

Thirty Years of *Tropical Resources: The Bulletin of TRI*

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Abstract

It is thirty years since the first article resulting from work of Fellows of the Yale Tropical Resources Institute was published. Since then, Fellows have written over 300 articles for the *Bulletin*. As a complement to our review of the current careers of TRI Fellows (Beasley et al. 2015), here we present a review and analysis of the research articles published in the *Bulletin*.

Introduction and a Brief History of the TRI Bulletin

The mission of TRI is to support interdisciplinary, problem-oriented student research on the most complex challenges confronting the conservation and management of tropical environments and natural resources worldwide. How its publication, *Tropical Resources: The Bulletin of the Yale Tropical Resources Institute*, reflects this mission is of key interest as TRI reflects on 30 years of tropical research.

The TRI *Bulletin* has undergone an evolution quite as thorough as that of the Tropical Resources Institute itself. Initially called *TRI News*, the publication once served as a combination newsletter, research catalogue, and networking tool for collaborating partners. That first issue, edited by Katherine A. Snyder, assistant to TRI's founding director, Professor William R. Burch, Jr., contained research articles from one faculty and one student contributor. The issue provided reference data for fifteen other working papers as well as literature from the broader community of tropical research.

It consisted of sixteen typewritten pages. This latest issue, on the other hand, was written on numerous personal computers, formatted in Markdown, and easily converted using open-source software to HTML and professional-quality PDF documents for electronic and hard copy printing and distribution.

Thirty years, thirty-seven issues, two titles, and eight different cover designs later, the TRI *Bulletin's* primary purpose is to highlight the research conducted by recipients of the TRI Fellowship, all Yale School of Forestry master's and doctoral students. Manuscripts are published in full and cover a broad range of topics in the natural and social sciences, many of which expand beyond TRI's stated focus areas in 1986 of secondary forest management, wildland protection management, and bioenergy systems. By 2015, *Tropical Resources* was 109 pages long and contained eleven research articles written by TRI Fellows.

It is clear that much has changed in the look and format of the TRI *Bulletin* over thirty years—but what about its content? How has the research itself evolved? To answer that question, we re-

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viewed every available article of *TRI News* and *Tropical Resources* from 1986 to 2015, examining patterns ranging from author gender to research ecosystem, as well as the broader global issues that the author sought to address. Some trends we discovered were predictable and others less so, but viewed as a whole, the *Bulletin's* many pages served to illuminate TRI's rich institutional history.

Methods

Digital copies of all volumes of the TRI *Bulletin* are available on the TRI website (environment.yale.edu/tri)¹ in various formats (older articles are scanned as images, newer articles are generated PDF files; we are in the process of converting all articles to text-based HTML to allow more refined searching and archiving). Together, volumes from 1986 to 2015 total 37 separate issues spanning a period of 29 years. Within these issues, 299 articles could be classified as research. Conference summaries, project updates, and biographical pieces were excluded from further analyses. Articles did not need to be authored by students to qualify; however, only 14 (4.7%) were authored by non-students.

For each article, we scored it for the following categories: author gender, status, and degree/s, region and country of study site, scientific field (natural science, social science, or interdisciplinary), discipline within field (e.g., ecology, anthropology, management), organism (animals, plants, or humans), location type (natural, rural, urban, or mixed), ecosystem (e.g., forest, freshwater), and global issues referenced (e.g., climate change, economic justice).

For degrees, ecosystems, disciplines, and global issues, we recorded up to two responses per article. We categorized study site ecosystems into six groups: agricultural, desert/arid, savanna, forest, freshwater, and marine. Some studies took place in multiple ecosystems (up to two were noted), and others had to be grouped according to their

closest relative (i.e., high altitude tundra was included in desert/arid). We recognized 11 field disciplines: anthropology/human behavior, agriculture/agroforestry, climate, ecology (including silviculture), economics, energy, environmental education, environmental management/planning, health, industrial ecology, and religion/ethics, reflecting the main areas of study in F&ES.

For global issues, two of nine potential areas were noted if they were referenced in the article: civil rights and equality, climate change, deforestation and habitat destruction, development and globalization, economic justice, hunger, invasive species, over-hunting and fishing, and pollution.

