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Briefly summarize the article (1–2 paragraphs). Discuss the data-collection procedures. How was the data collected? Via paper-and-pencil measures, computerized surveys, or interviews?

DISCUSSION #2. (ARTICLE ATTACHED) For this discussion, refer to the other article you found in the Capella library. The article should be a research report on a quantitative research study in a topic area of interest to you. Use the Article Analysis Worksheet to prepare for this discussion. Briefly summarize the article (1–2 paragraphs). Discuss the data-analysis procedures, addressing each of the following issues:

- How was the data analyzed?
- What statistical procedures were used?
- What were the results?
- Did the analysis confirm the hypothesis or hypotheses?

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Using Big Data and Quantitative Methods to Estimate and Fight Modern Day Slavery

Datta, Monti Narayan. *The SAIS Review of International Affairs*; Baltimore Vol. 34, Iss. 1, (Winter 2014): 21-33.



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Abstract

Given the hidden, criminal nature of contemporary slavery, empirically estimating the proportion of the population enslaved at the national and global level is a challenge. At the same time, little is understood about what happens to the lives of the survivors of slavery once they are free. I discuss some data collection methods from two nongovernmental organizations (NGOs) I have worked with that shed light on these issues. The first NGO, the Walk Free Foundation, estimates that there are about 30 million enslaved in the world today. The second NGO, Free the Slaves, employs a longitudinal analysis to chronicle the lives of survivors. The acquisition and dissemination of such information is crucial because policymakers and donors sometimes require hard data before committing time, political will, and resources to the cause.

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Headnote

Given the hidden, criminal nature of contemporary slavery, empirically estimating the proportion of the population enslaved at the national and global level is a challenge. At the same time, little is understood about what happens to the lives of the survivors of slavery once they are free. I discuss some data collection methods from two nongovernmental organizations (NGOs) I have worked with that shed light on these issues. The first NGO, the Walk Free Foundation, estimates that there are about 30 million enslaved in the world today. The second NGO, Free the Slaves, employs a longitudinal analysis to chronicle the lives of survivors. The acquisition and dissemination of such information is crucial because policymakers and donors sometimes require hard data before committing time, political will, and resources to the cause.

Unpacking the Problem of Contemporary Slavery

As Kevin Bales of the Wilberforce Institute for the Study of Slavery and Emancipation explains, "Slavery is the possession and control of a person in such a way as to significantly deprive that person of his or her individual liberty, with the intent of exploiting that person through their use, management, profit, transfer or disposal. Usually this exercise will be achieved through means such as violence or threats of violence, deception and/ or coercion."¹

Thus, at its core, slavery is a dynamic between two individuals, the enslaved and the slaveholder, in which the slaveholder has a monopoly of control and violence upon the enslaved. The slaveholder can coerce the enslaved to perform a number of abominable acts. This can include: sexual servitude on the streets of New York City;² adult labor in the coltan mines of the Congo;³ child slavery in the shrimp farms of Bangladesh; or forced domestic servitude in the suburbs of Los Angeles.⁴ Compounding the matter is that enslaved persons can spend years-sometimes decades-under such conditions.⁵ This can sometimes lead to slavery lasting across several generations. Short of homicide, slavery is one of the most inhumane crimes one person can commit against another.

In recent years, a number of governments and international governmental organizations have addressed modern day slavery at home and abroad. In the United States, Congress passed the Victims of Trafficking and Violence Protection Act (TVPA) in 2000. The TVPA established the President's Interagency Task Force to Monitor and Combat Trafficking-a cabinet-level group whose mission is to coordinate efforts to combat trafficking in persons-led by the U.S. State Department. Since then, the State Department has produced its annual Trafficking in Persons (TIP) Report, which has become "the U.S. Government's principal diplomatic tool to engage foreign governments on human trafficking."⁶ Although not without controversy, the TIP Report has educated many on the sources and impact of modern day slavery.⁷

On the global stage, between 2000 and 2001 the United Nations General Assembly adopted three protocols to its Convention against Transnational Organized Crime: (1) the Protocol to Prevent, Suppress and Punish Trafficking in Persons, especially Women and Children; (2) the Protocol against the Smuggling of Migrants by Land, Sea, and Air; and (3) the Protocol against the Illicit Manufacturing and Trafficking in Firearms. With 117 signatory countries, these protocols, known as the Palermo Protocols, advanced the global discussion not only on what constitutes contemporary slavery, but also on what the international community can do to mitigate its spread.

Although some may argue that international agreements like the Palermo Protocols and documents like the TIP Report matter only marginally,⁸ others counter they catalyze change.⁹ Building upon a crest of public awareness on human trafficking, U.S. President Barack Obama proclaimed in 2012 at the Clinton Global Initiative, "We are turning the tables on the traffickers. Just as they are now using technology and the Internet to exploit their victims, we are going to harness technology to stop them."¹⁰

Although he did not mention it explicitly, President Obama was referring to the idea of using big data to mitigate contemporary slavery. As Pulitzer-prize winning journalist Steve Lohr explains, big data is "shorthand for advancing trends in technology that open the door to a new approach to understanding the world and making decisions."¹¹ This typically involves using software to find trends and patterns in large amounts of aggregated data from the Internet, sometimes from publicly available data, and other times from clandestinely obtained data.

