

A WORLD SEABIRD ORGANIZATION AND SEABIRDS.NET: MEETING THE CHALLENGE OF THE NEW PARADIGM

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SUMMARY

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Profound changes are occurring in scientific communication, fueled chiefly by the Internet and World Wide Web. The new paradigm embraces open and comprehensive data sharing, but raises fundamental questions about intellectual property and career management prerogatives. A World Seabird Consortium (WSC), composed of member organizations, should be created to address the issues on behalf of seabird professionals. The WSC would manage the Internet domain Seabirds.net to use in conducting its organizational business and to serve as a one-stop gateway to seabird information on the Web. The Consortium would lead the development and implementation of global seabird databases, accomplishing that and other objectives mainly through the activity of chartered working groups. One group would be charged with codifying research roles, establishing data provenance and ownership, and engineering a reward system to encourage broad support of shared databases.

Key words: data archiving, data inventories, intellectual property, Internet, rewards and accreditation, seabird databases, Web domains

INTRODUCTION

In an earlier essay (Hatch 2010), I argued that a new paradigm is emerging in which scientists will share their original data, openly and comprehensively, across computer networks. This new mode of communication will complement and enhance the traditional practice (or old paradigm) of summarizing research findings in peer-reviewed journal articles, while limiting potential reuse of the underlying data. I described a suite of five databases which, if developed and implemented globally, would capture and disseminate a large share of the information on oceanic birds most relevant to conservation and environmental policy.

Because data sharing and recognition for scientific accomplishments are sensitive topics, I asked a sizeable number of colleagues to read the earlier essay on seabird databases and shifting paradigms and to offer—in condensed form—their thoughts on the subject. The 105 colleagues who responded to my questionnaire mentioned eight issues repeatedly (i.e., $\geq 5\%$ of respondents) as potential pitfalls or objections to the prospect of globally shared seabird databases (listed in Table 1; see also Appendix 5 in Hatch 2010 for a fuller account). The single most cited issue—“intellectual property rights” in shorthand—and items (7) and (8) on the list are three aspects of the same problem: how to protect and fairly reward the personal investment and creativity of individuals who generate scientific data. That problem is further addressed in this article.

Items (3), (4), and (5) on the list (Table 1) are matters resolved through careful design and implementation. With judicious use of supplemental data fields, contributor comments and attachments (in

effect, an integration of data and metadata), it is possible to capture all that is needed for a user to understand how particular data were collected and to assess their quality and suitability for a particular purpose. Data delivered in this manner differ from the traditional journal article mainly in that key information is conveyed in a telegraphic style, and in all cases users have direct access to the original data, rather than a processed version of the data wrapped in interpretation. Detailed schemas for three databases (World Seabird Colony Register, World Seabird Monitoring Database, World Seabird Trophic Studies Database) are posted at the *Marine Ornithology* website (Hatch 2010, Appendices 1 and 2). They are offered as templates that address the problems raised by issues 3–5 (Table 1).

Item (6) arose in response to my phrasing of a survey question, which posited that global seabird databases are fully achievable in 10 years. Having spent 18 years (and counting) working with others to realize a full-blown seabird monitoring database for the North Pacific, I am in no position to dispute the charge of over-optimism. I would note, however, that the pace of change in both the goals and methods of information technology is accelerating. That, and the fact that in some instances (e.g., seabird monitoring), many of the technical and developmental issues have been addressed, means that progress can occur rapidly on a global scale given a favorable professional climate.

That leaves item (2), the assertion that time and resources are simply lacking to do what must be done by professionals who are already over-committed. In the recent essay (Hatch 2010), I focused attention on three barriers to data sharing via seabird databases—intellectual

property rights, questions about scientific attribution, and technical issues vis-à-vis file sharing and computer security. In an earlier, similar treatment (Hatch *et al.* 1994), the list consisted of professional competition (equivalent to “attribution”), intellectual property rights and the practical constraints of time and money. I chose more recently to ignore the last point, on the following grounds. The time and effort entailed in getting one’s data into a shared database is prohibitive only if one views the activity as essentially *extracurricular*. When the activity comes to be viewed universally as an integral part of a scientist’s job, and when mechanisms are in place to *reward* the activity appropriately, then the perceived constraints of time and money will go away. We should concentrate on the root of the problem—developing our collective mandate and engineering a modern reward system to support it.