To allow comparison across time, we either tabulated articles and their categories by year or by decade. We used chi-squared tests to examine if the proportion of studies in each sub-category had changed across the three decades (1986–1995, 1996–2005, and 2006–2015).

Results and Discussion

A total of 299 research articles were published in the *Bulletin* between 1986 and 2015. The mean number of research articles per year was 9.7 (range = 2–16). However, this mean number obscures the low number of articles over the first five years (mean = 4.6, range = 2–7). From 1991, the yearly output has been higher although still with considerable variation (mean = 10.75 articles, range = 7–16; Fig. 1), in some cases driven by the presence of a double-issue (e.g., volume 32/33 was published in 2014 with papers from 2013 and 2014).

The number of articles published in each of the three decades was similar, with 87, 95, and 98 articles, respectively.

Authors

Of all the articles studied, only 23 had more than one author, ten of which were mixed-gender teams. For single-authored articles, from the first decade of the *Bulletin* to its third, the number of male au-

¹We were unable to locate copies of issues 14.2, and 15.2 (falls of 1995 and 1996 respectively), if indeed they were published.

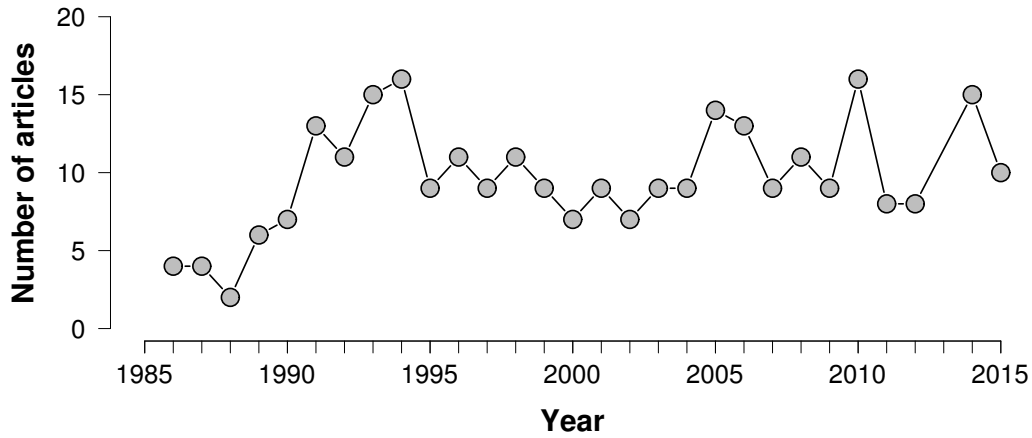


Fig. 1. Number of research articles in the TRI *Bulletin* per year.

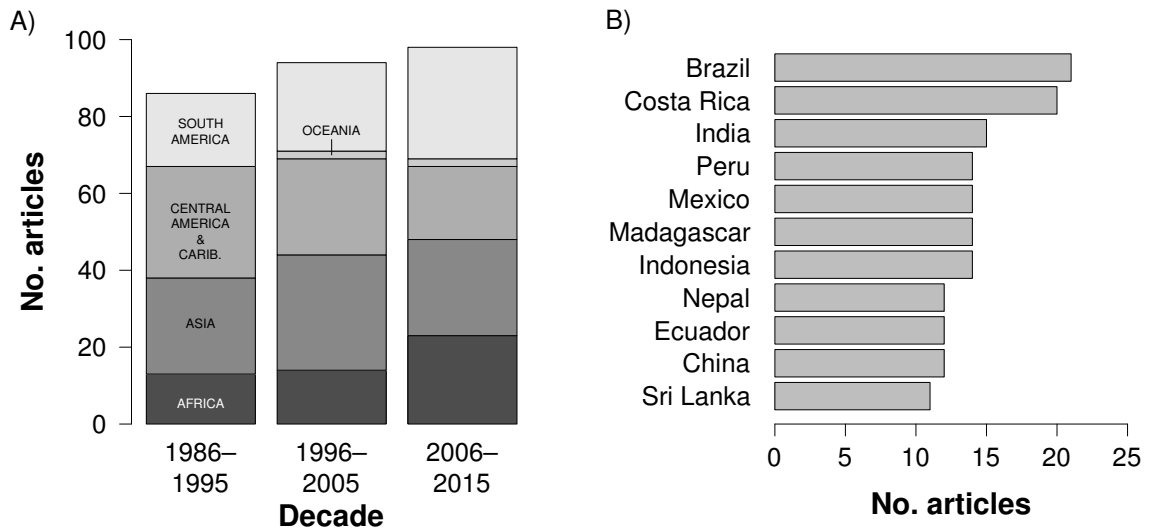


Fig. 2. Number of TRI *Bulletin* articles focused on (A) each global region by decade and (B) the eleven most popular countries.