Along the lines of utilizing publicly available data, the tech-giant Google announced in April 2013 a big data partnership with the Polaris Project, an antislavery NGO in Washington, D.C. The partnership, called the Global Human Trafficking Hotline Network, aims to use data mining software to identify human trafficking trends from the hotline

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that can eventually inform "eradication, prevention, and victim protection strategies."¹²

Although using big data to fight trafficking is new, the idea has been demonstrated by scholars like Mark Latonero of the Annenberg Center on Communication Leadership & Policy at the University of Southern California. Latonero's team partnered with local law enforcement agencies in Los Angeles, explored trends in human trafficking on websites like Backpage.com, and applied this information to target specific traffickers. This was done by mining data from advertisements for the sexual services of domestic minors on the adult section of Backpage in the Greater Los Angeles area, and identifying the phone numbers from those ads that appeared in the greatest frequencies. With this information, Latonero's team was able to provide law enforcement with data linking certain phone numbers to criminal networks.

The U.S. government is also using big data to mine private information networks, not on the World Wide Web, but on what is called the Deep Web— that part of the Internet that is not searchable on databases like Google. The Defense Advanced Research Projects Agency (DARPA), a branch of the U.S. military, recently launched a program called Memex to hunt criminal networks on the Deep Web. The first domain DARPA intends to undercover with this new technology is human trafficking.¹³

These developments in big data dovetail with a broader discussion within academia about how social science researchers can apply quantitative methods to estimate trends in contemporary slavery. Although rigorous, many studies of modern day slavery only exist in the policy and academic communities, and very few published works actually employ quantitative methods. In a comprehensive review of the research-based literature on contemporary slavery, Elżbieta M. Goździał and Micah N. Bump of Georgetown University found that, of 218 research-based journal articles, only seven (about 3 percent) were based on quantitative methods. Without hard data, it can be challenging for scholars to make generalizable inferences to inform policy.

In this paper, using big data as a backdrop, I discuss some novel quantitative methods employed by two NGOs I have worked with that shed light on contemporary slavery. The first NGO, the Walk Free Foundation, estimates that there are about 30 million enslaved in the world today. The second NGO, Free the Slaves, working with its local Indian partner, MSEMVS, assesses the lives of survivors and how they are reintegrating into society. The acquisition and dissemination of such information is crucial because policymakers and donors sometimes require hard data before committing time, political will, and resources to the cause.

The Walk Free Foundation

Australian philanthropists Andrew and Nicola Forrest established the Walk Free Foundation (Walk Free)¹⁴ three years ago to eradicate contemporary slavery. After meeting with Microsoft co-founder Bill Gates, Andrew Forrest was inspired to explore the underpinnings of contemporary slavery using quantitative methods. As Forrest recounts, "Global modern slavery is hard to measure, and Bill's a measure kind of guy," adding, "in management speak, if you can't measure it, it doesn't exist."¹⁵ For Forrest, it was important to inform people in the business and policy worlds of the extent to which slavery exists, country-by-country, to prompt action. Although some quantitative assessments of contemporary slavery existed, very little was publicly available. Forrest sought to collect more precise data to disseminate freely and thus launched a Global Slavery Index (GSI), on which I have been working since 2012.¹⁶

The 2013 GSI ranks 162 of the world's nations in terms of their level of contemporary slavery. Methodologically, these rankings are based on several factors; the most novel is an estimation of the proportion of the population enslaved in each country. For this measure, the GSI team (led by Kevin Bales and Fiona David) has drawn upon secondary source data analysis that Bales pioneered for his book, *Disposable People*, and later disseminated in *Scientific American*.¹⁷ These secondary sources consisted of a review of the public record, including materials from published reports from governments, the investigations of NGOs and international organizations, and journalistic reports. The GSI team has also drawn upon data from representative random sample surveys to extrapolate the prevalence of slavery for selected comparable countries. Figure 1 illustrates the 2013 GSI data for the proportion of the population estimated to be enslaved.

In Figure 1 the countries with darker shades indicate a corresponding higher proportion of enslavement. Some of the countries with the highest proportions are Haiti (about 2.1 percent of the population enslaved), Mauritania (about 4.0 percent of the population enslaved), Pakistan (about 1.2 percent of the population enslaved), and India (about 1.1 percent of the population enslaved).

Table 1 lists the 2013 GSI data in terms of the total estimated number of the enslaved, country-by-country. This is a novel contribution compared to other estimates of contemporary slavery. Such information can be useful to business people, policymakers, and students who want a more informed understanding of where slavery occurs and with what frequency.

Overall, the 2013 GSI estimates about 29.8 million are enslaved among the 162 countries under study. The country with the least number of estimated enslaved in 2013 was Iceland (twenty-two enslaved), and the country with the greatest number was India (13.9 million enslaved). The standard deviation (or spread) was extremely large: about 1.2 million enslaved.