The underlying premise of this article is that the Internet changes everything. One vision of the future is that science will be conducted online in a hyper-collaborative way that mimics the Wikipedia model—a completely open and real-time sharing of questions, models, data and discoveries (Wagner 2009). Outcomes of the revolution are hard to predict, but major changes in how we work and communicate our results seem certain. Seabird professionals are not exempt from the challenge confronting scientists generally. We can be overtaken and disoriented by events, or we can play a decisive role in effecting changes that are not only inevitable, but also highly beneficial, by design. Thus, my objectives in this article are: (1) to expound the rationale, structure and priorities for two initiatives that seabird professionals can use to work collaboratively toward shared goals, and (2) to offer suggestions for redesigning our reward system in ways that encourage open data sharing.

MEETING THE CHALLENGE

Why a world seabird organization?

The community of professionals who specialize in seabird research and conservation is a distinct and cohesive group. The ties that bind us are *birds* and *oceans*. That is why, regionally, a multitude of professional societies dedicated to seabirds have arisen since 1966. It also explains the robust and auspicious response to the call for an inaugural World Seabird Conference (held in Victoria, Canada, 7–10 September 2010). Oceans cover about 70% of the earth, and those of us who observe marine avifauna understand implicitly that

our work has implications that go beyond the particular species and populations we study.

In the earlier essay (Hatch 2010), I argued that new systems for quantifying and attributing contributions will be needed if data are to circulate independently of conventional publications. I allowed that new conventions would have to be adopted by all of science to succeed, but is that caveat really necessary? Speaking for myself, I am well satisfied when others in my *peer group* know about and appreciate my work, and I consider my peer group the world community of seabird professionals. While it would be nice to get recognition from the larger scientific community as well, the likelihood of that happening depends on how well I perform in the opinion of my peers in seabird research. If my peers could somehow certify to the rest of the world that I am a capable and productive seabird biologist, that would be ample reward for my choice of career and the contributions I make. So the problem becomes one of empowering the world seabird community to make and convey such judgments, credibly and accurately.

To navigate our changing scientific landscape, seabird professionals need a global organization—authoritative, all-inclusive and neutral with respect to existing entities that operate on a less-than-global scale. Because seabird specialists form a moderately large yet cohesive group, we can mediate the new paradigm on our terms if we choose to do so. While other disciplines will surely need to tackle the same issues, their requirements and collective responses may differ from ours.

I suggest an appropriate name for such an entity would be the World Seabird Consortium (WSC). In business, the term “consortium” describes an amalgam of existing, often multinational corporate interests—not dissimilar to the situation we face as seabird professionals. Moreover, the organization should in some respects be modeled after the World Wide Web Consortium (W3C). That widely known and successful task force has guided the development and adoption of standards for the Web since 1994, using proven methods of teamwork and consensus building (Jacobs 2005). The label World Seabird Union (WSU) would serve as well, were it not for its similarity to the British Ornithologists’ Union (BOU) and the American Ornithologists’ Union (AOU)—organizations very different in mission and structure (involving individual rather than corporate memberships) from what is proposed.

TABLE 1
Collegial responses to an essay advocating globally shared seabird databases^a

Issue	No. (=%) of responses, n = 105
(1) Intellectual property—colleague predicts a general reluctance to share data for fear of losing credit	35
(2) Time and financial resources lacking to do what is required	21
(3) Lack of standardization and comparability among studies	14
(4) Data quality—potentially poor or unknown	12
(5) Misinterpretation of one’s own data by others	9
(6) Realization of global seabird databases will take > 10 years	9
(7) Some users (aka “parasites”) will benefit disproportionately	6
(8) Devaluation of data collectors in the new paradigm	5

^a From Hatch (2010) Appendix 5; n = 105 colleagues who read the essay and provided written comments.

As an alternative to “consortium,” the epithet “federation” (World Seabird Federation, or WSF) would also describe the organization accurately, while avoiding any confusion caused by association with BOU and AOU. In this article, I use the appellation “World Seabird Consortium,” but would emphasize that the rationale, structure and functions of a world seabird organization are unaffected by the name it is given.

