Biological Field Stations: A Global Infrastructure for Research, Education, and Public Engagement

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Biological field stations (BFS) constitute a global network for long-term environmental monitoring and research, education, and public information. On the basis of a comprehensive inventory, we identified 1268 contemporary BFS, located in 120 countries. BFS occur in all biomes and cover terrestrial, freshwater, and marine systems, with the majority situated in protected areas. We emphasize the pivotal role that BFS constitute as a strategic infrastructure of global relevance for environmental research and monitoring and discuss their future development.

Keywords: global change, biodiversity, environmental research, nature conservation, sustainability

Human activities are fundamentally and in many cases irreversibly altering how the natural world functions (Vitousek et al. 1997, Rockström et al. 2009, Steffen et al. 2011). Moreover, there is general agreement that the rate of anthropogenic transformation of the Earth's biosphere, geosphere, hydrosphere, and atmosphere is continuing to increase in scale and magnitude (Rockström 2015, Steffen et al. 2015). To understand the causes and consequences of climate change, land-use alteration, biodiversity loss, and the formation of novel ecosystems and communities requires support from global monitoring programs and shared research infrastructure (Lindenmayer and Likens 2009, 2010).

Biological field stations (BFS) constitute a worldwide infrastructure of strategic importance for environmental research (Wyman et al. 2009, Billick et al. 2013, NRC 2014). Although they differ in size, location, and mission, BFS play a fundamental role in monitoring and understanding rapid environmental change at local, regional, and global scales, because they are found in all biomes and focus on marine, terrestrial, and freshwater systems alike (Wyman et al. 2009, NRC 2014).

In this study, we provide a comprehensive, global inventory of BFS, including information on their geographic location, affiliation, time of establishment, elevation, and research domain. On the basis of this inventory, we emphasize the pivotal role that BFS should play for long-term environmental monitoring and research, education, and active involvement of the public and decisionmakers in these issues. Finally, we discuss the future development of BFS as a strategic global network for monitoring and understanding rapid environmental change.

Compilation of the inventory

We defined *BFS* as outdoor laboratories for students, scientists, and the general public interested in the environment. BFS may employ permanent scientific and supportive staff while at the same time they may be open for visiting researchers. We excluded agricultural, forestry, and weather stations, as well as nature reserves, bird banding stations, and stations that primarily serve as information and education centers. We only considered BFS that actually are in operation. Indeed, it remains a challenge to define BFS properly, and we are aware that this definition may exclude other important outdoor institutions for research, education, and outreach.

Data collection. We compiled comprehensive information about contemporary BFS globally: station name, geographic location, affiliation, time of establishment, elevation, and main research domain. Data for BFS were collected between May 2010 and September 2014 using different types of sources. The inventory is based on extensive research of the Internet. We searched for the terms *research station*, *field station*, *field site*, *biological station*, *ecological station*, *biological field/research station*, *ecological field/research station*, *study site*, *marine biological/ecological station*, *zoological station*, *tropical research station*, *mountain research station,* and

BioScience 66: 164–171.
doi:10.1093/biosci/biv174 Advance Access publication 13 January 2016

environmental station using a search engine and the Web of Science Core Collection to detect information sources for BFS (*www.google.com*; *www.webofscience.com*). We searched in the languages English, German, Spanish, Portuguese, Italian, and French. The specific information on BFS was derived from their websites and reports, online material of field station and monitoring networks, and numerous personal contacts (see Acknowledgments). Existing compilations of field stations complemented the inventory. When available, we used multiple independent references and sources for cross-validation to reduce the heterogeneity in data quality.

Research domain. We collected information about the research focus of each BFS, distinguishing among terrestrial, marine, freshwater research domains, and combinations of these domains.

Location. We gathered information on geographic coordinates for each BFS. When exact coordinates could not be determined, the coordinates of a close location, such as the nearest town or the national park containing the BFS, were recorded. The BFS were allocated to continents and countries (classification: *http://unstats.un.org*) and to terrestrial biomes as defined by Olson et al. (2001).

To analyze whether BFS are located in protected areas (PAs), we used official and nationally designated PAs with known extent from the World Database on Protected Areas (IUCN and UNEP-WCMC 2013). BFS are located in PAs when they are within a PA or within a maximum distance of 5 kilometers (km) from a PA. Only stations with exact geographical coordinates available (889 BFS) and stations in national parks or other protected areas (52 BFS) were considered.