One important question is if the GSI has made a difference in the real world. One way to shed light on this is to explore some of the statistics achieved since the GSI's launch in October 2013. To date, the GSI has received over half a million website visits. There have been over thirteen thousand downloads of the full report, available in English, Arabic, French, and Spanish. Moreover, there have been over fifteen hundred media reports about the GSI in over thirty-five countries, including *The Economist*,¹⁸ *Die Standaard*,¹⁹ *La Vanguardia*,²⁰ *CNN*,²¹ *National Public Radio*,²² and *Time*.²³

Some of the media reports about the GSI illustrate how it can generate discussion on an underreported issue. In India, for instance, where the GSI estimates the greatest number of the enslaved to be, media response has been strong. The *Times of India* reported, "Sixty-six years after independence, India has the dubious distinction of being home to half the number of modern-day slaves in the world."²⁴ Perhaps due to such sentiments, the *Hindustan Times* discussed the causes of slavery in India and observed, "Some of the reasons for high numbers caught in slavery in India are the difficulty in accessing protections and government entitlements, such as the food rations card, corruption or non-performance of safety nets (such as the National Employment Guarantee, primary health care and pensions) and practices of land grabbing and asset domination by high-caste groups."²⁵

There is also some evidence that the GSI has begun to influence government policy. In January of this year, building upon the momentum of the GSI, Andrew Forrest signed a memorandum of understanding (MOU) with the Pakistani State of Punjab. In the business world, that a government would sign a deal with a businessman to help eradicate slavery in its own borders is atypical. Yet Forrest was able to leverage his influence in Pakistan to encourage a conversation that aims to provide the state of Punjab with inexpensive coal in exchange for assurances that the government will work toward the liberation of its own people. ²⁶ Although it is too early to see how Pakistan will hold up to its promise, this agreement may herald future MOUs between NGOs like Walk Free and governments that want to mitigate slavery, and one day even eradicate it.

The GSI may also be influencing heads of state. Former U.S. President Jimmy Carter references the GSI several times in his new bestselling book, *A Call to Action: Women, Religion, Violence, and Power*. And the GSI has been publicly endorsed by, among others, Hillary Clinton, Gordon Brown, Julia Gillard, and Tony Blair.²⁷

Free the Slaves

The GSI strives to use big data to count the number of slaves in the world. Other NGOs have begun to employ longitudinal techniques to chronicle the lives of survivors of slavery once they are free. One such NGO is Free the Slaves (FTS), which Kevin Bales, Peggy Callahan, and Jolene Smith co-founded in 2000 as the sister-organization of Anti-Slavery International (the oldest international human rights organization in the world).²⁸

Early in its evolution, FTS reasoned that the liberation of any slave would be beneficial not only for that individual, but also for the community, and thus produce a "freedom dividend," multiplied by each additional person freed. As FTS explains, "Local communities thrive when formerly enslaved people start their own businesses; communities begin to flourish as people come together to organize and watch out for one another; children go to school and the benefits extend for generations."²⁹

For the past decade, FTS has partnered with different grassroots organizations in Haiti, India, Nepal, Ghana, the Democratic Republic of Congo, and Brazil to empower local communities of the enslaved to seek liberation. In India, FTS has worked with a local grassroots organization called Mina Sansadham Evam Mahila Vikas Sansthan (MSEVMS).³⁰ Through the efforts of MSEVMS, over 150 villages have eradicated slavery and trafficking in recent years and many more are beginning to experience liberation in the North Indian States of Uttar Pradesh and Bihar, two of India's poorest states, as Figure 2 highlights.

In addition to empowering people in rural Uttar Pradesh to seek liberation, MSEVMS has been among the first NGOs to begin several longitudinal studies on the effects, in addition to quantitative studies of the predictive factors of enslavement. The studies are intended to provide insight into: (1) whether slavery and trafficking have been eradicated; and (2) whether the socio-economic conditions of people living in these communities have improved. I consulted with Free the Slaves at this time, and, along with Ginny Baumann, Jody Sarich, Austin Choi-Fitzpatrick, and Jessica Leslie, helped put together a follow-up report for the village of Kukrouthi in Uttar Pradesh.

The follow-up report was conducted among the residents of three hamlets in Kukrouthi village.³¹ There were two sources of information: The first was a set of 120 household level surveys, and the second was a set of focus group discussions. A total of 929 people were accounted for by the surveys. The time periods under comparison were 2009 (when the liberation process began) and 2011 (when the process of self-liberation by local residents was completed).

Some of the key findings between the 2009 and 2011 studies are as follows, providing credence to FTS's supposition of there being a "freedom dividend" after liberation.

Growth in Childhood Education

One important indicator of a freedom dividend in Kukrouthi village is the number of children in school. The underlying premise is that in free communities children receive better education, which fuels a society's human capital. In Kukrouthi, the team from MSEVMS found evidence of significant growth in childhood education rates. Whereas in 2009 only 69 percent of the school-aged children were reported to be in school, by 2011, 91 percent were enrolled, as Figure 3 illustrates.

Better Nutrition

Another key indicator illuminating the freedom dividend is access to adequate nutrition. As with childhood education, the team from MSEVMS reported a dramatic increase in the number of families that were able to eat three meals a day, from 31 percent in 2009 to 71 percent in 2011. This was more than a 200 percent increase, as Table 2 details.

