

COMMENTARY

Reducing the Ecological Impact of Field Research

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Researchers and students at biological field stations, especially in remote areas, are subject to leaving “footprints,” as we conduct research, work, and live in sensitive ecosystems. These footprints include travel, personal trash and waste, and field equipment (e.g. flagging, tree markers, plot markers, trail markers, monitoring devices, etc.). In this commentary, we argue that the field of primatology’s commitment to minimum impact research should be more explicitly and visibly integrated into our ethical protocols with regard to field research and instruction in sensitive environments. We review current ethical codes and potential solutions to reducing our “researcher footprints” while conducting fieldwork. Using Costa Rica as an example, we address how sustainable fieldwork differs among varying cultural contexts and argue that researchers should be made responsible and accountable for how our presence, research, and teaching might impact the environment. We conclude by recommending a set of guidelines to be added to ethical protocols regarding research design, station policies, and the conduct of research and teaching in the field. *Am. J. Primatol.* 00:1–9, 2012. © 2012 Wiley Periodicals, Inc.

Key words: ethics; fieldwork; sustainability

INTRODUCTION

In this commentary, we examine current codes of ethics to address the potentially missing elements of researcher/student/visitor waste management practices during field research and other educational activities in fragile ecosystems, different cultural contexts, and in rural environments. We argue that ethical guidelines should integrate a minimum impact protocol as we research and teach at field stations. In the *American Journal of Primatology* from September 2010 to September 2012, 122 (61.9%) of a total of 197 research articles were based on data collected at one or more field stations. Currently, there are 34 field assistant/volunteer/internship opportunities at primate field stations in less economically developed communities [<http://pin.primate.wisc.edu/jobs/list/avail>, July 3, 2012]. Additionally, there are numerous field school/study abroad opportunities as many different disciplines are integrating hands-on experience in environmental education [e.g. Alagona & Simon, 2010; Hodder, 2009; MacKinnon, 2010]. The Organization of Biological Field Stations listed 268 member stations and 21 field course opportunities from July to August 2012 alone [<http://www.obfs.org>, July 10, 2012]. Hands-on field experience is necessary for students who desire a career in field research, but how do our field classes and research programs potentially impact fragile environments? Are we in danger

of contributing to the destruction of the exact areas that we are attempting to study and conserve?

Ideally, field stations develop into long-term research facilities that employ local people, promote rigorous research and conservation, train students, and work toward a “sustainable society” [Ehrlich, 1982; Garber et al., 2010; MacKinnon & Riley, 2010; Strier, 2010; Wilson, 1982; Whitesell et al., 2002]. As researchers, professors, and students, we visit biological field stations for short- or long-term use, bringing our flagging tape, toiletries, insect repellent, batteries, appetites, and personal waste; potentially treating the station as a hotel with limited regard to how we pack in, pack out, or dispose of waste while there. In many cases, trash and recyclables may be moved from place to place until they end up burned or in a landfill. Given the potential impact

SM Watts is an AAAS Science & Technology Policy Fellow assigned to the National Science Foundation. Disclaimer: Any opinion, finding, and conclusions or recommendations expressed in this material; are those of the author and do not reflect the views of the National Science Foundation.

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Received 16 July 2012; revised 9 September 2012; revision accepted 9 September 2012

DOI 10.1002/ajp.22086

Published online in Wiley Online Library (wileyonlinelibrary.com).

of our research and teaching in rural environments, who is responsible for providing waste management guidelines? What are the various responsibilities of the researcher, field course instructor, research station management, and home institution? In this commentary, we review current sustainability practices with our research station (La Suerte Biological Field Station, Costa Rica) as an example. We then recommend a set of guidelines to be added to ethical protocols that guide research design and station policies.