We used the Human Influence Index (HII) to analyze whether BFS are located in low, intermediate, or high human-influenced areas. BFS located in terrestrial realms and with exact geographical coordinates were considered (889 BFS). BFS in Antarctica and marine stations were excluded. The HII considers population density, land transformation, accessibility, and electrical power infrastructure and ranges from 0 (wild or untouched) to 72 (totally modified; Sanderson et al. 2002). The HII is produced by the Wildlife Conservation Society (WCS) and the Columbia University Center for International Earth Science Information Network (WCS and CIESIN 2005).

Affiliation. We gathered information on the current affiliation of each BFS. When a BFS was supported through several affiliates, all of them were recorded. We distinguished among stations affiliated with (a) national parks and governmental institutions (e.g., ministries); (b) non-profit and private organizations (e.g., foundations); (c) research institutions, academies of science, and museums (e.g., Leibniz Association, botanical gardens); and (d) universities and colleges.

Establishment. Information on year of establishment was collected when available (i.e., for 76% of all BFS). When a station remained at the same location but changed ownership or affiliation, the year of first establishment was recorded. Establishment dates were grouped by decade (1850 to 2013).

Elevation. Information on the elevations of BFS was collected when provided. For all other stations with exact coordinates available, elevation was calculated on the basis of the ASTER Global Digital Elevation Model Version 2 (ASTER GDEM V2, Tachikawa 2011). In total, information on elevation was compiled for 912 BFS. For the distribution of elevations of Earth's surface, data from the National Geophysical Data Center based on the 1 arc-minute global relief model ETOPO1 were used (Eakins and Sharman 2012).

Results

We identified a total of 1268 contemporary BFS, located in 120 countries (figure 1). The majority of active stations are based in the Northern Hemisphere, between 30 degrees and 60 degrees latitude. In the Southern Hemisphere, a high proportion of BFS is located in Antarctica (figure 2a). Most of the stations are located in the Americas (45%, with 32.8% in North America), Europe (19%), and Asia (15%). About half of the BFS (634 stations) conduct research in terrestrial systems, whereas 295 stations operate across ecosystem types. Freshwater stations are particularly abundant in Europe (figure 1a, supplemental table S1), whereas marine stations are most abundant in North America (30% of all marine stations; figure 1b).

Most BFS are located in the temperate forest zone (501 BFS), the tropical and subtropical broadleaf forests (271 BFS), and the tundra zone (129 BFS). There, the density of BFS ranges from 11.2 (tundra) to 33.5 (temperate conifer forests) stations per million square kilometers (km^2). In mangroves, the density of BFS is 62.7 (supplemental figure S1, table 1). In contrast, the density of BFS remains low in deserts and xeric shrublands (2.3 BFS per million km^2), tropical and subtropical grasslands and savannas (3.2), and the boreal taiga (4.1). Of the BFS with exact coordinates available, 57% are located in protected areas (PAs), with 77% of marine BFS found in PAs (supplemental figure S2).

Most BFS are located in areas with low or intermediate human influence (552 BFS). In contrast, few BFS are located in highly influenced areas (177 BFS; table 2). The altitudinal distribution of BFS ranges from sea level to 4526 metres above sea level (masl), with most stations (508 BFS) located below 200 masl (density: 12.1 BFS per million km^2; supplemental table S2). Above 200 masl, the density of BFS ranges from 1.6 (4000–5000 masl) to 4.7 (1000–2000 masl; table S2) BFS per million km^2.

Contemporary BFS exhibit a long and distinguished history. The earliest BFS still in operation was founded in 1859 in Concarneau, France (Station de Biologie Marine). In Japan, the first BFS was founded as early as 1886 (Misaki Marine Biological Station; affiliated with the University of