In the course of a long government career, I have been asked on many occasions to justify public investment in seabird research. My usual answer is twofold (Hatch *et al.* 1994). First, wildlife managers and the public are concerned about the welfare of particular species and populations that may be affected by human use of coastal lands and marine resources. But equally important—and quite apart from any inherent value placed on this particular group of animals—is the role that seabirds can serve as indicators of change in the marine environment. Whereas the first point tends to have a regional focus, the latter is universal, especially as global climate change becomes an overarching issue.

Recognizing our need to address pressing issues of data sharing vis-à-vis the career management decisions of individual seabird specialists, and the value of developing and promoting collectively the use of seabirds as biological indicators, I recommend the World Seabird Consortium adopt a mission statement such as the following:

The World Seabird Consortium supports the global community of seabird specialists by setting and rewarding high standards of professionalism, serves the broader communities of science and the public by tendering seabirds as indicators of marine environmental change, and promotes high-quality science as a vital component of seabird conservation.

What is Seabirds.net?

Computers on the Internet are uniquely identified by a system of IP (Internet Protocol) addresses, consisting of hard-to-remember strings of numerals such as 159.263.224.40 (an arbitrary, nonfunctional example). If the IP address of the machine hosting the Pacific Seabird Monitoring Database (PSMD) were 132.118.161.37, you could type that address in your browser’s address bar to reach the PSMD. It is easier, however, to remember the name “seabirds.usgs.gov” and type that instead. The latter is called a domain name, and its sole purpose is to make a computer address intelligible to humans and easy to remember. As such, all domain names must themselves be unique (i.e., there is a one-to-one correspondence between every domain name and the IP address to which it refers). Domains are subdivided hierarchically, with the ranking of subdivisions proceeding from right to left (e.g., “seabirds” is a subdomain of “usgs,” which is a subdomain of the domain “gov”). At the uppermost level are a number of familiar categories, called top-level domains, under which all Web content is organized—e.g., “com,” “edu,” “gov” and “net” as well as the national identifiers “uk,” “ca,” etc.

Only one Internet participant at a time can own a given domain name. Names that are short, easy to remember and particularly meaningful (strategically descriptive, you might say) have commercial value, and are often referred to as “premium” domain names. They are bought and sold. If you want to place content on the Internet under a particular domain name, you must first check whether the name is already taken. If it is, you must come up with a different name, or convince the owner of your first choice to sell it to you. The control

point is the first subdivision under one of the top-level domains (e.g., “usgs.gov”). If you own that domain, then you are privileged to further subdivide your domain however you want.

Anticipating the need for an Internet domain to serve the world seabird community, the Pacific Seabird Group in late 2007 bought the domain name “Seabirds.net” from a previous owner (a speculator). The domain name was chosen as the simplest, most generic and most appropriate label for such an enterprise. The intent is to transfer ownership of Seabirds.net to a world body (i.e., the World Seabird Consortium). Seabirds.net can then serve as a platform for the WSC to use in conducting its business on the Internet. To access a preliminary version of Seabirds.net, type “Seabirds.net” in your browser (with or without the familiar “www” prefix).

It is worth stressing that neither the WSC nor Seabirds.net is intended to compete with, replace or duplicate anything that existing seabird organizations are already doing. Rather, the initiatives will allow seabird professionals worldwide to engage in joint ventures that are not feasible at present because of the lack of an all-inclusive organizational structure and coordinated presence on the Web.

A working model for the WSC

There are many structures and procedural systems a World Seabird Consortium could adopt to conduct its work efficiently. The following ideas are offered as one model that may prove satisfactory.

The WSC would be composed of member organizations. Organizations participating in the first World Seabird Conference would be appropriate to include initially. To facilitate decision-making and the implementation of policies, a WSC Directorate would be formed, consisting of a single delegate or a small number of delegates from each member organization. The Directorate would periodically elect executive officers from within its ranks. Responsibilities of the Directorate would consist mainly of deliberation and action on recommendations formulated in a number of chartered working groups. Each working group would have a clearly stated mission and a specific timetable for completing its work. Its volunteer membership would consist of persons with relevant expertise and interest, drawn from the general memberships of WSC member organizations. Persons unaffiliated with any existing seabird organization might also serve on working groups if special expertise is needed but is unavailable among the membership. WSC working groups would operate in part by iteratively posting their draft recommendations on Seabirds.net for review and comment by individuals and organizations affiliated with the Consortium.