CURRENT ETHICAL GUIDELINES

“Out into the field they go, keeping their appointed rounds just as if they had a sack of mail instead of a pack of optical, acoustic, or chemical instruments over their shoulders. If they use every moment carefully, working from dawn to dusk, they may return with the critical data in hand. Sunburned, scratched, weary, and perhaps even undernourished, the field workers do return. Leaning against the doorsill to greet them is the colleague from down the hall, dressed in his immaculate white lab coat, sipping a cup of coffee. He looks up, smiling, and says slyly ‘How’d your vacation go?’” Hailman [1973:149]

As field researchers of nonhuman primate ecology, we first encounter our ethical responsibilities by defining a protocol to be approved by an animal care and use committee and obtaining permission to work at field stations. Here, we follow Brussard [1982:327] and define a field station as “any facility or tract of land used primarily for biological research and teaching and which is maintained in a natural or seminatural state” and extend this definition to include other disciplines. Fedigan [2010] argues that field researchers face different ethical dilemmas than lab researchers and defines some of the most relevant ethical issues faced by field primatologists to include disease transmission, habituation, and interaction with human community members. She also argues that field primatologists should be concerned with disposal of trash, habitat alterations during research, and providing human food to research subjects. Strier [2010] expands on this notion detailing the potential for researchers to leave footprints via trail building and providing advice on how to minimize soil erosion and plastic waste used for collecting samples. Field primatologists have also questioned their own pattern of visiting and revisiting primate environments. Repeated visits can create research subject habituation while increased trail use can lead to more efficient illegal poaching opportunities after researchers leave [Malone et al., 2010].

Overall, field primatologists have established an excellent track record for promoting, evaluating, and

re-evaluating our ethical responsibilities [Fedigan, 2010; Fuentes, 2006, 2010; Hill, 2002; MacClancy & Fuentes, 2010; MacKinnon & Riley, 2010; Malone et al., 2010; Nash, 2005; Sommer, 2010; Strier, 2010; Sussman, 2010; Wolfe, 2005]. However, these ethical guidelines currently emphasize animal care and use, protection of primate health, and respect for/involvement with the local human community [Table I, Garber et al., 2010; MacKinnon & Riley, 2010]. In our review of nine ethics statements or grant guidelines, we found only two documents to briefly mention effects on plants and animals that are not part of the study. The American Psychological Association states that during field research “Every effort should be made to minimize potential harmful effects of the study on the population and on other plant and animal species in the area.” [APA, 2012]. The Animal Behavior Society/Association for the Study of Animal Behaviour guidelines state “. . . for both scientific and ethical reasons, investigators studying free-living animals are expected to take precautions to minimize the imposition of fear, distress or lasting harm on individual animals, as well as minimizing the impacts of the study on the populations and ecosystems for which the individual animals are a part” [2012:303]. We laud these organizations for including these statements specific to field research but believe that given the relatively recent culture of sustainability in the United States and on college and university campuses, that issues of minimum impact during field research should be more strongly stated and integrated into professional ethics statements, research designs, and funding agency requirements.

CULTURE OF SUSTAINABILITY

“Real Americans don’t give two shakes of an aerosol can about the environment.”
Colbert [2006]

Stephen Colbert’s television gimmick is to expose absurdity through facetious reporting and mock news, but it appears that college campuses are, in fact, attempting to make the world more sustainable. According to the Princeton Review’s Guide to Green Colleges, 322 colleges and universities are deserving of “green status” due to their “notable commitment” to sustainability [Princeton Review and US Green Building Council, 2012]. The guide states that 65% of 12,000 college applicants report that they desire information on campus commitment to the environment and 24% of their respondents would base their college enrollment decision on the school’s commitment to sustainability. Universities are ranked on waste diversion, environmental literacy requirements, alternative transportation, and whether the schools have a formal committee dedicated to advancing sustainability on campus. Additionally, 429

TABLE I. Ethics Statements Considering the Use of Wild Mammals in Field Research. Information in Table Refers to Specific Statements in Ethical Guidelines with Regard to Field Studies

Organization	Ethics statement/ guidelines								
	Animal care and use—momentary pain or distress and/or the three (replacement, reduction, and refinement)	Appropriate permits—source country, governmental organizations	Informed consent—humans	Guidelines for trapping, holding and release	Protection of nonhuman animal health in the wild including sanitation	Scholarship (e.g. data management, dissemination, co-authorship, and acknowledgment)	Human safety and training or involvement	Local human community respect and/or involvement	Minimize impact on ecosystems
American Association of Physical Anthropologists	X	X	X			X			
American Psychological Association	X	X		X				X	X
American Society of Primatologists	X				X				
American Society of Mammalogists	X	X		X			X		
Animal Behavior Society/Association for the Study of Animal Behaviour International	X	X		X					X
Primatological Society					X		X	X	
Leakey Foundation		X*							
National Science Foundation-GPG	X	X*	X	X			X		
Wenner Gren Foundation		X*							

American Association of Physical Anthropologists [2003]; American Psychological Association [2012]; American Society of Primatologists [2001]; Animal Behavior Society [2012]; International Primatological Society [NDa,b]; Leakey Foundation [ND]; National Science Foundation [2011]; Sikes et al. [2011]; Wenner Gren Foundation [ND].

