we tried to use the power of mass media to disseminate the value of traditional culture. The media in China is under government administration at different levels. Its official status grants it great authority. The coverage of our project on local television networks not only promoted our work but also gave us an implied official endorsement, making our message to the public more powerful.

Fourth, we used the power of religion to help with environmental conservation. During our field work, we found that traditional religious activities are alive and popular. In the worship of the dragon kings and in the ceremonies to pray for rain, we detected a great respect for nature—one that is deeply rooted in the core beliefs of harmonious coexistence of heaven, earth, and humans in the Chinese cultural tradition. We feel that these aspects of local religion should be emphasized and that activities devastating the environment could be interpreted as sins that are offensive to the



The new housing units of the relocation settlement. Photo courtesy of Anrong Dang.

deities of nature. In the near future we are planning to collect data on the popular religious beliefs of this area to further understand the connections to an environmental conscience.

Fifth, we used the power of education by approaching the future generations. During our field work, we found that knowledge of the village cultural traditions is diminishing among the younger generations. They are more involved in a popular culture that mimics the culture of urban centers. Therefore, it is critical to create opportunities for the younger generation to learn to appreciate their cultural traditions in order to keep them alive. We engaged local students in our research and presented our project to the local community college with very positive responses from the students.

Sixth, we are using the power of information technology to disseminate our findings. A website was created to introduce the village of Dang Jia Shan and the culture of the surrounding areas in order to let people worldwide know about the environment-friendly lifestyle of this Chinese village. On the website, we use virtual reality to allow on-line visitors to tour the village interactively. We will use GIS to integrate the information we collected in the village to support future planning and decision-making.

Seventh, we used the power of Earthwatch volunteers. The local community viewed the volunteers as foreign “experts.” Our volunteers from diverse backgrounds have indeed been able to offer many valuable suggestions. Since modernization in China is a comparative concept using western developed countries as reference, the foreigners’ opinions have significant weight. In the past two years, the local government has solicited our advice and suggestions for local social development and the volunteers have done a great job in

advocating for the value of the traditional culture. From this perspective, we have witnessed how much the Chinese people have been influenced by western developed nations in their efforts to achieve modernization, where developed nations are perceived as examples for the developing countries to follow. Therefore, to realize the goal of environmental conservation, it is vitally important for the developed nations, especially the United States as the most influential world power, to set good examples. However, we also feel that the traditional lifestyle of Dang Jia Shan is equally inspirational to “westerners.” Therefore, we have been actively seeking publications of our research findings in the U.S. in the form of conference presentations, journal articles, exhibitions, and eventually a comprehensive book about life in the village of Dang Jia Shan.

Our lead Principal Investigator is also collaborating with one of the Earthwatch volunteers who is a writer to produce a book about the volunteer’s personal experience in the village.

We hope that our efforts will contribute to the building of a global conscience of environmental conservation and a universal culture of sustainability. Through the lens of our experience in the small mountain village on the loess plateau, we learned that the environmental problems we are facing are global in nature, and they are as much technical as they are cultural. Working on these issues requires collaboration on a global scale, and we are indeed grateful to Earthwatch for making such collaboration possible.



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## Heritage Conservation in the Pacific Islands: Whose Heritage, Whose Agenda, Whose Benefit?

Patrick D. Nunn



Photo © Patrick Nunn

In the tropical Pacific Island nations, as in many parts of the “developing world,” issues of heritage conservation are not as straightforward as they are elsewhere. Science has an important role in discovering this heritage, in recording its character in appropriate and globally-agreed ways, and in disseminating these results as widely as possible in both professional scientific circles and to the general public. The justification for scientific investigations is the same worldwide. Whatever our ethnicity, our species is one, and all of us have the right to know our cultural heritage wherever it may be found. Such an intellectual position is easy to justify when you have the global picture, but many people, particularly in the “developing world,” do not have this.

### Whose heritage?

For many such people, heritage is often primarily intangible—language and oral traditions (myths) are good examples. What outsiders might regard as tangible heritage is often alien, removed from the past in people’s consciousness by a lack of appropriate recording methods—megaliths and ancient settlements exposed by archaeological research, for example. Undeniably, for those

who have a global view of such tangible heritage, this belongs in the first instance to the ethnic group that occupies the area before it belongs to the global family of people.

Trying to force a group of people to take ownership of their heritage may be a well-intentioned strategy, but is questionable. Is it not possible, for example, that a group of people may choose to disown their heritage? This is precisely what has happened in many tropical Pacific Island nations. About the time of European contact, indigenous people—their numbers massively depleted by the introduction of alien disease—were often taught to be thoroughly ashamed of their pre-Christian history. The effect of this in countries like the Cook Islands is that early history is almost completely unknown amongst the general population, the few examples of tangible heritage generally untended and falling apart. In Fiji, historians and anthropologists have long been amazed at the almost total lack of curiosity that Fiji Islanders have about their pre-Christian past. Rather than scientific truth, improbably concocted myths about islander origins abound.