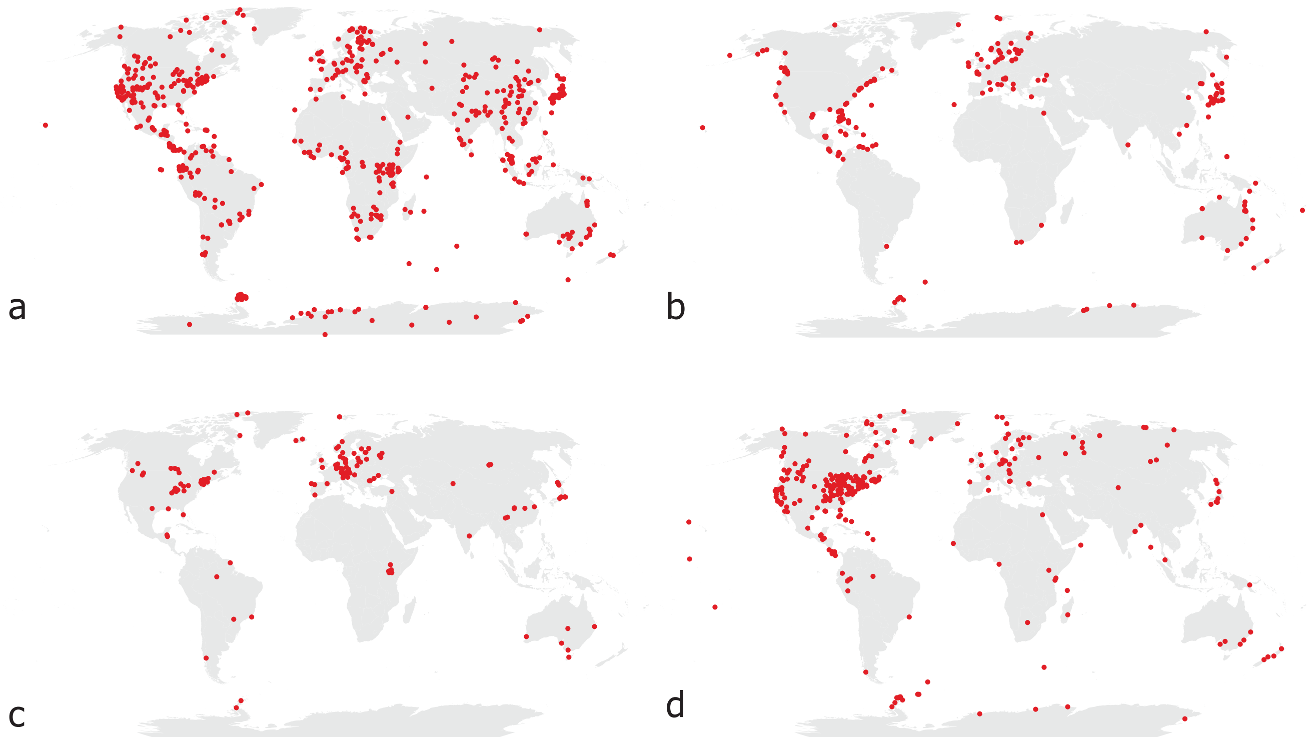

Figure 1. The global distribution of 1268 biological field stations (BFS). a: terrestrial BFS; b: marine BFS; c: freshwater BFS; d: BFS with multiple research domains.

Tokyo). By 1920, 12 stations had been established that are still in operation. In China, the first BFS still in operation was founded in 1955 (Shapotou Desert Experimental Research Station, affiliated with the Chinese Academy of Sciences). At present, 55 BFS are operating in China. In Russia (46 BFS), the Sevastopol Biological Station was founded in 1871 (today named A.O. Kovalevsky Institute of Biology of the Southern Seas, located in the Ukraine) and the Biological Station Rybachi in 1901. In the United States (today: 307 BFS), the Forbes Biological Station (Illinois) and Flathead Biological Station (Montana) were founded in 1894 and 1899, respectively. The Orcadas Base was founded in 1904 as a post office; in 1950, it became the oldest permanent station in Antarctica (French Polar Team; supplemental table S3). Since 1982, the year that the Organization of Biological Field Stations (OBFS) was founded, more than 430 currently operating BFS were founded worldwide, mostly focusing on terrestrial research (266 BFS), followed by marine (50 BFS) and freshwater (41 BFS) research (figure 2b, supplemental figure S3).

After World War II, the opening of newly established BFS, which are still in operation, increased globally. In the 1950s, for example, 92 BFS were established, of which 48 BFS are focusing on terrestrial research (figure S3). The establishment of BFS differs with continent. Whereas the opening of stations in Antarctica peaked in the 1950s, the formation of BFS in Europe and Oceania peaked in the 1960s. In Asia, the establishment of new stations increased in the 1970s. In the United States, 22% of the contemporary stations were founded in the 1990s, and in Africa, 33% of the present stations were established between 2000 and 2009 (figures 2b and S3).

The majority of the BFS are administratively tied to universities and colleges (38% of all stations); 18% are associated with museums and nonuniversity research institutions; 17% are run by nongovernmental and nonprofit organizations; 12% are supervised by governmental institutions, including national parks; and 13% are affiliated with more than one organization (table 3). Affiliations differ by country and region. In Japan, for example, 95% of the 70 contemporary BFS are affiliated with universities. In Antarctica, 51% of the BFS are affiliated with governmental institutions. In Africa, one-third of the BFS are tied to nonprofit and private organizations, followed by universities (23%). In China, 49 out of 55 BFS are affiliated with the Chinese Academy of Science. In Russia, 30 out of 46 BFS are affiliated with the Russian Academy of Science (table S3).