thors halved, the number of female authors more than doubled, and the proportion of females grew by 80% ($\chi^2 = 10.9$, $df = 2$, $p < 0.001$, Fig. 2F). This change parallels a growth in female representation both at the Yale School of Forestry and Environmental Studies and in graduate programs overall during that time.

The vast majority of researchers were students (95.3%), with the remainder being Yale faculty or non-Yale affiliates. Degree tracks were difficult to measure over time as the school's offerings changed (MES was dropped and MEM added in 1998), but it was clear that over its tenure, the *Bulletin's* contributors have been primarily master's students. Master of Environmental Studies and Master of Environmental Science were the highest contributing degrees ($n = 122$), followed by Master of Forestry and Forest Science ($n = 73$), Master of Environmental Management ($n = 47$) and doctoral students ($n = 31$). Thus, the TRI *Bulletin* continues to occupy the unique niche of providing a publication opportunity for master's level environmental researchers in the tropics.

Study site

Studies were conducted in all tropical continental regions. The number of studies conducted in Africa and South America were greater in the most recent decade compared to the first decade (Africa had 13 in 1986–1996 versus 23 in 2006–2015, South America had 19 versus 29), maybe driven by a growing population of F&ES students who are from those continents and choose to do research in their home countries or native languages. Conversely, the number of studies focused on Central America-Caribbean decreased (29 versus 19), and Asia remained constant (25–30). Despite this apparent change in balance among regions, there was no significant change in the proportion of studies from each global region across the three decades of publication, both when we included the four studies from Oceania ($\chi^2 = 9.7$, $df = 8$, $p = 0.29$) or excluded them ($\chi^2 = 7.6$, $df = 6$, $p = 0.25$; Fig. 3A).

Over the course of the TRI *Bulletin's* history, research has been featured from 61 countries. Of these countries, about half ($n = 29$) were featured in only a single study (e.g., Comoros, Haiti, Liberia, Paraguay, and Vietnam). Thirty-two countries were highlighted by two or more articles over the three decades (e.g., five studies in Bolivia, three in Ghana, and two in Thailand). Eleven countries had ten or more studies since 1986 (Fig. 3B), split evenly between the Americas ($n = 5$) and Asia ($n = 5$), plus Madagascar. As we might expect, countries with large areas of tropical forest featured prominently in this list (e.g., Brazil, Peru) as well as those with a strong tradition of sending students abroad for graduate study (e.g., Brazil, India, Mexico). Further, some countries have organizations with strong partnerships with TRI and F&ES, such as those examining silviculture in Costa Rica and Sri Lanka.

Study characteristics

In line with the increasingly broad focus of the School of Forestry, reflected in the addition of 'Environmental Studies' to its name in 1972, there was a significant shift from studies focused on plants ($n = 37$ in 1986–1996 to $n = 22$ in 2006–2015) to studies focused on people ($n = 40$ to 69), which now outnumber plant studies 3:1 ($\chi^2 = 11.09$, $df = 4$, $p = 0.026$, Fig. 2A). Studies of animals concerned only a mean of 9 studies per decade (range = 8–10).

Likely tied to this trend was a change in the types of location and ecosystem that were studied. In its first decade, the *Bulletin* contained comparable numbers of studies based in rural ($n = 37$) and natural ($n = 31$) areas, and only two studies had an urban focus. By 2006–2015, however, natural area studies were far less popular ($n = 7$), while rural ($n = 62$) and urban ($n = 5$) research had both increased significantly ($\chi^2 = 34.2$, $df = 6$, $p < 0.001$, Fig. 2B). This change aligns with the move from plant to human-focused research, but notably, rural and mixed location studies still far outnumber those conducted solely in urban areas.