* All permits necessary including IACUC, Institutional Review Board, Ethics committees at home institutions/organizations.

university leaders in 52 countries have signed the Tallories Declaration (<http://www.ulsf.org>) to declare their commitment to sustainable practices, teaching, and research in higher education [2012]. We argue that this culture of sustainability must also guide research and teaching in the field and abroad. One starting point is to integrate a “Leave No Trace” philosophy to our current ethical codes and to extend the culture of sustainability off campus to research areas beyond campus boundaries. The Organization of Biological Field Stations provides a manual for field station managers and suggests minimum impact field station management but it is unclear if and when guidelines are implemented and followed by the member stations [Lohr, 2001].

SUSTAINABLE FIELD PRACTICES IN COSTA RICA

Compared to other countries, Costa Rica provides an interesting context for addressing sustainable human behavior in a rural setting. During the past three decades, the Costa Rican government has pursued a new “Green Revolution” as their economic future [Hernández et al., 2003]. This economic future stresses ecotourism, protection of forested areas, carbon credits, and other financial incentives for local people to protect their forested land [Campbell, 2001; Evans, 1999; Joyce, 2006]. Costa Rica protects large tracts of forest via 33 national parks, 78 reserves and protected zones, and 17 biological preserves and field stations. A total of 32% (1.63 million hectares) of the country is protected land (*cf.* USA = 26%) and it is estimated that Costa Rica experiences a 1.9 billion US dollar per year tourism industry [Fallas, 2007; Joyce, 2006]. Although Costa Rica is considered relatively forward thinking about environmental issues, a large percentage of the rural population lacks access to recycling facilities and landfills, creating a decentralized system of waste disposal. Steps toward a more uniform program were made in May 2010 when Costa Rica passed the Law for the Integral Management of Residues that mandates municipal responsibility for proper handling of all recyclable and non-recyclable solid waste. The law will be implemented over the next 10 years [Law for and Integrated Management of Residues, 2010].

Biological field stations are becoming increasingly common in Costa Rica [MacKinnon, 2010]. We visited ten field stations in Costa Rica and interviewed station managers or long-term field workers currently on site. Many field stations had some form of recycling, however formal programs are rare among smaller, remote stations. For example, one station drops recycling behind a grocery store where glass and aluminum are then driven to a recycling center approximately 20 km from the town. Be-

cause recycling is not centralized in Costa Rica, there are certain barriers identified by most, if not all of the site representatives including finding recycling centers (especially for plastics and e-waste), transportation costs, and training workers and visitors to properly dispose of waste. To reduce the burden of researcher waste, one station requires visitors to be responsible for their own garbage by packing it out. For other stations, it is not financially feasible to recycle due to the cost of transportation. Others find links with companies or organizations to meet their needs. One relatively large station (in closer proximity to a town) works with Chiquita® to support their recycling program. Due to a lack of recycling programs in town, the station encourages local staff to bring recyclables from home. Batteries are commonly used at field stations and are very difficult to recycle in Costa Rica. Therefore, most stations ask researchers, field course participants, and other visitors to send batteries back to their home countries for recycling. Ultimately, many field stations burn paper waste so any materials placed in the paper waste containers will end up in the soil and surrounding environment.

Some facilities have taken the initiative to make changes in waste diversion strategies but the cost and time involved have prevented full implementation and stations tend not to extend their efforts to the local communities. One website discussed a “sustainability contract” upon arrival at the field site, but this contract did not appear on the website and it was unclear if students and researchers followed guidelines as they packed their belongings for their field experience. Only four stations promoted detailed sustainability priorities (e.g. a sustainability button to click on for more information) on their websites. Tirimbina Rainforest Center in Costa Rica provides a useful template for highlighting sustainability policies on the home page of their website [<http://www.tirimbina.org/>].