In such instances, scientists can do no more than disseminate their findings as widely as possible, particularly through the communities in the areas where research has been carried out. But it is not enough, in a global context, to simply then sit back and expect heritage conservation to suddenly become a priority. Scientists need to ensure that their discoveries are reported as widely as possible in the global context, so that one day global priorities might filter back to the local communities.

### Whose agenda?

Heritage conservation for its own sake (rather than for economic benefit) is mostly a preoccupation of the “developed world” and has thereby found its way onto global agendas. Many scientists and professional heritage-conservation managers take this preoccupation as a global truth, and are often surprised to find that it is not self-evident to people in the “developing world.” Many local communities in the Pacific Islands regard heritage as irrelevant because their priorities are economic development (individual and communal) and their vision of the future is generally short-term,

typically involving the unsustainable exploitation of natural resources for profit. And what right do outsiders have to say that this is wrong?

### **Whose benefit?**

The universal justification for the conservation of heritage is that this belongs to everyone. If the immediate “owners” of a particular site are reluctant to conserve it, then international efforts should be brought to bear, even if the site falls short of World Heritage status. What is happening in many parts of the “developing world” is that tangible heritage is being destroyed in the name of economic progress. Often it is being destroyed even before its existence is known or at least properly recorded. Such an approach may appear defensible at present, both to national governments and to

local communities more concerned with revenue generation, but in fifty years time there may be only regret that so much of value was destroyed for short-term profit.

Experience shows that, besides being of scientific value, cultural heritage is also important in defining ethnic groups and their origins. Fifty years from now, in a world of increasing cultural homogenization, ethnic definitions that seem unimportant or self-evident today may become priorities. For such reasons it is imperative that science records as much tangible heritage as it can, and strives where possible to preserve this, even if this runs counter to the stated interests of the people it primarily seeks to serve.

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## **Example Leads Policy**

*Peggy Rismiller*

Thirty years of field work has taught me that an effective way of translating scientific results into conservation actions is to empower individuals in the greater community. Living and working while learning through example, sharing knowledge, and engaging with scientific methodologies help individuals gain courage and confidence to proactively tackle local conservation issues. Local action precedes and outlives official policy.

The needs of communities are irrevocably but often obscurely linked to nature. Communities have faith in what they see. They are naturally cautious in accepting what scientists say. In the past scientists have been placed on pedestals and were all too often unapproachable. In the context of environmental sustainability it is especially essential for 'today's scientists' to integrate themselves into the community and not remain separate or set aside from it.

Within the community I recognize my role as a scientist as being two-fold. Sound science follows protocols, procedures, and dissemination of facts. As a scientist I have a professional commitment and responsibility to long term research and goals. Scientists can encourage and help individuals reconnect with nature. This includes restoring, reactivating, or kindling a passion for the environment. For



Photo © Peggy Rismiller

passion to blossom and grow into taking responsibility for one's own back yard, a person must first have a clear understanding about their place in the big scheme of things. As scientists we can help individuals realize and visualize how they fit into the environment and why/how our lives are dependent on the environment and not the other way around.

Ten years ago when asked about field research and "why it matters" for a 1997 Earthwatch Institute publication I gave the following, now frequently quoted perspective: "Humans are not custodians of nature, but part of it. In the biosphere of this universe, our species is one minute speck. While humans argue and debate their role on the planet, nature continues. By observing and learning from organisms that have existed and will continue to exist independent of our species, we establish a perspective of another reality. Loss of perspective is deadly. In human society, money makes the world go round. In nature, money will never make the sun come up. Understanding our place in nature is not key to the planet's continued existence, but it is to ours."

While inspiring and getting people motivated, we involve them in sound science. This means sharing knowledge, tools, and methodologies that help facilitate an individual's conservation actions. Working in the field, volunteers and colleagues become surrounded with living models from nature and submerge themselves in a sustainable environment. They become participants, not viewers. This situation often puts people in a position to look at their personal core values and social values in relation to nature.

The echidna/goanna research and the lifestyle at the Pelican Lagoon Research & Wildlife Centre are based on "nature's time" as compared to "human time." We share this environmental concept as well as our scientific curiosity. We teach individuals scientific methods and put them in positions of responsibility. Promoting development of skills, introducing sound environmental principles while encouraging individuals to expand their horizons, and reinforcing awareness increases confidence and empowers people to be proactive in their own communities.

As a result of participating in an Earthwatch project, individuals are contributing real solutions to environmental challenges in their communities. A few examples of positive on the ground actions include:

1) A corporate volunteer from Indonesia was aware of the necessity for having clean water for living and was distressed by the pollution and rubbish accumulating on her home island. While in the field she saw this complex social/environmental problem could be resolved by locally manufacturing rainwater tanks using recycled materials. Once home she established a village program to clean up and recycle the rubbish. Through corporate partnerships, plans were made to establish small businesses, generate employment, and manufacture portable rainwater tanks using sustainable methods.