Similar to location type, study ecosystem varied significantly over time ($\chi^2 = 29.7$, $df = 10$, $p = 0.003$, Fig. 2C). The two most common ecosystems saw dramatic change: fewer studies were conducted in forests (58 studies to 38) and more studies were conducted in agricultural land (12 studies to 28). Further, the number of studies in fresh water doubled from 4 to 11. Studies in deserts, savannas, and marine ecosystems showed little variation and even combined accounted for only about 10 studies per decade. This shift in ecosystem likely reflects the increasingly applied nature of the work of TRI Fellows, broadening from the management of forests to the management and study of the environment and its inhabitants as a whole.

Fields of enquiry

The Tropical Resources Institute, and the School of Forestry and Environmental Studies more widely, aim to be interdisciplinary institutions. In agreement with this goal, there was a significant increase in social science and explicitly interdisciplinary studies from the first decade to the third, concurrent with a decline in natural science studies ($\chi^2 = 20.5$, $df = 4$, $p = 0.0004$, Fig. 2D). Interdisciplinary studies, while consistently the smallest category, included intriguing topics such as the future of yerba mate farmers in Argentina, use of Himalayan 'viagra' in Bhutan, dynamics of mangroves and the fishing industry in Madagascar, and the role of sacred pools in forest conservation in Benin.

In addition to the broad fields of natural and social science, we sorted the *Bulletin* articles according to discipline. A predictable scenario was observed. Between 1986 and 2015, studies in ecology decreased while studies in anthropology, health, and environmental management increased ($\chi^2 = 33.1$, $df = 18$, $p = 0.016$, Fig. 2E). Despite active and engaged faculty in F&ES, economics and energy articles represented only a small and stable fraction of studies, and climate and industrial ecology only appear as disciplines in the second decade, reflecting

recent understanding of these important issues.

Global Issues

TRI Fellowships are aimed at addressing some of the most complex challenges in the conservation and management of tropical environments. This aim is reflected in the broader global issues that motivate studies published in the *Bulletin*, with most authors placing their study in to this larger context. Deforestation and habitat destruction was by far the most common issue addressed ($n = 152$), referenced in more than half of all articles. Including all unsustainable extraction of plant material, this category showed no decline in its significance over time. Other global issues did show substantial variation among decades, but not significantly so, when we looked at all issues together ($\chi^2 = 29.6$, $df = 18$, $p = 0.042$).

The issue of development and globalization, second to habitat destruction, increased from 24 to 32 studies from the first to the third decade. Maybe unsurprisingly, references to climate change and global warming were absent from the first ten years of the *Bulletin*, but are increasingly common, whereas the issue of hunger and famine decreased in prevalence.

Conclusion

The patterns of publications in the TRI *Bulletin* reflect the interests as well as changes occurring within F&ES as well as society at large. Some elements of *TRI News* and *Tropical Resources* have been maintained throughout all three decades of publication. These include a commitment to student-directed, primarily master's level research; representing a diverse array of regions and countries across the global tropics; and addressing ongoing threats to tropical environments such as deforestation, habitat destruction, and development.

Other aspects of the *Bulletin* have shifted. More research is being conducted by women. More projects are focused on social science, humans, and the environments that humans inhabit. Pure