Composting, or using food waste to produce mulch is one method to limit burning valuable nutrients. Seven stations used pigs as a primary method of food disposal; burning or burying excess scraps when larger research groups left considerable amounts of food. However, many stations had alternative methods to turn food scraps into compost including vermicomposting, closed compartments, and double-dug holes. One station used efficient microorganisms (EM) with a honey mixture to break down foods in a three-compartment system [see Miller et al., 2008 on EM]. At another station, a raised vermicomposting system with worms was purchased from a local worm composting company. Cost, availability of supplies, and other contextual barriers (such as the threat of inadvertently feeding wild animals) shape each composting system. The results of feeding of wild animals through compost can be devastating

both to the animals and to our attempts at ecological and behavioral research [Altmann & Maruthi, 1988; Loudon et al., 2006].

LEAVING TRASH IN THE FIELD: A CASE STUDY FROM LA SUERTE BIOLOGICAL FIELD STATION, COSTA RICA

“I have seen tropical forests littered with the remains of previous research projects—objects no longer useful to anyone, such as flagging tape, seed and insect traps, tree tags, metal stakes, and rope hanging from branches.” Fedigan, 2010:759

Since the early 1980s, the number of field opportunities for students has grown. Hodder [2009] reports that based on data from 33 institutions, there are over 400 different undergraduate courses at biological field stations and marine laboratories. Many professional scientists stress the importance of their early experience at field stations in establishing them in their field today [Brussard, 1982; Garber et al., 2010; Gladfelter, 2002]. Given this importance and potential traffic moving through field stations, it is critical we that we engage in and teach minimum impact research.

More than 1,000 students have taken courses at La Suerte Biological Field Station in Northeast Costa Rica, and there have been several longer term projects that have produced doctoral dissertations and M.A. theses [Garber et al., 2010]. One of us (RS) walked 20 random 20- to 50-m transects (length based on accessibility)—throughout the 700-hectare site of tropical premontane wet forest at La Suerte Biological Field station [Garber et al., 2010]. A total of 85 pieces of field trash were collected. Each transect averaged approximately 4.3 pieces, most was flagging on trees (70.6%) and on the ground (29.4%). Flag trash was overwhelmingly prevalent (95.3%), and there was no evidence that these flags were part of long-term projects. During August 2012, we collected all flag trash encountered during a 3-hr session following several summer field courses and research projects. The results of this effort are pictured in Figure 1. We believe that this kind of behavior is a violation of professional standards. We should work to prevent questionable research practices and there should be penalties for researchers when these practices take place [National Academy of Sciences, 2009]. For example, the researcher could be asked to pay for removal of trash or pay a fine before being allowed to return to the research site. Students, field assistants, and their advisors should be held accountable. Rather than policing researcher behavior, a contract should be established at the onset of field projects and field courses so that all parties know



Fig. 1. Flag trash collected by Santa Clara University's Costa Rica field course in August 2012.

the guidelines and penalties [Hairston, 1970 and see Appendix].

INTEGRATING MINIMUM IMPACT GUIDELINES INTO OUR CURRENT ETHICAL RESPONSIBILITIES

Spear [2004, 2005] suggests the guidelines of the “Leave No Trace Center for Outdoor Ethics” as a starting point for researchers and visitors of biological stations. This represents a first step for reducing waste at the source including minimal use of flagging and trail markers, reducing packaging, and packing out all hazardous waste (insect repelling items, batteries, etc.) and is successful when visibly and systematically communicated [Blangy & Nielsen, 1993; Daniels & Marian, 2005; Simon & Alagona, 2009].

Guidelines for reducing your ecological footprint at biological research stations [The Leave No Trace Center for Outdoor Ethics, <http://www.lnt.org> Spear, 2004] should include:

- (1) *Educate yourself, your assistants, and your students.* Before traveling to a field station, know what is available with regard to trash removal, recycling, and composting. Have every researcher, instructor, assistant, and student sign a sustainability contract (Appendix).
- (2) *Use durable surfaces, minimize new trails, and follow footsteps.* Field researchers have an obligation to conserve and maintain the current state of trails made in the forest to prevent widening and the need to create new trails. Trails should only be constructed for the purposes of monitoring research subjects and cutting trails should be restricted to principal investigators, instructors, and field station personnel. Not only is trail widening a form of habitat loss, but it increases opportunities for poaching and avenues

for invasion by exotic organisms. Educate your students about trail widening and only go off trail when absolutely necessary for research. Deconstruct trails that no longer play an active role in research.