The World Seabird Consortium should be incorporated as a non-profit, tax-exempt organization following the applicable laws of the country in which it is incorporated. Tax-exempt status would aid in fundraising. The WSC should establish a financial account, ready to receive funds raised toward WSC-sanctioned activities. The creation of a sizeable endowment is a worthy goal that could pay in part for routine operations and special projects. Funds would be disbursed by the WSC Directorate in support of WSC-sponsored projects.

A content model for Seabirds.net

With proper handling, Seabirds.net would rapidly become a one-stop gateway to all information about seabirds available on the Internet.

This would be accomplished through external links and links to content generated by the WSC. The key is to organize the information neatly and logically for maximum accessibility. The structure should be comprehensive and flexible, capable of assimilating any and all kinds of information as it becomes available. The job of designing and maintaining Seabirds.net has the hallmarks of library science. A standing work group within the World Seabird Consortium would be charged with conducting this vital activity.

A preliminary content model for Seabirds.net is presented in Figure 1. The diagram shows only some likely top-level nodes; Appendix 1 gives a fuller description of the model, including many suggestions for subdirectories. One top-level node—a world directory of seabird personnel—has special significance from the outset. As parties within the WSC would need to communicate frequently with all seabird professionals, it is essential to create an exhaustive directory, with each person responsible for keeping his or her contact information current. Individuals might also wish to add content to their entry in the directory: a statement of



Fig. 1. Preliminary content model (top-level nodes) for Seabirds.net.

interests and experience (including searchable keywords), a link to a personal web page, downloadable reprints of published papers, a personal photo, etc. (Appendix 1). The personnel directory could also be a place to display accreditation by the WSC, as discussed later in this article.

PRIORITIES FOR THE WSC

It is proposed that the World Seabird Consortium would have, initially, six primary functions, each supported by a dedicated working group (Table 2). Ownership and management of Seabirds.net has already been highlighted. The perplexities of data sharing and scientific attribution (item 2) are considered following this brief synopsis of other business.

A major impetus for establishing the WSC is the development and administration of global seabird databases, numbering five initially: a World Seabird Colony Register (WSCR), World Seabird Monitoring Database (WSMD), World Pelagic Surveys Database (WPSD), World Seabird Tracking Database (WSTD) and World Seabird Trophic Studies Database (WSTSD). The WSC could fulfill its administrative role by purchasing and maintaining a server named Seabirds.net on which all five databases would physically reside. Alternatively, the WSC could develop Seabirds.net as a shell that integrates any number of servers around the world in a virtual system (a so-called “distributed” database). Either way, the ownership, responsibility and credit for global seabird databases should be vested in the WSC rather than in any member organization(s). Working groups composed of experts and concerned stakeholders would be chartered by the WSC to guide development of the databases.

Whatever implementation model is employed for global databases, the WSC should develop and promote a common language specification for packaging and transmitting data between computers on the Internet. The standard created by the World Wide Web Consortium for doing that is called XML (Extensible Markup Language). Each discipline (seabird research, for example) that uses XML for data transfer is responsible for creating its own dialect of the language, defining data labels, hierarchies and value constraints in a manner tailored to its needs. A chartered working group within the WSC would be assigned the task of creating the specification for Seabird Research Markup Language (SRML), updating it as required and assisting WSC stakeholders in adapting to its use. At least some members of the working group should have expertise in database design, programming and computer systems management for the project to succeed. SRML should be a discipline-oriented, ‘lightweight’ XML specification—readily comprehensible to

TABLE 2
Proposed functions of the World Seabird Consortium

Function	Working group(s)
(1) Owns/manages Seabirds.net	Web Portal Management Group (WPMG)
(2) Develops standards and protocols for data sharing and individual performance metrics	Professional Metrics Working Group (PMWG)
(3) Develops/administers world seabird databases	Several
(4) Develops/sanctions Seabird Research Markup Language (SRML)	Markup Language Development Group (MLDG)
(5) Hosts world seabird conferences	World Conference Organizing Committee (WCOC)
(6) Sanctions Marine Ornithology as organizational journal	Marine Ornithology editorial board

seabird practitioners and easily (if only *optionally*) integrated into their personal data management systems. The working group would also create tools for translating SRML documents into EML (Ecological Metadata Language), CSDGM (Content Standard for Digital Geospatial Metadata) or other generic, complex metadata formats proposed for biological data (FGDC 2006, KNB 2010). The translation tools would be provided by WSC, to shield seabird researchers from much of the arcane and confusing detail that attends data-sharing protocols currently available on the Internet.