Improved Access to Health Care

Yet another strong indicator of a freedom dividend is access to health care, even if of rudimentary quality. In 2011, MSEVMS reported that almost the entire population of Kukrouthi village had access to healthcare. This was another dramatic increase compared to 2009, when MSEVMS found that just 52 percent of families received health care treatment. Table 3 provides a breakdown of this comparison.

Improvement in Childhood Vaccinations

Lastly, in 2009, just one-third of children had the proper number of recommended vaccinations (i.e., three vaccinations). By 2011, this had increased to 90 percent, as Table 4 shows.

A World Without Slavery

Applying quantitative methods to the study of contemporary slavery could contribute significantly to shedding more light on the phenomenon. In collaboration with my colleagues at the Walk Free Foundation, I have used quantitative methods to estimate the total number of enslaved in the world today. This, in turn, has generated discussion among the media and policy community on how to mitigate modern day slavery, with an eye toward its eradication. With Free the Slaves and MSEVMS, we have begun to chronicle systematically how communities can benefit from freedom. This information provides preliminary evidence to policy makers that liberating slaves provides a wide range of socioeconomic benefits.

The modern day anti-slavery movement is young. Moving forward, we need more scholars and policy makers who want to explore what quantitative methods and big data can do for the movement. We are at a point in the world where everyone agrees that contemporary slavery is a wrong that must be addressed. The time is ripe for further discussion on how to make this a reality. I hope we can get there, at least in part, through employing quantitative methods and exploring big data.

Sidebar

... at its core, slavery is a dynamic between two individuals, the enslaved and the slaveholder, in which the slaveholder has a monopoly of control and violence upon the enslaved.

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Footnote

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Details

Subject

Education;
Health care access;
Studies;
Violence;
Presidents;
Internet;
Immunization;
Human trafficking;
International agreements;
Methods

Location

United States--US

Title	Using Big Data and Quantitative Methods to Estimate and Fight Modern Day Slavery
Author	Datta, Monti Narayan
Publication title	The SAIS Review of International Affairs; Baltimore
Volume	34
Issue	1
Pages	21-33
Number of pages	13
Publication year	2014
Publication date	Winter 2014
Publisher	Johns Hopkins University Press
Place of publication	Baltimore
Country of publication	United States, Baltimore
Publication subject	College And Alumni, Political Science--International Relations, Business And Economics--International Commerce
ISSN	19454716
Source type	Scholarly Journals
Language of publication	English
Document type	Feature
Document feature	References; Tables; Maps
ProQuest document ID	1552151665
Document URL	http://library.capella.edu/login?url=https%3A%2F%2Fsearch.proquest.com%2Fdocview%2F1552151665%3Faccountid%3D27965
Copyright	Copyright Johns Hopkins University Press Winter 2014
Last updated	2014-12-16
Database	ProQuest Central

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Descriptive statistics in research and teaching: are we losing the middle ground?

Şerban Procheş¹

DISCUSSION #2

Published online: 14 August 2015
© Springer Science+Business Media Dordrecht 2015

Abstract There is a poignant divide in contemporary research between qualitative and quantitative approaches, with relatively few disciplines employing the two concurrently and harmoniously. Qualitative methods are to be found almost exclusively in social sciences, and only a few disciplines in this field integrate them with quantitative approaches. The quantitative approach is especially developed in natural sciences, with exceptionally sophisticated methodology developed around hypothesis testing and inferential statistics. The obvious middle ground is represented by the historical approach, combining verbal description with descriptive statistics. The latter offers amazing options towards data visualisation, yet carries relatively little weight in terms of academic success. This paper presents an account of how descriptive statistics has fared historically, with an emphasis on disciplines in the natural sciences and geography—where the author can contribute a personal account. I argue that a more even spread of the three broad types of methodologies would benefit research across fields. Such a spread, if reflected in the school system, would be particularly helpful in facilitating the transition from secondary to tertiary education, and from there to entering research.

Keywords Data visualisation · Descriptive statistics · Geography · Inferential statistics · Life sciences

1 Introduction

The main distinction between ancient knowledge and mainstream present-day research resides in numbers. And one can easily get lost in numbers. This observation, or a related subliminal feeling is what started the rebellion we call qualitative research (for some details on how this happened, see Bulmer 1984). The success of qualitative research is

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presently limited to social sciences, and this methodology carries most weight in the field probably incorrectly termed ‘human geography’ (see Johnston 1984 for the scope of this discipline, and Rafols et al. 2010 for a citations-based assessment of its relationships). Nevertheless, true geography is a natural meeting point for the quantitative and qualitative, due to its use of numerical approaches towards describing unique features.

In saying “describing” I have introduced an important point: geography, ever since the days of exploration, produces maps. And maps are nothing else than two-dimensional plots, which essentially present novel, previously unexpected patterns. That is, something that is usually not testing the validity of prior expectations (bar the case of Columbus searching a new way to the Indies, whether we call that a prediction or hypothesis; Niaz 2004). Consequently, it does not qualify as hypothesis testing. It simply describes, and in doing so it uses numbers, but in a purely descriptive way.