- (3) *Dispose of waste properly and do not forget your flags and equipment.* If we plan to study organisms or plots that may not be accessed by others, field researchers must install markers (surveyor's measuring tape, flags, cords) that clearly demarcate the plant/area involved. These markers and their removal should be addressed in the research design. On all marks, name and final date of the project should be noted. At the end of research, retrieve all materials. Avoid use of plastic and use biodegradable or photodegradable markers whenever possible.
- (4) *Take only the smallest samples necessary.* Reduce sampling and do not disturb organisms that are not part of the research. Plants and animals need not be removed for "show and tell." Observe them in their natural habitats. Respect all aspects of the ecosystem and work around plants and animals.
- (5) *Bring less so we burn less.* Field research stations often lack trash services; waste that cannot be recycled or reused may be burned due to costs of waste transport. Be mindful that facilities may not exist to deal with aerosol cans, batteries, and plastic bottles. Therefore, reduce use of these items and pack necessary empties out to the appropriate facility, which may be in a researcher's home country.
- (6) *Make your purchases reflect the recycling systems available in the community near your field station.* Recycling systems in rural areas, if available, may support only glass and aluminum. If possible, take plastic bottles to recycling centers in the closest urban center or pack them home.
- (7) *Your hygiene is your responsibility.* Pack out all toilet paper and waste products from the forest. Use biodegradable soaps. Often, there is no filtration system available to process wastewater.

CONCLUSIONS

Minimum impact guidelines are a critical component in any nature management strategy: as researchers and educators, we must be more explicit in applying this ethical framework. Researchers have an individual responsibility to engage in and promote minimum impact research. Field course instructors must educate their students about minimum impact research before they arrive to the field station. Field station managers should make their sustainability requirements visible on site and in their promotional materials (e.g. website). Finally, we believe that funding agencies and societies with ethical guidelines/statements should add minimum

impact protocols to their grant application guidelines and ethics statements to better conserve and promote future study of our study organisms and their habitats.

The current culture of sustainability on university and college campuses should be integrated into our research and teaching with knowledge of the ecosystem and waste diversion possibilities in fragile ecosystems near rural human communities. In some areas of Nicaragua and Costa Rica, local communities have encouraged the use of plastic bottles as portable small-trash receptacles; when filled, they are then used as construction material for tables, fences, or walls [Garber et al., 2010]. Innovative repurposing of trash that might otherwise be burned or buried in sensitive ecosystems should be promoted through the efforts of field stations in partnership with local communities. We are confident that many professional primatologists integrate minimum impact protocols into their research designs [e.g. Fedigan, 2010; Garber et al., 2010; Strier, 2010]. However, we believe that minimum impact research should be more explicit in our ethical guidelines and promoted as we train students and field assistants. Minimum impact guidelines with regard to field research and studying abroad must be more visible.

ACKNOWLEDGMENTS

We thank Patrick Archie, John Farnsworth, Michelle Marvier, Shannon Vallor, and Carly Zipper for comments on earlier versions of this manuscript. We thank Paul Garber and two anonymous reviewers for feedback to improve this commentary. We thank Rosibel Aguilar Porras, Johnny Cambronero, Agustin Flores Aguilar, Estanislado Flores Martines, Andrew Halloran, Kiara Herrera, Tracey Mangin, Israel Mesen Rubi, Renee Molina, Marisa Perez, Raimundo Picado Zasiga, Yinetta Ureña Román, and Fran and Modesto Watson for assistance, guidance, and hospitality in Costa Rica. We also thank everyone who provided information about research stations, recycling facilities, and institutions. Finally, we thank the participants of the 2012 Santa Clara University Costa Rica field course for collecting all of the flagging and other trash pictured in Figure 1: Kalea Cleeton, Michael Cooke, Arianna DiCicco, Gregory Gate, Kristie Kurtz, Allison McNamara, Elisa Phillips, Nicole Powell, Aaron Thom, and Carly Zipper. This research was supported by Santa Clara University's Environmental Studies and Sciences department and Santa Clara University's Markkula Center for Applied Ethics Hackworth grant for student research (RS). This research complied with the legal requirements of Costa Rica, and the American Society of Primatologists principles for the ethical treatment of primates.