In the run-up to the first World Seabird Conference, the level of interest expressed worldwide suggests the event will not be the last of its kind. WSC member organizations would likely want to convene jointly at intervals in the interest of furthering shared goals. An interval of 5 years seems about right and—because the first World Seabird Conference is happening in 2010—is easy to remember (WSC I in 2010, WSC II in 2015, WSC III in 2020, and so on). Roman numerals distinguish conferences from the acronym of the World Seabird Consortium, and the symmetry of labels (WSC and WSC III, for example) would reinforce the linkage between world conferences and the World Seabird Consortium.

Finally, the WSC should adopt *Marine Ornithology* as its official organizational journal. At present *Marine Ornithology* is published by the Pacific Seabird Group on behalf of the African, Australasian, Dutch, Japanese, Pacific, and UK seabird groups; and acceptance of the journal among seabird researchers is proceeding steadily, if only gradually. Seabird-oriented papers are published in a variety of ornithological and multidisciplinary journals, and that practice will continue. Nonetheless, many of us will welcome the day when we have open access to a dedicated journal where we can expect regularly to find much of the best work produced by our peers in seabird research. With the full backing of the World Seabird Consortium, that day could arrive relatively quickly. Wider involvement in the production of *Marine Ornithology* is desirable, and the WSC's world directory of seabird professionals would be a continuing pool of experts to engage as editors and reviewers. Both the WSC Directorate and the *Marine Ornithology* editorial board can foster rapid growth of the journal by promoting it affirmatively. Publishing in *Marine Ornithology* will be as prestigious as we choose to make it.

SCIENTIFIC ATTRIBUTION AND REWARDS

A major undertaking of the World Seabird Consortium should be the development and administration of global seabird databases, but concerns about intellectual property rights are a significant barrier (Table 1). Seabird professionals are not alone in struggling with this issue or weighing options for overcoming it (Nelson 2009). In my view, it is not enough under the new paradigm simply to *require* scientists to engage in timely and comprehensive data sharing (Whitlock *et al.* 2010). There must be suitable repositories available, and there should be strong *incentives* for scientists to participate.

Under the new paradigm, it is necessary to distinguish between generating and contributing data, on one hand, and analyzing and interpreting data, on the other, and in some measure to reward the two independently. In the following discussion, I offer suggestions on how to do that. The treatment includes some new terminology and acronyms, intended partly to lend the ideas a certain degree of specificity and concreteness. I envision a re-engineering of our reward system proceeding in five steps, as follows.

Defining and tagging units of data

At present, the only currency of scientific exchange that is universally credited is publication in the peer-reviewed literature. Some form of “bibliometrics” is applied, implicitly or explicitly, when we judge the performance of individual scientists. The strong connection between publication and private ownership of data creates disincentives to share data (and conflicts when disagreements over data ownership arise). The new paradigm calls for the use of data per se to be tracked and attributed, including, but not limited to, their use in scientific publications. If data are to be honored as currency, it is necessary to have consensus on the denominations. As seabird professionals, we can start by defining our Accountable Data Units (ADUs). For example, it is reasonable to designate the “observation” (measurement of a population parameter in a given species, location and year) as the ADU of seabird monitoring. Other units are appropriate for pelagic surveys, seabird telemetry, colony surveys and trophic studies (Table 3).