Biological field stations—present and future

We provide the most comprehensive inventory of active BFS worldwide. Existing networks differ in the definition of stations, are geographically or thematically restricted, and do not consider fully stations in emerging economies and developing countries. For example, the Organization of Biological Field Stations, with 196 member institutions, and the National Association of Marine Laboratories (NAML), with 126 members (in 2002; Klug et al. 2002),

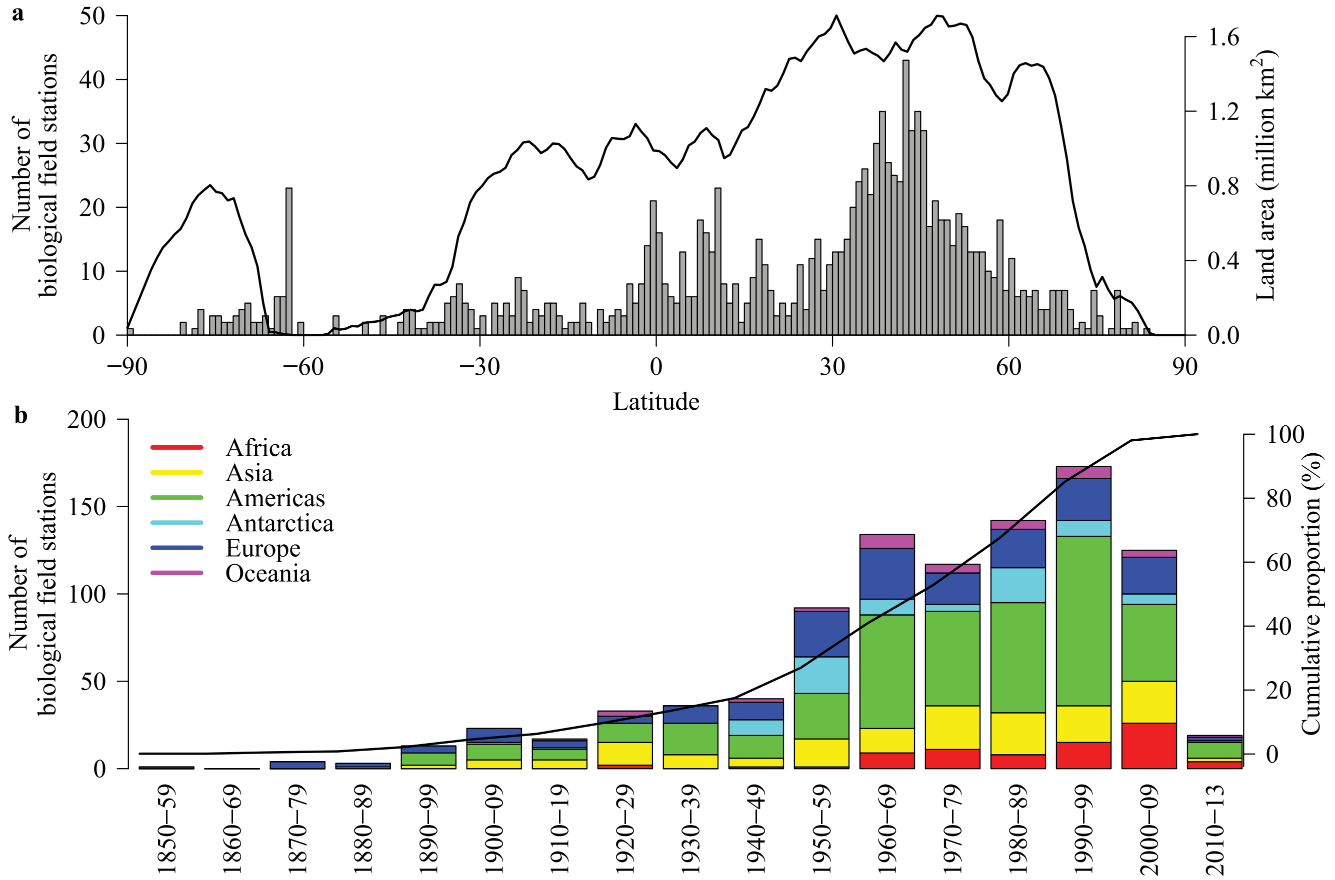

Figure 2. a: Latitudinal distribution of land area (square kilometers, km^2; black line) and the number of biological field stations (BFS, bars); b: The establishment of BFS (individual continents) over time and the cumulative proportion of BFS (black line; n = 972).