2) A teacher from Western Australia had always been interested in renewable energy. Living and working at a facility that has been energy self-sufficient for more than twenty-five years gave her the background and confidence needed to tackle local government who were doing little towards using renewable energy. Single-handedly she sought and received grants for implementing a sustainably powered school. The system was up and running at the beginning of this year. Her students have petitioned the government to follow their example for all new educational facilities. Their momentum has not stopped. Students are now talking with local developers about sustainable housing.

3) Experiencing living in and working with, not against, nature has changed the perspectives of many students and adults. After a recent expedition one young student told me: "I grew up on the land; my family has been on the land for generations. Nature was always the big challenge—the adversary. Working with you in the environment I was surprised to see how things fit together. I am learning a new vocabulary and it is opening a whole new world for me. Rich diversity means rich life. This land is alive. It has a living skin. Even in a drought. This project gave me a lot to think about. Sure this whole continent (Australia) is in trouble – it's either blowing away, washing away, burning up or being eaten alive by some pest. The place to start change, to begin the healing is on my own

land. I can take responsibility better than any one else, any organization or any policy. I am learning to live with nature, not fight it. "

Giving people the opportunity to interact with nature on a non-confrontational, objective basis is a big eye-opener. Seeing individuals make the breakthrough and understand the connections makes life exciting and knowledge euphoric. I am reminded of our place in the universe and that nature is the essence of this planet, the existence of global life.

As a PI, I don't view "the spirit of Earthwatch" as being about scientists bridging gaps between community and nature or about creating a healthy balance between the needs of the community and the needs of nature. I view it as scientists being an integrated part of the community, sharing knowledge with individuals, and sparking the realization that we are part of nature, not separate from it. Empowered, confident individuals are prepared to take action and responsibility in the natural world surrounding them.

Results of scientific research can assist with policy. At the same time the effects of individuals are collectively more far reaching than policy, which has been implemented as a result of research or expediency.

A conservation activist recently told me, "You scientists do the 'Hot Spots' of conservation work. We, the rest of the community start in one small corner and spread. You should support and then draw on our collective knowledge. There are only about 100,000 scientists compared to 17 million other people in our community (Australia). When I speak with politicians I tell them to remember INS: It's the numbers stupid."

The cyberspace signature of one young Earthwatch participant is "educate the young and the old may listen." He is now employed by a state government and is helping develop conservation policy at community, state, and national level.

Challenges and solutions for translating scientific results into conservation actions? Lead individuals by example and their actions will lead policy.



Photo © Peggy Rismiller

*Dr. **Peggy Rismiller** has more than 20 years of experience as an environmental physiologist and wildlife biologist. She is an experienced Earthwatch Principal Investigator (PI) and has worked with Earthwatch volunteers on Kangaroo Island since 1988. Peggy completed her Ph.D. in Biology/Environmental Physiology at the Philipps University in Marburg, Germany, and was the first woman to receive the university's Science Dissertation Award. A post-doctoral position at the University of Adelaide brought her to Australia in 1988 to work with tiger snakes (a live-bearing reptile) and echidnas (an egg-laying mammal). After a short research interlude back to Germany in 1990, she returned to Australia to stay. Since 1991, she has been a Visiting Research Fellow in the Department of Anatomical Sciences at the University of Adelaide and Senior Research Scientist at Pelican Lagoon Research & Wildlife Centre.*

*Peggy's professional studies center on whole animal physiology, ecology, and how animals interact and help shape their environment. Of special interest is how photoperiod and climate affect biological processes and species survival. Her other interests include puppetry, magic, aboriginal history, native bush tucker, and herbal medicine.*

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## Social Sciences and Conservation

Stephen Williams

At the 2007 Principal Investigator Conference, Earthwatch's research department invited guest speaker Diane Russell, USAID, to discuss the social sciences and their application to conservation. As Earthwatch Institute works to deliver our Sustainable Cultures priority area and integrate social science throughout the program, we appreciate any and all questions or comments. We are here to help and provide the tools you need for conservation success. The following summarizes the presentation by Dr. Russell and lists some available resources.

### Entry Points

There are many ways in which the social sciences can be adapted to a specific scientific project. Each situation is unique, but all Earthwatch projects have some aspect to which the social sciences apply. A few examples of entry points can be found in the following areas. How does each of these issues apply to your project?

- Cultural approaches to conservation.
- The extent to which a "do it yourself" philosophy can be useful in conservation work.
- Potential for multi-disciplinary research and collaboration to improve output.
- Understanding and integrating the academic and applied sides of conservation.
- Appropriate roles for volunteers in research.
- Understanding and engaging local communities.
- Livelihoods and conservation.
- Governance, human rights, and conservation.