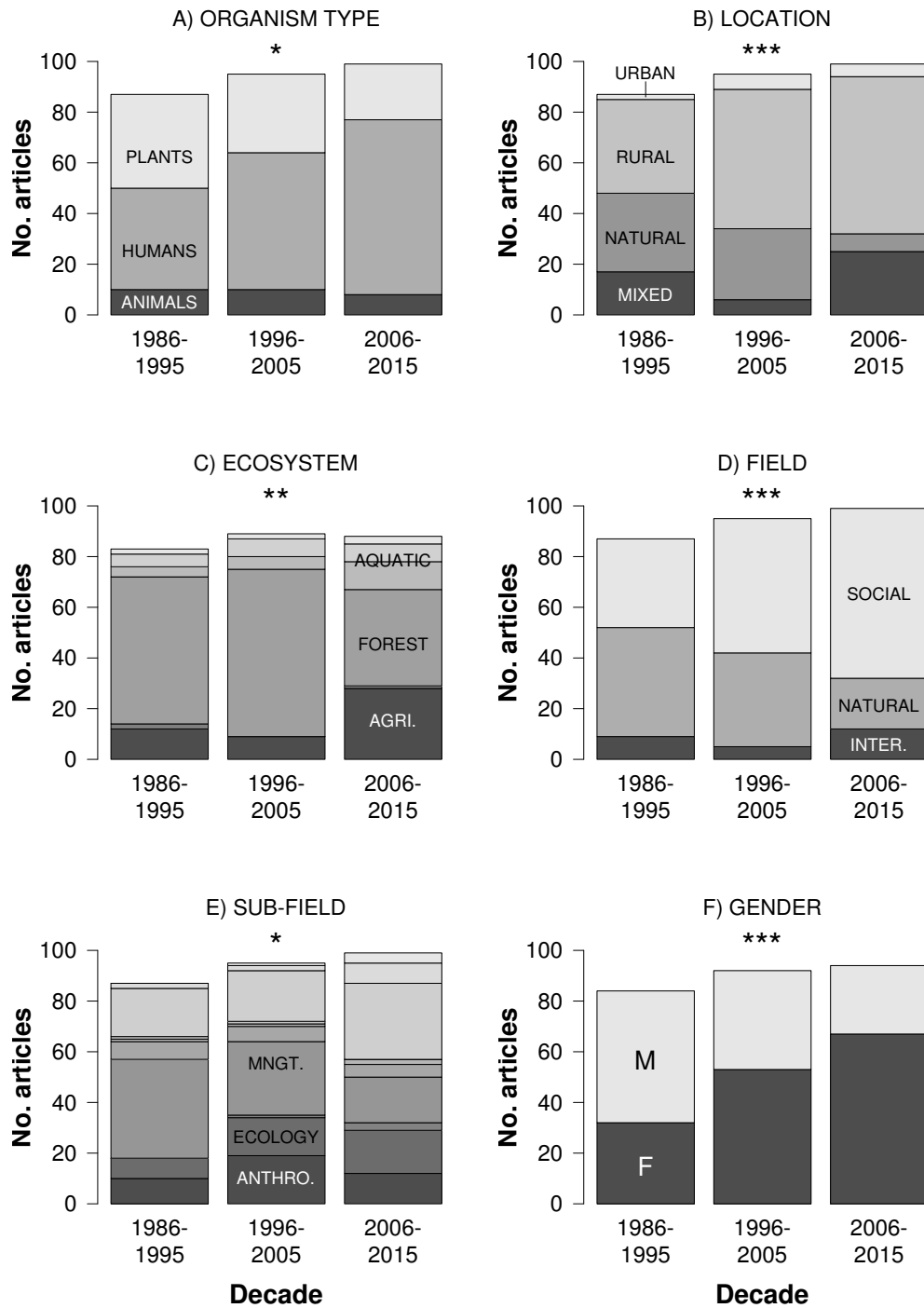


Fig. 3. *TRI Bulletin* article traits by decade: (A) primary organism studied; (B) primary location of research; (C) primary ecosystem studied; (D) general field of research; (E) sub-discipline; and (F) author gender. Stars indicate degree of statistical significance: * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

ecological studies are less common than studies of environmental management, planning, politics, and land use. Fewer studies are forest-focused. Crossover and interdisciplinary research is growing.

We might glean from these trends that the direction of tropical research itself has changed, and is changing. The demographics and definition of the field are expanding and diversifying. The inextricable fates of the natural environment and human communities – especially those in less-developed countries – are more broadly understood and the urgency of conservation-oriented research only grows.

As the *TRI Bulletin* enters its fourth decade, we expect many of these trends to continue. To remain relevant, TRI Fellows' research must strike a balance between asking meaningful cutting-edge questions and upholding the legacy and diversity of fields, regions, and ecosystems that the Tropical Resources Institute seeks to recognize and conserve.

Student interest alone is not the only factor shaping the themes of TRI research, however. Degree and course offerings, funding levels, in-country partnership opportunities, and faculty interests all play a role in ensuring that future student research achieves this desired balance. We hope this retrospective analysis will be a helpful tool as strategies and procedures are put into place that will shape the next thirty years of TRI research.

Acknowledgements

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References

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