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APPENDIX: MINIMUM IMPACT IN FIELD RESEARCH EXPECTATIONS FOR RESEARCHERS AND STUDENTS

The purpose of this set of expectations is to provide a set of minimum impact standards to preserve the integrity of our research at ----- . In addition to the guidelines that are required by you as a researcher or student for maintaining respect of research subjects, these rules aim to improve the greater research environment by preventing the misuse of field station resources, facilities, and field space.

WHAT IS THIS DOCUMENT USED FOR?

This document is not a policy, but rather a supplement to the already existing ethical codes and rules identified by your organization or school, research country, and Institutional Review Board or Institutional Animal Care and Use Committee (IACUC). By signing this document, you are agreeing to uphold these expectations.

EXPECTATIONS FOR RESEARCHERS AND STUDENTS:

- (1) Researchers/instructors/students will employ general guidelines from the “Leave No Trace Center for Outdoor Ethics” [Spear 2004] that include but are not limited to

- (a) Repackage food and research supplies before entering the field to minimize the load as well as the potential for forgetting packing materials in the field.
 - (b) Use a map and compass and/or a global positioning device (GPS) to eliminate the need for rock cairns, flagging, or markings of other kinds.
 - (c) Know your own abilities and the abilities of those who go into the field with you.
 - (d) Know what regulations or special concerns apply to the field site and surrounding community.
 - (e) Prepare for extremes in weather and potential hazards, and know how to generate an effective response to emergencies. This includes having awareness of the ecosystem around the field station and greater area (e.g. rainy season, lightening, wind).
- (2) Researchers/students will be conscious of the remoteness of field stations and access to utilities.
 - (a) *Water*: Purchase biodegradable soaps and cleaning liquids to limit toxicities in wastewater. Researchers/students should also be conscious of water supply, as many stations have very limited resources.
 - (b) *Energy*: Some stations operating away from urban centers lack electrical transmission from a major system. They may receive electricity from diesel-powered generators or other isolated equipment. Keep energy usage to a minimum.
 - (c) *Recycle/waste*: Researchers/students should learn how each field station recycles, as every station is different. To limit waste altogether, researchers will carry out hazardous waste (e.g. batteries and insect repellent). When purchasing materials, defer to glass containers, which are more likely to be recycled or reused.
 - (3) When placing marks or other objects in the field, use biodegradable materials when possible. At the end of the research project, it is required that you pick up all the materials that were placed in the site. On all marks or objects, name and final date of the project should be visible. If you encounter waste in the forest, collect it. Field station staff that find expired marks will remove them *and determine penalization for littering*.
 - (4) As outsiders and guests to a new place, researchers/students should actively engage in the local culture (e.g. supporting local businesses and services).
 - (5) Pay particular attention to resources that professors/mentors provide prior to visiting the research station in order to best prepare for a new environment.

I agree to...

- (1) Be respectful of the community of _____, the staff at _____, and the culture and people of _____.
- (2) Avoid smoking in the forest and field station buildings and I will dispose of all cigarette remnants promptly and properly.
- (3) Behave in an appropriate and respectful way to all other students and researchers at the field site and in the country of _____.
- (4) Dispose of all trash in the appropriate receptacles and avoid leaving any trash or litter in the field or around the station. I realize that trash may be burned at the field site, and will avoid bringing items that cause further damage when burned (e.g. plastics, batteries, or aerosol cans). When I cannot avoid bringing these items, I agree to bring them back to the United States with me to be disposed of properly.
- (5) Respect the forest and its inhabitants and avoid touching, handling, capturing, or killing any living organism unless approved for my research. If I am to bring food into the forest, I will not open any packages in the presence of animals that may be attracted to our food. I understand that intentional or unintentional feeding of animals may lead to my dismissal.
- (6) I understand that if it is determined that I am not following the above guidelines, I will be dismissed from the field station and incur any and all charges that may be associated my behavior.

I, _____, agree to the expectations listed above and will abide by these standards to the best of my ability. The value of field stations and fieldwork is important for my experience and for the experience of future researchers. Therefore, when I leave the station it should be left in the same, if not better, conditions than when I arrived.