### Principles

Any project dealing with a community (i.e. social science project) should be aware of three primary social science principles:

Ethics: Be aware of ethics, intellectual property rights, data collection techniques, human subjects and the significance of sharing information within and outside a community. Concentrate on doing no harm.

Holistic Perspective: Constantly aim to understand the holistic, systemic point of view in

thinking about action and analysis. This means building both individual and institutional capacity, so that change can reach beyond transitory individuals to become sustainable.

Giving Back: Always keep in mind the idea of giving back to the community and generating output.

### Methods

The primary social science principles should be applied in everyday research by following certain methodological guidelines. These include the following:

- Maximize your preparation when going into the field by cultivating an awareness of existing theories behind the action.
- Triangulate your data by using multiple and diverse data sources (try to get a scientific sample).
- Be aware of the types of relationships you are cultivating (e.g. partnership, participation models, and sustainability) and their development (i.e. entry point, critical point, full engagement).
- Be conscientious about your data collection. For example, make sure to transcribe interviews within a short time of when the interview was conducted, or make an effort to get the scientific names for local species.
- Practice adaptive management, which means being flexible and open to local needs and ideas.
- Practice responsible time and team management, to maximize your accountability to and respect of the local community.
- Practice appreciative inquiry, which means entering a community with a view towards mutual learning and always beginning research with a positive, respectful attitude.
- Do your best to move along the "value chain" in a community, making contacts with the most knowledgeable sources and then fanning out from there. Try to access all types of knowledge relevant to your project, including expert, selective, broad collective, differentiated, and market or livelihood.

## **Resources**

- Social Science Research Network ([www.ssrn.com](http://www.ssrn.com))  
*Resources on economics, entrepreneurship (research and policy), financial, legal, management, marketing and negotiations accessed through specialized research networks*
- Intute ([www.intute.ac.uk/socialsciences](http://www.intute.ac.uk/socialsciences))  
*Database of web resources, internet training, blog, timelines and news related to the Social Sciences*
- USAID Frame ([www.frameweb.org](http://www.frameweb.org))  
*Multi-lingual site (English, Spanish, French) by USAID with news, online communities, a library, events and opportunities, partner pages, and publications related to sharing knowledge within the natural resource community*
- Poverty and Conservation Learning Group ([www.povertyandconservation.info](http://www.povertyandconservation.info))  
*An information portal providing project documentation, meeting notes and databases used by the Poverty and Conservation Learning Group; also includes case studies, organizations, initiatives and other useful links*
- Eldis Biodiversity Resource Guide ([www.eldis.org/biodiversity/index.htm](http://www.eldis.org/biodiversity/index.htm))  
*Includes links to biodiversity websites, resource guides, country profiles, and forums on such topics as: development vs. conservation; biodiversity policy and the CBD; climate change; protected areas; intellectual property rights, and more.*
- Human Dimensions ([www.hd.gov](http://www.hd.gov))  
*Web portal for interagency natural resource management, also includes news, upcoming events, magazine articles, and notes from previous meetings*
- Anthropology and the Environment ([www.eanth.org](http://www.eanth.org))  
*Environmental section of the American Anthropological Association, includes online resources (links to internet resources, syllabi, publications, pre-peer review), a listserv and a newsletter*
- Society for Conservation Biology ([www.conbio.org](http://www.conbio.org))  
*Site for a global community of conservation professionals, includes publications, meetings and activities, resources, academic programs, education and teaching, policy and a bulletin board.*
- Social Science Working Group ([www.conbio.org/workinggroups/sswg](http://www.conbio.org/workinggroups/sswg))  
*This is a global community of conservation scientists and practitioners that creates forums, promotes dialogue and debate, and build social science capacity among conservation practitioners by providing syllabi, short courses, other tools*
- Earthwatch Institute Research Department ([research@earthwatch.org](mailto:research@earthwatch.org))  
*Please contact us with your comments or questions. We are here to help!*

Be sure to check out Dr. Russell's book: *Groundwork for Community-Based Conservation*.

## **New Flexible Tools for Measuring Conservation Success**

*Valerie Kapos, Andrea Manica, Rosalind Aveling, Philip Bubb, Peter Carey, Abigail Entwistle, John Hopkins, Teresa Mulliken, Roger Safford, Alison Stattersfield, Matthew Walpole and Andrew Balmford. Cambridge Conservation Forum, c/o Dept of Zoology, University of Cambridge, Cambridge CB2 3EJ, UK (VK) val.kapos@unep-wcmc.org.*

The past three decades have seen enormous and increasing effort being devoted to securing the future of the world's species and ecosystems through a tremendous variety of conservation programmes and projects. A major challenge now facing conservationists, policy-makers, and donors alike is how to evaluate the success of conservation efforts in order to identify those approaches that are most effective and distinguish them from less productive approaches. The Cambridge Conservation Forum—a consortium of 28 global to local organisations—has spent three years developing a conceptual framework and a practical scorecard for evaluating all major categories of conservation activity.