The use of descriptive statistics is by no means restricted to geography. In several other fields, it is often associated to the broader ‘historical’ approach, whether that be a reference to centuries-history, natural history, or others. (One needs to keep in mind that many disciplines, including social sciences, largely restrict the meaning of the word ‘historical’ to cases where timelines are invoked.) The historical approach tends to lack the *sine-qua-non* condition of repeatability required by hypothesis testing and its servant-turned-master, inferential statistics, and best met through experimentation rather than observation (van der Leeuw and Redman 2002). Nevertheless, the historical method cannot ignore numbers; in fact some of its more modern expressions are the pinnacle of data visualisation.

The glory days of the historical method represented an intermediate stage in the development of science—the stage when maps stopped being mere hand-drawings and started incorporating coordinates, and when Linneus and his followers split the plant and animal kingdoms into classes, orders, families and genera. As mentioned, the initial perception-based stage of our worldview has currently recovered and is living a new life in the form of qualitative research. But, unfortunately, this intermediate stage which, I argue here, should also be operating as a middle ground between the other two major approaches to research (qualitative and inferential), has never quite recovered its status, and mostly serves as an accessory to hypothesis testing.

Without going too deeply into the philosophy of science, and focusing mostly on method use, this paper proposes to (1) be an account of the present-day place of descriptive statistics across several disciplines with an emphasis on biology and geography, (2) discuss other situations where descriptive statistics are surfacing, (3) comment on the educational implications of this situation, and finally (4) make suggestions towards a systematic approach to the intuitive accumulation of knowledge, stressing the importance of descriptive statistics. The first two objectives will be addressed jointly, discipline by discipline. As some disciplines have over time expanded into entirely new fields of study, and new disciplines arose within them, there will be no attempt to do so hierarchically; fields and disciplines will simply be listed in a linear sequence. The concluding sections will address the remaining two objectives.

2 Biology: an overview

The field of life sciences has seen a couple of revolutions over the last few centuries. From the phase of taxonomy, anatomy, and physiology (when, along a different dimension, the botanical and zoological components were still sharply separated) it has moved to an all-

encompassing evolutionary perspective, and thence to the current new divide between organism-level and cell/molecular level biology. To understand the use of methodologies and their development, the disciplines within biology need to be analysed one by one.

3 Taxonomy

As illustrated in a marvellous book by Berlin (1992), taxonomy is in no way the exclusive domain of modern science. Traditional societies, in particular hunter-gatherer ones, have had for a very long time a spectacular understanding of species diversity, achieved in a way that is almost entirely descriptive. Starting with Linneus in the eighteenth century, taxonomy took centre stage among natural sciences. Since, the methods have shifted from simple text descriptions occasionally accompanied by full body illustrations to text descriptions increasingly placing an emphasis on numbers (both sizes and number of segments/units/appendages—summarised as the metric and meristic approaches), and illustrations more and more focussing of those organs specifically relevant to identification. Descriptions along the lines of “I hypothesise that this is a different species, and test this hypothesis by providing numbers for it and its closest relatives and testing for significant differences” exist, though they are by no means the norm. The understanding is that differences are sufficiently clear not to require such tests, which essentially equates to the gestalt approach of ethno-taxonomy. Even the very process of typification for new species, besides its importance in providing reference material, likely finds its roots in a gestalt approach—one fundamentally refuting the need for any inferential statistics. Another important point to add here is the matter of the different species concepts being used concurrently for different (and sometimes even for the same) groups of organisms. The biological species concept proposes that organisms belong to the same species if they can produce fertile offspring, which is at least in theory testable, while other concepts propose different approaches, of debatable testability. The lack of uniformity in this respect has repercussions on species numbers as a variable to be mapped in ecology and biogeography.

The current state of taxonomy is both encouraging and distressing. The good news is that the number of new species being described on an annual basis is increasing, to the point where the dreaded question “can we actually describe most species before they go extinct” is leaning towards a positive answer (Costello et al. 2013). The bad news starts to filter through when zooming in on those who make it happen. A substantial proportion of the people who still describe species are amateurs, high-calibre amateurs, but nevertheless people who have to earn an existence as lawyers, business folk, or medical doctors. Without implying that researchers in different fields are likely to become billionaires, it is worth mentioning that research funding depends on the impact of one’s previous research, and impact is not the strongest point with taxonomy. It is indeed difficult to gather tens or hundreds of citations on articles that only three or four other people in the world (those working on the same group of organisms as yourself) will ever read. But at the same time, the reasons why citations have risen to power elsewhere need to be analysed. The more acceptable (if merely self-justifying) one is that citations are in order, when building a big pile of knowledge, for those who tested similar hypotheses. The less acceptable one is that, in fact, once at the helm, hypothetico-deductive thinking felt strong enough to marginalise everyone else, kicking taxonomy and the like when they were already down.

These days, few taxonomists are entirely happy people. The younger generation have turned to phylogenetics (see below) quite flexibly. But older generations have over the space of the last twenty or so years been removed from the glory seat of those who discover and thus

help preserve biodiversity. One of the adaptations asked of them in order to survive academically involves switching to studies that test, or at least pretend to test, hypotheses.