are the two main organizations that represent a major share of BFS in North America. SCANNET (32 stations), on the other hand, covers northern Europe (SCANNET 2010) and Primate Info Net focuses on primate-related field studies and sites (95 studies and sites; Primate Info Net 2015). The World Register of Field Centres identifies more than 700 globally distributed stations focusing on environmental research (Royal Geographical Society 2015). A recent initiative by the US National Academy of Science lists 984 globally distributed field stations (defined as field camps and stations, marine laboratories and nature reserves), mainly embedded in protected areas (NRC 2014). Our inventory only partly overlaps with the collected stations of NRC (513 of 984 stations, in December 2014), most likely because of a different definition approach (see above). The present study gathers comprehensive information on BFS across the globe, analyzes their distribution, identifies research directions, affiliations, as well as potential gaps and opportunities, whereas the National Research Council (NRC) reviewed existing knowledge on field stations in general and provided recommendations for their further development.

However, even the present inventory is by no means complete. BFS are changing identity and emerge and disappear rather quickly (Arvey and Riemer 1966, Wyman et al. 2009). Nevertheless, this inventory can be considered a major step toward bundling information on BFS globally, increasing their visibility, closing existing gaps, and promoting coordinated research and education activities on pressing environmental and societal challenges. In a next step, information on research facilities, personnel resources, financial endowment, teaching, and outreach activities of BFS on a global scale needs to be compiled.

Global network of BFS. Environmental science and biology are rapidly emerging domains, and research is increasingly conducted in collaborative and interdisciplinary teams and networks (Wyman et al. 2009, Billick et al. 2013, Kwok 2013). A multiple temporal and spatial scale approach is particularly relevant for biodiversity protection and ecosystem management (Soberon and Sarukhan 2010, Perrings et al. 2011). Nonetheless, global biodiversity research remains fragmentary and lacks an integrative approach (Görg et al. 2010). The major share of BFS are located in and close to protected

Table 1. The total number and density of biological field stations (BFS) in terrestrial biomes (nomenclature Olson et al. 2001).

	Number of BFS	Density (BFS per million square kilometers)
Tropical and subtropical moist broadleaf forests	238	11.9
Tropical and subtropical dry broadleaf forests	22	7.2
Tropical and subtropical coniferous forests	11	15.4
Temperate broadleaf and mixed forests	364	28.3
Temperate coniferous forests	137	33.5
Boreal forests/taiga	62	4.1
Tropical and subtropical grasslands, savannas, and shrublands	66	3.2
Temperate grasslands, savannas, and shrublands	59	5.8
Flooded grasslands and savannas	4	3.6
Montane grasslands and shrublands	10	1.9
Tundra	129	11.2
Mediterranean forests, woodlands, and scrub	69	21.3
Deserts and xeric shrublands	65	2.3
Mangroves	22	62.7
Rocks and ice	10	0.9

Table 2. Biological field stations (BFS) related to the Human Influence Index (HII).

HII	Number of BFS
0	12
1–9	136
10–19	247
20–29	157
30–39	94
40–49	50
50–59	31
≥ 60	2

Note: 0–9, low human influence; 10–29, intermediate human influence; ≥ 30, high human influence.

areas; therefore, conservation ecology is a main focus of them (Wyman et al. 2009). At the same time, the rapid transformation of ecosystems worldwide calls for pertinent research and monitoring programs in human-dominated systems and in sensitive areas such as savannas, deserts, mountainous regions and offshore locations. Consequently, a concerted strategy aimed at founding BFS in such regions is required to enable monitoring, research, education, and information along distinct environmental and geopolitical gradients.

Education, teaching, and public information. Most BFS are located in remote locations, well suited to study biodiversity and ecosystem processes in natural settings (Brussard 1982, Lohr 1996). The hands-on contribution of BFS to the education of young students in environmental research is of tremendous value in a way that cannot be approached on a university campus (Arvey 1966, Lohr 1996, Hodder 2009, Janovy and Major 2009, Billick et al. 2013). In this respect, BFS must continue to play a fundamental role in educating the next generation of environmental scientists. The Sagehen Creek Field Station (California, United States), for example, improved its IT bandwidth by partnering with a local, rural school district, the USFS and a nearby university; in return, it provides learning opportunities for students (Baker 2015). Further reasons to offer education and teaching activities are the generation of income, the improvement of public relations, and strengthening of the ecological literacy of the broader public (Whitesell et al. 2002). Furthermore, the information of the local human population on ongoing ecological programs and related challenges as well as the active integration of citizens into research programs are major tasks of BFS (Billick et al. 2013). Activities at BFS range from courses for students, teachers, and ecotourists to workshops for conservation workers or local farmers (Whitesell et al. 2002), including formal courses, research experiences, and internships (Hodder 2009).