In this work, we recognised that appropriate measures of success will differ among different types of conservation action. Therefore, we defined seven broad categories of conservation activity that cover all of the actions taken by organisations involved in the project and their partners:

- Management of sites, habitats, landscapes and ecosystems;
- Management of species and populations;
- Efforts to develop, adopt, or implement policy or legislation;
- Efforts to enhance and/or provide alternative livelihoods;
- Training and capacity building;
- Education and awareness-raising; and
- Research and conservation planning.

Many conservation projects involve more than one, or indeed all of these types, and in some cases the boundaries between activity types may be fuzzy. Nonetheless, each activity type relates differently to conservation impact (Figure 1). Broadly, the first two are those with the most direct impact on native ecosystems, habitats, species, and/or populations. The latter five influence conservation status less directly and often through their effects on species and site management. Research, which must always be combined with some other type of conservation action in order to have conservation impact, is in some ways the farthest removed.

Common issues in assessing the effectiveness of all the categories of conservation action include:

- Conservation objectives are often not clearly stated and assumptions are often not explicitly specified;
- Project monitoring and evaluation tend to address the priorities of the donor(s), which may or may not coincide with conservation objectives (e.g. research or social development objectives may be given higher profile);
- Impact assessment is difficult within project time frames because of the time lags involved in the outcomes and biological responses; and
- Unanticipated impacts are often very important and difficult to track.

To help address these and other issues, we developed a conceptual model linking action to conservation impact for each category. These models all follow a basic sequence from problem identification and design of intervention, through various aspects of implementation and intermediate outcomes, to reducing threat and/or improving the ability of the system to respond to pressures and, ultimately, to improved conservation status.

The models vary in structure and complexity among the different activity categories, the simplest ones being those for species and site management, the two categories on the inner ring of the diagram in Figure 1, which show the most direct linkage between implementation and the threat reduction and improved response outcomes. The models are longer and more complex for the activity categories on the 'outer ring', showing the dependence on intermediate conditions and outcomes for the achievement of threat reduction and/or improved responses. The longest (and most linear) model is that for research (Figure 2), which shows that for research to have conservation impact, it must not only generate results, but those results must reach those who can use them ('uptake') and must be applied in conservation practice. Consultation with stakeholders is important in all of the models and the feedback loops consistent with adaptive management are implicit throughout.

These models provide the framework for scorecard-style questionnaires about the outputs, outcomes, and impacts of conservation actions. Their design is consistent across the different models, and the user is asked both to categorise the evidence on which each answer is based (as opinion, supported opinion or hard evidence) and to summarise it. There are carefully chosen standard approaches to dealing with missing information. The questionnaires have been tested and refined through application to a large number of real conservation projects.

Applying the most recent versions to sample projects from 10 conservation organizations has shown that (a) standard questions about the links between activity and conservation impact can help project implementers to identify the likely impacts of their actions, even for projects still in progress and for activities such as capacity building or policy-related work where biological impacts are not commonly measured;

and (b) while few organizations are good at openly declaring whole projects to be complete failures, or indeed sharing widely their failures, examining projects by their component interventions can help to identify more and less successful approaches.

Users have been enthusiastic about the utility of these tools not only for evaluating the impacts of completed projects, but for planning new ones and ensuring that appropriate monitoring is in place to determine their impacts. We are introducing a new electronic version of the tools to facilitate their wider use to improve conservation practice. Furthermore, analysis using a simple scoring system can be used to synthesize experience from a diverse range of activities and projects and identify semi-quantitatively some important predictors of conservation success.

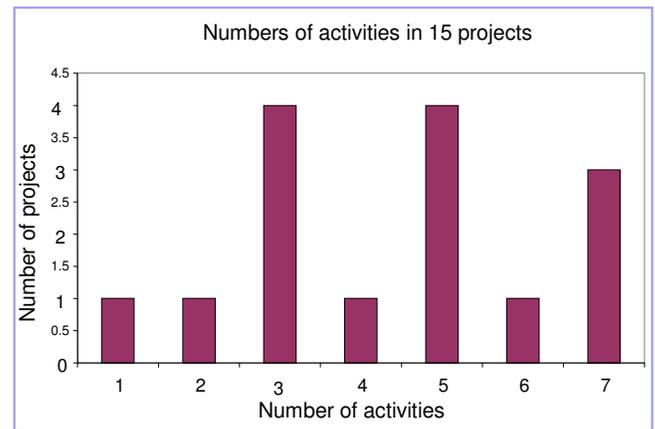
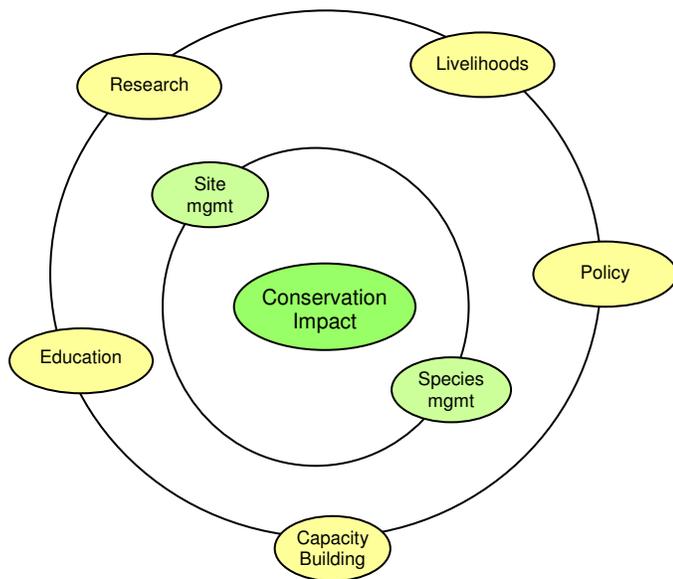