4 Phylogenetics

The most common way for taxonomists to redeem themselves and purge the sin or descriptiveness, is phylogenetics. The phylogenetic method proposes to replace the traditional and fairly rigid classification approach with a fluid ordination-based one, whereby the relationships between organisms are thoroughly tested, and eventually presented in the form of a tree of life, as proposed by Darwin himself (see Tassy 2011). It has to be noted, however, that Popper (1965), the main proponent of hypothesis testing, described the Darwinian worldview underpinning phylogenetics as a “metaphysical research programme”, not suited for rigorous testing.

In any phylogenetic piece of research, there is in fact ample room for being descriptive and, in description, intuitive. Characteristic traits can be listed for branches at any level in a phylogenetic tree, in a similar way to those defining genera, families, orders and so on. This fact allows for the current co-habitation of taxonomy and phylogenetics, a co-habitation that has however often looked like a battlefield. The widely accepted truce at this point is that higher taxa can still be retained. There may, however, be such taxa that do not fit neatly in a phylogenetic tree. Polyphyletic taxa—those made up of organisms that look similar but are not really related, were a lost cause from the beginning. More recent victims have been the paraphyletic taxa, those who are related not in a sibling relationship, but are actually one embedded in the other. Desperate calls (e.g. Brummitt 2003) that these actually make sense in a descriptive way by being defined on common characters have fallen on mostly deaf ears.

Despite the pledge of testability solemnly taken by most phylogeneticists (and see educational interpretations of this in Catley et al. 2013), there are strong suggestions that phylogenetics is essentially just another discipline focused on the beauty of description. This is best illustrated by the exquisitely decorated phylogenetic trees forming the backbone of many recent publications (e.g. Ricardo-Betancur et al. 2013). One of the most important journals in the field, *Molecular Phylogenetics and Evolution*, has gone as far as to present pictorial abstracts—ultimate evidence that a picture is better than two hundred and fifty words, especially when that picture is a phylogenetic tree with full-body images of animals aligned on its side. It should be mentioned here that, in fact, the phylogenetic approach is in most cases just a simplification of the relationships between organisms. Indeed, presenting living or fossil species as branches on a tree does not leave room for cases of hybridisation or horizontal transfer of genes, apparently more common and important than previously thought (Bergthorsson et al. 2004). And simplification is to a great extent about simplicity of description, and ultimately, beauty.

5 Species lists

A special place in any survey of descriptive endeavours should probably be reserved to (usually annotated) species lists. Widely known as faunas for animals and floras for plants, they started off as very similar to each other, but currently their fate does not look quite the same. Floras, at least as far as higher plants are concerned, are feasible tasks for most countries or conservation areas, and one can easily argue that they are critical to describing as well as understanding vegetation patterns, in turn critical towards multiple practical

endeavours. In the case of animals, vertebrates are often well covered in regional field guides, especially in the case of birds. Field guides complete with illustrations, maps, and brief descriptions including details of behaviour, are approaching the status of works of art, and in them has been concentrated the contemporary soul of natural history. But their public success is seldom associated with scientific laurels. Faunal studies looking at invertebrates, as were rigorously put together in the second half of the twentieth century, are sadly regarded as a low form of scientific expression.

Species lists, whether of plants or animals, are also commonly relegated to reports rather than journal articles. To attempt publishing such lists, otherwise most valuable for conservation purposes, in any form other than supplementary online material, one would commonly have to redefine them by pretending to be testing hypotheses. Such hypotheses most likely have to be of a phylogenetic nature, as phylogenetics provides a testing framework for all things taxonomic.

6 Vegetation science

In the same way as animal and plant species, plant assemblages at the landscape level can be classified, and this classification has taken a convoluted trajectory somewhere between the ecstasy of discovery and an attempt to objectivity. This story has been narrated in detail and with some humour by Colinvaux (1978). The discipline still stands firm, with at least one fairly highly cited journal (*Journal of Vegetation Science*), although this is increasingly testing hypotheses and adopting phylogenetics as a means of explaining community assembly.

7 Ecology

Having started off from humble beginnings, ecology is one of the most powerful scientific disciplines of the day. Only molecular sciences of a medical inclination can claim to be better cited. And this power stems to a great extent from its hypothetico-deductive approach. Ecological statistics, although capable of magnificent descriptive graphs, first and foremost prides itself with its multi-layered approach to hypothesis testing. Increasingly this relies on modelling techniques of the “how do our observed data compare with ten thousand never observed but perfectly imaginable realities” kind (Gotelli and Graves 1996). Much of the discipline’s sophistication runs along the lines of: “what are the relevant imaginable realities to compare one’s data with”. Incredible amounts of ecological literature have hashed and rehashed methodologies to the point where the discipline now spreads like a vast dome built on concepts, few of which are intuitive. Some of these are in existence simply because of *p* values below the magic 0.05, and often claim far-reaching applications, but they have very little to say to the non-specialist picking a flower and asking a question.

8 Biogeography

This discipline started off with the description of geographic units based on the distribution of plants, animals, and vegetation types (floral kingdoms, zoogeographic regions, and biomes). Arguably such maps are some of the most fascinating descriptive exercises ever to have been

undertaken. The current focus of the discipline is to a greater extent leaning towards the reasons for such distribution patterns, not only in species assemblages but also in single species. That this is relevant to conservation is beyond doubt. There is however a great curiosity component involved, as highlighted in the fact that biogeographers need to be reminded now and then of their relevance to conservation (e.g. Richardson and Whittaker 2010). Insofar as current biogeographical research is searching for the reasons behind present or past species distributions, the field is hopelessly lost to hypothesis testing. But the desire to return to biogeography's descriptive roots is certainly still there, as shown by the recently reignited interest in regionalisation (Procheş and Ramdhani 2012; Holt et al. 2013).