To develop sustainable solutions for the management of our biosphere under rapidly changing environmental conditions, BFS should play an increasing role in informing and educating the public and decisionmakers. At the regional level, BFS may serve as honest brokers in evidenced-based decisionmaking. At a global scale, BFS may contribute to coordinated research networks to assess and understand global environmental change.

Table 3. The institutional affiliation of biological field stations in each continent.

	Governmental institutions and national parks	Nonprofit and private organizations	Research institutes, academies of science, and museums	Universities and colleges	Multiple affiliates
Africa	21	37	14	27	17
Americas	50	142	53	235	102
Antarctica	42	2	23	1	14
Asia	25	9	61	76	14
Europe	18	15	78	113	17
Oceania	2	11	4	39	6
Total	158	216	233	491	170

Supporting global initiatives and networks. Decisionmakers are seeking reliable information from science and require support from global networks. At the same time, an active integration of social and environmental aspects is important in solving problems caused by global environmental change (Perrings et al. 2011). In this respect, BFS may play a fundamental role and offer long-term commitment in supporting global programs and networks such as the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), the Group on Earth Observations Biodiversity Observation Network (GEO BON), the Long Term Ecological Research (LTER) Network, the Ocean Observatories Initiative (OOI), and the Global Lake Ecological Observatory Network (GLEON). Concurrently, BFS need to adopt a more holistic approach and, at the same time, they must continuously evaluate and adapt their monitoring, research, education, and outreach activities in a coordinated way (Lindenmayer and Likens 2009). Fulfilling these requirements, BFS will be able to strengthen their role in initiating, coordinating, and supporting comprehensive long-term research and monitoring programs.

Threat and long-term support. Despite their pivotal role in understanding and protecting natural ecosystems, BFS are under continuous risk of closure because of financial insecurity, lack of public support, and weak governance (Whitesell et al. 2002, Wyman et al. 2009, NRC 2014, Schubel 2015). BFS that are very narrow in their activities and do not dynamically evolve and adapt are particularly at risk. In the year 1945, for example, 53 biological stations were operating in the United States, of which only 20 survived until 1966—most of them in much altered conditions (Arvey and Riemer 1966).

Historically, BFS provided easy access to the natural environment and focused primarily on natural history studies and the collection of biological material. Studies were mainly carried out by individual researchers. Today, many stations are increasingly equipped with state-of-the-art infrastructure, including large-scale field experimental sites, advanced sensor networks, and very well-equipped laboratories. At the same time, more and more BFS make their unique infrastructure and rich data publically available (Whitesell et al. 2002, Michener et al. 2009, Porter et al. 2009, Wyman et al. 2009).

A continuous adaptation necessary to meet future requirements depends on the solid funding of BFS. Today, the annual operating budget of field stations ranges from thousands to millions of US dollars, with large differences across regions and types of stations. Taking an average annual budget of US$1 million per station, the global network of BFS constitutes an environmental infrastructure worth above US$1.3 billion per year; which is comparable with the annual budget of CERN (1.11 billion CHF in 2014, approx. US$1.2 billion). Therefore, a single infrastructure of global importance in physics costs as much as the entire network of contemporary BFS.

Financial support for BFS comes from a variety of sources such as governments, private organizations, and universities, as well as from inhouse-generated resources such as education and training programs, research income, room and meal charges, and station fees for facilities and services, which may range from less than $1 to $100 per day per person (Whitesell et al. 2002). A recent example for the missing long-term support of BFS is the Charles Darwin Research Station in the Galapagos Island, which faces an increasing difficulty in covering the running costs for the Station (Charles Darwin Foundation 2015).

Host institutions together with funding organizations and politicians need to develop sustainable concepts to maintain BFS as an infrastructure of regional and global importance. Developing such sustainable concepts, BFS are asked to increase the information flow; share infrastructure facilities; provide access to data resources, long-term data sets, and expensive mobile instrumentation; enhance research capacity and financial efficiency; and initiate and support coordinated environmental process studies on a global scale (Wyman et al. 2009, Billick et al. 2013, NRC 2014).