Figure 1 - The seven major categories of conservation activity. The diagram on the left is a simple representation of how they relate to conservation impact; species and site management are more closely linked to conservation impact than the other, more distant categories of conservation action. The graph shows that projects are commonly complex, including three or more types of conservation activity.

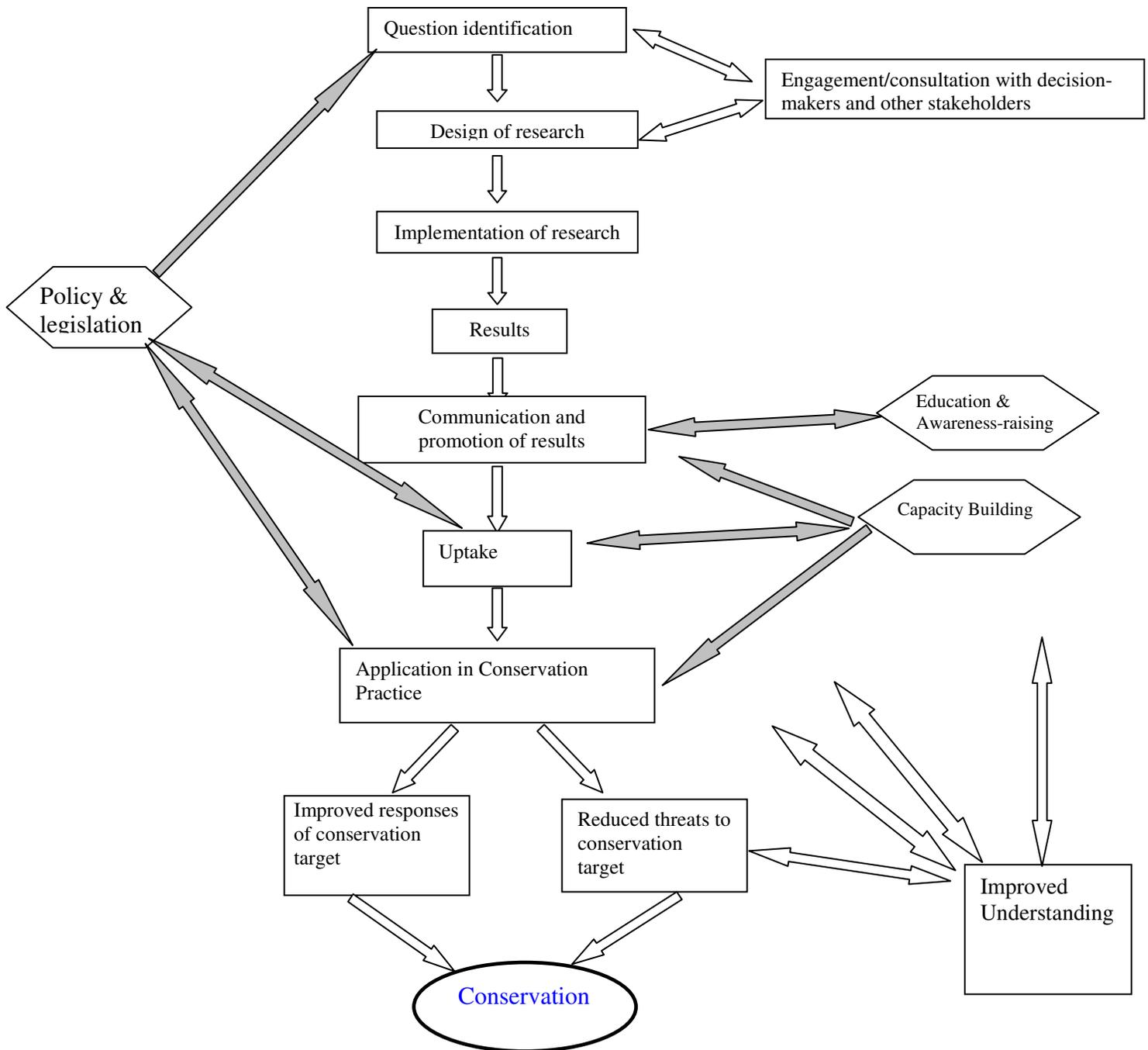


Figure 2 - The conceptual model developed by CCF as a framework for assessing the conservation impact of research. While engagement with stakeholders is principally depicted at the early stages of the process, it should be understood to be fundamental throughout, as are the iterative feedback loops characteristic of adaptive management. Hexagons and grey arrows show key points of input from other types of conservation activity (those relating to policy, capacity building and education), but these are indicative rather than exhaustive. Research aims to improve the information on which conservation action is based. If the research question is properly identified and the research is well-designed and implemented, then it is likely to produce good results. However, these results will only affect conservation if they are appropriately communicated and promoted to the right audiences, if those audiences understand them and if they apply them in conservation practice. If these things happen then research may play a role in reducing threat, improving responses and thus in improving conservation status. This and related models are the basis for a diagnostic scorecard tool, now available in electronic form for evaluating the impact of conservation-related projects.

## Workshop Discussion

Dr. Daniela Maldini, Director of Research for Earthwatch Institute, set the stage for the discussion by asking the audience how they perceived the role of the scientific community in translating research results into conservation action. The discussion focused around whether citizens at large should take responsibility for implementing scientific recommendations derived from data or whether it is more appropriate for the scientist to directly advocate for conservation. Overwhelmingly, the participating researchers felt that having **direct involvement** in conservation and **disseminating knowledge** to audiences other than the purely academic ones were key roles for today's scientists. In addition, emphasis was given to the importance of **data sharing** and **collaborative multi-disciplinary work**.

The audience was also asked to define the role of governmental organizations, NGOs, and the business community in helping translate science into conservation. Specifically, we discussed the role that Earthwatch Institute should play as a funder of research projects and as steward of education for volunteers and community fellows. The majority of the participants felt that it was imperative for organizations involved in conservation work to support scientists in the field in additional ways beyond monetary support. Funders should take a lead role to ensure that the **information collected in the field reaches the appropriate audiences** in the appropriate format. Participants agreed that often scientists are not trained in delivering information to non-academic audiences and are not effective in communicating with the general public and with government officials. Effective **information sharing** communicated at the appropriate level could go a long way toward an understanding of how ecosystems works and how the average individual can participate in supporting conservation action.