9 Geography

Much to the dismay of contemporary geographers (both human and physical), I will have to start here by referring to geography in its traditional sense, which has largely become limited to school-level teaching—that is, to features on maps. Geography intrinsically lacks the repeatability attached to the core scientific disciplines (biology, chemistry, physics), as each broad-scale physical feature on earth's surface is unique. One can find patterns that are repeated in the ways in which humans, plants, animals, and physical processes interact with these features. However, that would not be testing much about the earth—more about humans, plants, and so on. So any data sets pertaining to such studies—sets of spatially explicit data—end up more often published in journals focusing on those specific fields. Note that, in the process, these new data are degraded from discoveries to data sets. In this context, it is encouraging to see the appearance of a *Journal of Maps*, one that brings the focus back to traditional geography. With regards to physical geography in its modern incarnation, this is a field where technology takes centre stage, with Remote Sensing (RS) and Geographic Information Systems (GIS) being all about data acquisition and processing, and leaving the data sets themselves to the fields they pertain to. This is entirely disconnected from human geography, which is shown by its overall citation connectivity to be simply a discipline of social sciences (Rafols et al. 2010), and one arguably more obstinate than others in the use of qualitative methods in their purest form. More exciting though, there have been wakeup calls as to the opportunities to map individuals' movement and life experiences while making use of technology (e.g. Quercia et al. 2010).

10 Social sciences

A first look for descriptive statistics in the social sciences is likely to be disconcerting to those who spend their lives perfecting such methods. If we were to pick a few random articles from the tens of thousands published on an annual basis, we would mostly find such things as pie charts, ignoring the ample evidence available that these are likely to be misinterpreted by the human eye (Cleveland 1993). Social sciences have clearly become the victims of their own success, which accounts for their low citation rate. But to stop here would be a great injustice.

Social sciences are in fact the only field where qualitative, descriptive and inferential methods are all used, and often in thoughtful and complementary ways (Sale and Lohfeld 2002). A remarkable recent example is represented by the World Values Research initiative, which, besides hypothesis testing (of debatable objectivity), has resulted in some of

the most spectacular global maps of human consciousness—what might as well be the real meaning of the phrase “human geography” (Ingelhart and Welzel 2005, 2014; Ingelhart et al. 2008). It’s also from social sciences or the broader humanities sphere that numbers are drawn to innovate data visualisation techniques—one notable example in this direction being the work of McCandless (2009, 2014).

11 School education

We have all been taught back in school using a descriptive approach—it may have only contained a very few data plots, but quite likely it included extreme values (the earliest records of this and that, the highest mountains and deepest seas, longest rivers and longest reign of a king). Quite likely, we were not exposed to inferential statistics until we went to university, although there is an increasing trend globally to introduce this approach at high school level. It is worth mentioning here though, that the descriptive approach taken at school level creates a way of thinking likely to be kept, at least to some extent, throughout one’s life (see Madden 2011). The greater emphasis given to inferential thinking at school level in certain countries is both derived from, and influential in, key traits seen in their respective contemporary cultures, and potentially linked to their competitiveness and performance on an international scene (Kwon et al. 2013).

12 University education

In a university setting, critical to this discussion is the concept of multiple scholarship, as outlined by Boyer (1990)—scholarship of discovery, integration, application and teaching. While developed in a discovery and teaching context, the descriptive approach is particularly powerful towards integration, where contemporary mapping tools can make the blending of data and ideas into an object of beauty. The relevance of integration is evident, for example, in the continued use of textbooks, despite a widespread feeling that, in any dynamic field, textbooks can become obsolete before they get a chance to be used. While generally using figures reproduced with permission from original articles, textbooks also often produce new figures, usually descriptive ones, and manage to collect a fair number of citations on this account. These citations would often be hard to come by if one attempted to publish such figures in the primary literature (but see, for example, the success of the journals specialising in review articles).

It is certainly unfortunate that academics are not encouraged to focus on integration, given that integration is critical in being able to convey a bigger picture to the students. A better connection between teaching and research could be beneficial to both these activities, and alleviate some of the research-teaching conflicts that arise in academic settings (see Elsen et al. 2009; Pan et al. 2014).

13 Conclusion

Based on this review I contend that, as new disciplines in natural sciences developed, they took an increasingly inferential approach, to the point where descriptive statistics has been pushed in a corner.