To be successful in the long run, individual BFS need to develop a broad portfolio; strengthen the link among research, education, and outreach activities; and integrate societal issues (Perrings et al. 2011, Billick et al. 2013, NRC 2014). With this in mind, BFS offer a unique opportunity to improve our understanding on pressing environmental and social challenges and therefore deserve the utmost support to fulfill their pivotal role at the regional and global scales.

Acknowledgments

We thank Emily Bernhardt, Jonathan Jeschke, Jens Nejstgaard, and the three anonymous reviewers for helpful comments on the manuscript. We thank Ulrike Herrmann for collecting data on the exact spatial location of BFS. And we are very greatful to Nuray Akbulut, Ionut Aron, Leon Barmuta, Meryem Beklioglu, Martin Blettler, Núria Bonada, Andrew Boulton, John Brittain, Stuart Bunn, Antonio Camacho, Jean-François Carrias, David Crook, Thibault Datry, Aaike De Wever, Renata Dondajewska, Christoph Matthaei, Nikolai Friberg, Ryszard Gołdyn, Brij Gopal, Stanley Gregory, Mary Harner, Jürgen Hofmann, Ken Irvine, Vera Istvánovics, Robert Kanka, Bakhtiyor Karimov, Georgiy Kirillin, Werner Kloas, Cathy Koot, Jan Kubecka, Sam Lake, George H. Lauff, Jonathan Marshall, Alexander Milner, Michael Monaghan, Guiseppe Morabito, Jeanne Nel, Peeter Nõges, Alaa G. M. Osman, Ana Ostojic, Judith Padisak, Eric Pattee, Momir Paunovic, Gwendolin Porst, Isabelle Providoli, Antonio Pusceddu, Luisa Ricaurte, Joandomènec Ros, Glen Scholz, Juna Shrestha, Nikos Skoulikides, Gunta Springe, Alisha Steward, Vera Straškrábová, Evzen Stuchlik, Alexander Sukhodolov, Doerthe Tetzlaff, James H. Thorp, Henn Timm, Lena Timoshkina, Colin Townsend, Jacek Tylkowski, Yordan Uzunov, Kozo Watanabe, Alfred Johny Wüest, Hannu Ylönen, Liu Zhengwen, Stamatis Zogaris, and Nagy Zoltán, who provided very helpful information on BFS. This research was supported by the EU-funded project BioFresh (*www.freshwaterbiodiversity.eu*).

Supplemental material

The supplemental material is available online at *http://bioscience.oxfordjournals.org/lookup/suppl/doi:10.1093/biosci/biv174/-/DC1*.

References cited

Arvey MD, Riemer WJ. 1966. Inland biological field stations of the United States. BioScience 16: 249–254.

[ASTER GDEM V2] ASTER Global Digital Elevation Model V2. Ministry of Economy, Trade, and Industry, National Aeronautics and Space Administration. (22 September 2014; *http://gdem.ersdac.jspacesystems.or.jp/*).

Baker B. 2015. The way forward for biological field stations. BioScience 65: 123–129.

Billick I, Babb I, Kloeppel B, Leong JC, Hodder J, Sanders J, Swain H. 2013. Field Stations and Marine Laboratories of the Future. Organization of Biological Field Stations. (9 December 2015; *www.obfs.org/fsml-future*).

Brussard PF. 1982. The role of field stations in the preservation of biological diversity. BioScience 32: 327–330.

Charles Darwin Foundation. (23 June 2015; *www.darwinfoundation.org*).

[CERN] Conseil Européen pour la Recherche Nucléaire. (23 June 2015; *http://press.web.cern.ch/facts-and-figures/budget-overview*).

Eakins BW, Sharman GF. 2012. Hypsographic Curve of Earth's Surface from ETOPO1. National Centers for Environmental Information, National Oceanic and Atmospheric Administration. (9 December 2015; *www.ngdc.noaa.gov/mgg/global/etopo1_surface_histogram.html*).

French Polar Team. (24 June 2015; *http://french-polar-team.fr/LU_Orcadas_Station_Laurie_Island_South_Orkney.php*).

Görg C, Neßhöver C, Paulsch A. 2010. A new link between biodiversity science and policy. GAIA 19: 183–186.

Hodder J. 2009. What are undergraduates doing at biological field stations and marine laboratories? BioScience 59: 666–672.

[IPBES] Intergovernmental Platform on Biodiversity and Ecosystem Services. (23 June 2015; *www.ipbes.net*).