Lastly, participants were given the opportunity to discuss the importance of implementing **sustainable** practices in their field and office operations. Most agreed this was needed not only to decrease the project's environmental footprint, but also to set a good example for local communities.

### Dissemination of knowledge

Effective conservation requires that communities support their local conservation efforts and understand the importance of the resources they are protecting. Involving

communities often requires them to shift their cultural values. This is an extremely difficult task that takes time, consistency, and builds trust. It is important to engage and empower local champions who can take leadership roles. Local advocates generally have a better rapport and level of trust and, therefore, can motivate people. Religious leaders can be very influential in certain cultural settings, for example. Scientists will also have to ensure communities that conservation practices will not jeopardize their livelihood, so community based solutions and community involvement at the onset of a conservation project are important keys to success and project longevity. The idea is to bring in alternatives that are good for all stakeholders.

Different communities may require the involvement of different stakeholders depending on the project requirements and objectives, the make-up of the community, and other considerations. However, reaching out to children is a key factor in any community: it not only builds a new set of values for the future of the community but also ensures that the parents are engaged.

Another important stakeholder to engage is the local politician or policy maker. This segment of the community is often out of the reach of the single researcher and organizations such as Earthwatch could be instrumental in linking scientists with key political figures. Having these leaders understand the conservation issues and having their cooperation could be essential to a project's success.

Generally speaking, participants agreed that effective conservation requires pressure from the top down--international agreements, national policy and law, NGOs, ministers—and from the bottom up—stakeholders, tour operators, enforcement officers, students, teachers.

In addition, the media plays an increasingly important role in the dissemination of knowledge. However, media controlled news is often inaccurate and too general. The participants encouraged Earthwatch to use a handful of trusted journalists but emphasized the importance of screening the content and ensuring it is trustworthy.

Participants highlighted the importance of educating scientists in communication and presentation skills related to non-academic

audiences. Many professionals have not been trained to talk to the general public and often their presentations contain too much jargon and are so complex that the message gets lost.

### **Data sharing**

In general, participants agreed about the value of sharing information both within the scientific community and between researchers and stakeholders. Most advocated increasing data availability through the internet or other shared networks. The advantages of data sharing were perceived as being many, particularly the increased sample size, providing for more accurate results, and more powerful statistical outcomes. Also, data sharing is the only viable option for faster results when the priority is conservation and action and not academic. Data sharing reduces the chances of a scientist's grand discovery, but we now realize the priority should be monitoring, conservation, and transparency. Additionally data sharing provides awareness and knowledge to communities that otherwise would not have access to the information, thus fostering a heightened sense of the importance of conservation.