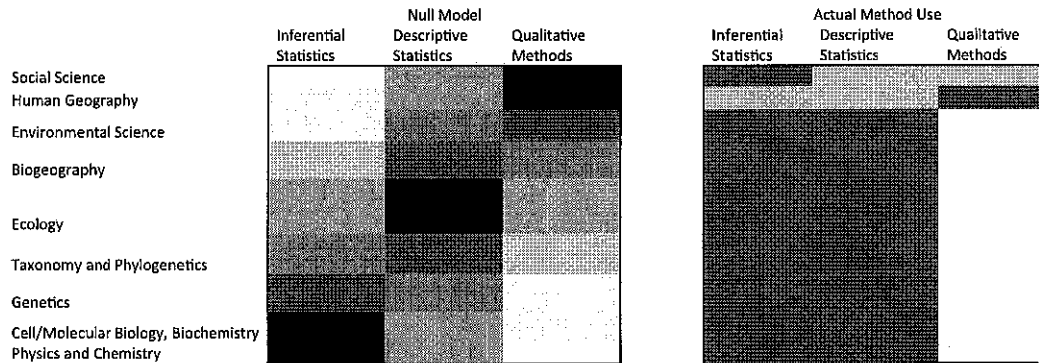


Fig. 1 A null model for the distributions of method intuitiveness in answering questions from various research disciplines (arranged in a *linear sequence*), presented together with the author's experience of the degree to which these methods are actually employed. *Darker shades* indicated more intuitive/more used methods

Figure 1 proposes a null model whereby the most intuitive answers to questions from different fields of research are answered with different methods, in a way that follows a simple gradation along a linear arrangement of disciplines. Of course, it can be argued that these should not be arranged in a linear sequence, as the relationships between them are far more complex—and this has already been beautifully illustrated in a two-dimensional space (in itself a simplification, but the easiest way to visualise things on paper or a computer screen) by Rafols et al. (2010). One should however keep in mind that the relationships between disciplines are in a sense self-fulfilling prophecy, as perceived links foster further connections, and trans-disciplinary collaboration grows accordingly (see studies on specialization and collaboration, e.g. Belmaker et al. 2010; Bhupatiraju et al. 2012). Getting back to Fig. 1, the actual use of methods, at least in this author's experience, is sufficiently skewed as to erase most of the pattern expected from the proposed null model. The use of qualitative methods is largely restricted to social sciences and human geography, while the descriptive approach is widely used across the scientific fields, but nearly always as a supporting method in studies that (claim to) primarily test hypotheses. Although purely descriptive approaches continue to exist (as is the case in taxonomy), these are at least cancelled out by hypothesis-testing papers using no descriptive statistics at all. While various disciplines differ in this respect, this is usually at levels finer than the broad research fields illustrated here, with research paradigms using different methodologies coexisting in most fields. This pattern will need to be confirmed using actual meta-analyses of methodologies across disciplines.

Interestingly enough, dominant paradigms within narrower disciplines often have little to do with the place of the discipline within the greater scene of human knowledge. In this sense, the discipline-by-discipline treatment followed above was probably inevitable. This discipline-specific mixing of methods is of relevance in a philosophy-of-science context. It is probably more than just Darwinism that fits Popper's description as more of a 'research programme' than a falsifiable hypothesis—the description may be applicable to most research schools, insofar as they develop their own specific culture.

The tension between realism and falsificationism decried by Early (1999) appears to remain in the realm of philosophy, with few researchers questioning the basic paradigm of their discipline, and either supplementing hypothetico-deductive studies with descriptive statistics as felt necessary, or providing a hypothesis for otherwise descriptive studies as required. If there is a single rule across disciplines though, it is the broad acceptance of hypothetico-deductive approaches as having the upper ground, except where qualitative methods are employed.

But are more descriptive studies really needed? It can be argued that, at least in social sciences, raw data are often presented in government or non-governmental publications, and there is no need to present these in peer-reviewed publications. However, such data may be unequally represented across countries, income inequality being accompanied by a data inequality factor. This effect may not be restricted to social sciences, but notable in natural science too. Nevertheless, globally-relevant data, which are often easily available to all, remain poorly presented visually across many fields. Recent work such of McCandless' books (2009, 2014) will hopefully stimulate interest in this direction, and soon we could have global data suitably illustrated on a broader scale.

The question is—if we are to even out the use of methodologies (cf. null model in Fig. 1), while utilising the same overall research capacity, where would one need to cut down, and at what levels? Without denying the importance of inferential thinking in decision making and even in brain development (Byrnes and Dunbar 2014), I propose a smoother transition into it for both individuals and disciplines. At an individual level, earlier exposure to inferential statistics would reduce the differences between high school and university students in this respect (García Alonso and García Cruz 2010), and make the step from one level to the other less painful (painful it certainly is for most South African students—and I suspect elsewhere in the world too). At the same time, I would advocate giving a higher status to descriptive studies, while retaining hypothesis testing for situations where multiple descriptive studies have led to key questions becoming clearly crystallised. I would also encourage formally linking the ways of questioning things between qualitative and quantitative research. This would create a more cohesive research landscape, and one likely to be found more attractive by new entrants. While the concept of common sense may be viewed as having little relevance to research, any research discipline ends up creating its own paradigm, its own idea of what is common sense. A cross-discipline culture that would accept and incorporate some informal inferential thinking (Madden 2011) would promote the use of simple inferential statistics, but at the same time remove inferential statistics from the pedestal that separates research from the man on the street, and qualitative from quantitative paradigms.

Acknowledgments The author is indebted to his wife, Cecile, for providing a social sciences perspective, and to the National Research Foundation of South Africa, who funds his research through the Incentive Funding for Rated Researchers programme.

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