[IUCN, UNEP-WCMC] International Union for Conservation of Nature, United Nations Environment Programme's World Conservation Monitoring Centre. 2013. The World Database on Protected Areas (WDPA) December Release. UNEP-WCMC.

Janovy J Jr, Major KM. 2009. Why we have field stations: Reflections on the cultivation of biologists. BioScience 59: 217–222.

Klug MJ, Hodder J, Swain H. 2002. The role of biological field stations in education and recruitment into biological sciences. Paper presented at the Education and Recruitment into Biological Sciences: Potential Role of Field Stations and Marine Laboratories Workshop; 11–12 February 2002, Washington, DC.

Kwok R. 2013. The great outdoors. Nature 503: 301–303.

Lindenmayer DB, Likens GE. 2009. Adaptive monitoring: A new paradigm for long-term research and monitoring. Trends in Ecology and Evolution 25: 200–201.

———. 2010. Effective Ecological Monitoring. CSIRO, Earthscan.

Lohr SA. 1996. A new horizon for biological field stations and marine laboratories. Trends in Ecology and Evolution 11: 228.

Michener WK, Bildstein KL, McKee A, Parmenter RR, Hargrove WW, McClearn D, Stromberg M. 2009. Biological field stations: Research legacies and sites for serendipity. BioScience 59: 300–310.

[NRC] National Research Council. 2014. Enhancing the Value and Sustainability of Field Stations and Marine Laboratories in the Twenty-First Century. National Academies Press.

Olson DM, et al. 2001. Terrestrial ecoregions of the world: A new map of life on Earth. BioScience 51: 933–938.

Perrings C, Duraiappah A, Larigauderie A, Mooney H. 2011. The biodiversity and ecosystem services science–policy interface. Science 331: 1139–1140.

Porter JH, Nagy E, Kratz TK, Hanson P, Collins SL, Arzberger P. 2009. New eyes on the world: Advanced sensors for ecology. BioScience 59: 385–397.

Primate Info Net. (23 June 2015; *http://pin.primate.wisc.edu*).

Rockström J, et al. 2009. A safe operating space for humanity. Nature 461: 472–475.

Rockström J. 2015. Bounding the Planetary Future: Why We Need a Great Transition. Great Transition Initiative. (9 December 2015; *www.great-transition.org*).

Royal Geographical Society. World Register of Field Centres. (23 June 2015; *www.rgs.org/OurWork/Fieldwork+and+Expeditions/World+Register+of+FieldCentres*).

Sanderson EW, Jaiteh M, Levy MA, Redford KH, Wannebo AV, Woolmer G. 2002. The human footprint and the last of the wild. BioScience 52: 891–904.

SCANNET. 2010. A Circumarctic Network of Terrestrial Field Bases. (23 June 2015; *www.scannet.nu*).

Schubel JR. 2015. Some thoughts on keeping field stations and marine labs afloat in turbulent times. BioScience 65: 458–459.

Soberon JM, Sarukhan JK. 2010. A new mechanism for science–policy transfer and biodiversity governance? Environmental Conservation 36: 265–267.

Steffen W, et al. 2011. The Anthropocene: From global change to planetary stewardship. Ambio 40: 739–761.

Steffen W, Broadgate W, Deutsch L, Gaffney O, Ludwig C. 2015. The trajectory of the Anthropocene: The great acceleration. Anthropocene Review 2: 81–98.

Tachikawa T, Hato M, Kaku M, Iwasaki A. 2011. Characteristics of ASTER GDEM version 2. International Geoscience and Remote Sensing Symposium (art. 6050017).

Vitousek PM, Aber JD, Howarth RW, Likens GE, Matson PA, Schindler DW, Schlesinger WH, Tilman GD. 1997. Human alteration of the global nitrogen cycle: Causes and consequences. Issues in Ecology 1: 1–15.

Whitesell S, Lilieholm RJ, Sharik TL. 2002. A global survey of tropical biological field stations. BioScience 52: 55–64.

[WCS, CIESIN] Wildlife Conservation Society, Center for International Earth Science Information Network. 2005. Last of the Wild Project, Version 2, (LWP-2): Global Human Influence Index (HII) Dataset (IGHP). NASA Socioeconomic Data and Applications Center (SEDAC). (26 June 2015; *http://dx.doi.org/10.7927/H46W980H*).

Wyman RL, Wallensky E, Baine M. 2009. The activities and importance of international field stations. BioScience 59: 584–592.

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