The concern shared by many was related to the potential illicit use of data before the owner had an opportunity to publish. For many this threat was real and had been experienced. For others, it appeared to be a myth. The value of web sites specifically dedicated to data input and sharing was discussed at length by Brad Norman and Jason Holmberg as they answered questions related to their presentation. The value of sharing data was seen as higher than the risk of data being misused. User agreements were suggested as useful precautions against potential misuse as well as copyright protection (specifically for photographic material). Cooperative publications were seen as being the most progressive way of producing scientific outcomes. Another concern expressed was the possibility that data on distribution of protected or endangered species could give specific locations to poachers or tour operators and be detrimental to the species being conserved. Data sharing also exposes the scientist to potential scrutiny and criticism. Being wrong should be accepted and expected. The advantage of sharing is that errors will be corrected. A controlled login could be used for more specific data such as GPS locations.

### **Sustainable projects**

In general, participants agreed that it is important to work on making day to day operations in the field "greener" to act as a

positive role model to volunteers and community fellows. Some participants pointed out that cost, time, and specific circumstances on the ground may serve as barriers to implementing energy conserving and "greener" practices in the field. Peggy Rismiller's presentation on how her project is run in a sustainable manner inspired many. It was suggested that Earthwatch institute a sustainability policy and that project assessment practices should include metrics to evaluate a project's "Sustainability Index" and require scientists to include carbon emission provisions in their operational plans. In addition, Earthwatch should develop a manual, providing tips on how to cut costs and consumption both at the accommodations and in the field. In general, all volunteers should be encouraged to contribute to a sustainable lifestyle while at the project site by timing showers or using gravity-fed ones, turning off lights when not in use, maintaining the minimum necessary heat, limiting the use of air conditioning systems, using a cup to brush their teeth, using wind up radios and flashlights, installing solar panels, and more, depending on the field site. Principal Investigators were encouraged to quantify savings achieved by a volunteer team and to highlight these figures during the team debriefing. Another suggestion was to make volunteers directly responsible for monitoring these energy saving activities. Earthwatch was encouraged to share their carbon emissions policy with all the Principal Investigators [see <http://www.earthwatch.org/site/pp.asp?c=dsJSK6PFJnH&b=2763535> to learn how Earthwatch is taking steps to reduce our carbon footprint].

### **Recommendations**

The following recommendations should be especially useful to organizations supporting research in the field as ways to further ensure that scientific information is properly translated into conservation action.

#### Facilitating the dissemination of information and knowledge by:

- disseminating a project's research findings to a wide audience of scientists and across disciplines;
- providing effective ways to educate local, regional, national, and international stakeholders; and
- facilitating the intersection of scientists and governmental bodies responsible for environmental management.

Encouraging and facilitating data sharing by:

- generating opportunities for scientists from different disciplines and with complimentary strengths to meet and discuss common interests;
- providing platforms and opportunities for data sharing; and
- facilitating grants that fund hosting of databases or web based data dissemination.

Providing the resources for setting up and maintaining a sustainable operational footprint in the office and in the field by:

- facilitating the set up of sustainable operational practices;
- providing a funding structure and plan for “greening” projects; and
- being an information source for ways to run a sustainable operation.

**Conclusion**

In order to conserve species and livelihoods, scientific and academic communities must accept the importance of data sharing, advocacy, and the role of involving local stakeholders. They are pieces of the same puzzle and must fit together for us to achieve a sustainable balance in nature. Our best tool to push this agenda is the collective experience and expertise of Earthwatch-sponsored scientists. This workshop represents the first step to opening the doors of communication and sharing ideas, and we look forward to more opportunities for the dialog to continue.

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**Acknowledgements**

We appreciate all of the contributors, presenters, and participants of the workshop for sharing their ideas and discussing ways in which we can better work together. Special thanks go to the many volunteers that helped organize the workshop and edit these proceedings: Philip Johansson, Jennifer Goebel, Jessi Flynn, Emily Donaldson, Anna Janovicz, Kathy Santos, Tim Smith, Rachel Borgesano, Marie Studer, Roger Mitchell, and especially Earthwatch’s Research and Field Management departments.

**Earthwatch Institute**

Earthwatch Institute is an international environmental organization whose mission is to engage people worldwide in scientific field research and education to promote the understanding and action necessary for a sustainable environment. Since 1971 Earthwatch has been bringing together individual volunteers and scientists on field research projects as a means of providing essential funding and a dedicated labor force for international scientists. Earthwatch believe that by involving the general public in science, they gain the knowledge, skills and motivation needed to take responsibility for the environment. Earthwatch currently supports over 130 environmental research projects in 50 countries. Since 1971 the worldwide organization has recruited over 80,000 volunteers in support of 2,800 field research projects in 118 countries. These volunteers have contributed over 10 million hours to essential field work.

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