To track the contribution and use of data, every ADU, and every contributor of an ADU, must have a unique reference. In the software industry, such a requirement is met using an invention called the Globally Unique Identifier (GUID, pronounced gwid; also known as a Universally Unique Identifier, or UUID). A GUID is a hexadecimal string, 32 characters long, such as {c456bfe0–5292–4cc6–8de7–5ed7b7de1fdc} (the GUID that identifies me as a data contributor in the PSMD). The algorithm used to generate a GUID within a computer effectively guarantees that no two will be the same, anywhere, ever. Another GUID, {8c16ce7d-7300-464f-b546-ea945969eeef}, refers to an observation I contributed to the PSMD on the mean brood size of Red-faced Cormorants *Phalacrocorax urile* at the Semidi Islands, Alaska, in 1979. Obviously, GUIDs are anything but human-friendly (I will never bother to memorize mine), but computers handle them easily, and never make a mistake. Once my Globally Unique Contributor ID (GUCI, pronounced goosey, or gucci) is duly recorded in a global database (such as the proposed WSC world directory of seabird personnel), it can be used to pinpoint me in cyberspace, for as long as I live, and ever after. Likewise, that observation I made on Red-faced Cormorants in 1979 can be forever associated with my name, because it has been assigned a Globally Unique Data Identifier (GUDI, pronounced goody). This is the basic principle behind the shift from a publications-based scientific economy to a publications/data-based scientific economy.

Creating data inventories

An essential step in creating each of the seabird databases is conducting an inventory of the pertinent data at the level of the applicable ADU (Table 3). Suggestions for achieving the desired thoroughness are offered in Appendix 2. It is unnecessary and counterproductive to place arbitrary or subjective quality-control limits on what is included in the data inventory. Properly designed and applied, the records in a shared database should speak for themselves regarding data quality. Users determine suitability; thus the preferred philosophy is that every item of information has potential value.

If our goal is to minimize the permanent loss of data, the importance of having a complete inventory of existing data cannot be overstated. In building a comprehensive database, the inventory becomes an invaluable “to-do” list. It also facilitates the next step in the process.

Establishing data provenance and ownership

Usually, more than one person deserves credit when any unit of information comes into being. Roles range from an individual having sole responsibility for all conceptual and on-the-ground aspects of a study to someone (or some institution) having funded the work but having made no other contribution, manual or intellectual. Intermediate scenarios abound—a student conducts a study largely conceived (or not) by his or her professor(s); field observers assist in data collection, applying some measure of personal creativity, expertise and judgment (or not); peers in a research laboratory routinely discuss and critique each others' work and come to feel mutually vested in all products emanating from the lab; an investigator creates protocols for a long-term study that is eventually inherited and continued by others—and so on. In our publications-based scientific economy, credit is meted out in the byline and in the acknowledgments section of a published product. The wide gap in meaning (formerly) and effect (still) between those two options has led predictably to “authorship inflation” (Weltzin *et al.* 2006).

In transitioning to a publications/data-based economy, a vital job for the WSC (specifically, its Professional Metrics Working Group; Table 2) will be to define and codify the roles that individuals can play in seabird research. The goal ultimately is for every unit of data to have one or more names attached, each name being qualified as to role(s) played, and roles being universally understood and identified by their GUIDs.

Data provenance and ownership are sensitive issues that must be handled systematically—and transparently—with an appropriate institution (WSC) serving as mediator. The protocol at this step would be the filing of a Data Provenance Agreement (DPA). One or more of the principals involved in any project would create and file (online at Seabirds.net) a DPA in advance of collecting data. The (updateable) DPA would list persons contributing to the project, specify their roles and declare publicly the plan for managing the ownership and release of project data. As a way of forestalling disputes over data provenance and ownership, routine use of DPAs would be a standard of professional practice endorsed and facilitated by the WSC.

Dealing with legacy data is a bigger problem, but similar in principle. As suggested earlier (and in Appendix 2), inventories of seabird data should be created in a comprehensive and free-wheeling manner, irrespective of data ownership or provenance. However, at

least one contact (GUCI) should be associated with every ADU from the outset, for the purpose of jump-starting the creation of retroactive DPAs. The person or persons initially identified in the inventory would draft a DPA, or recommend the colleague(s) who should do so. The resulting postdated (“after-the-fact”) DPAs, however incomplete or inaccurate, would be posted on Seabirds.net, for review by affected seabird workers, named or unnamed in a draft DPA. Notices concerning the existence of draft DPAs, and access to them, could be managed using a Google Maps®-style interface, allowing seabird workers to locate rapidly all data in which they feel they have a stake—by locations, species, years and data types. After it had allowed a specified period for public vetting, and had found no disagreements or had resolved any, the WSC would post the final version of a DPA on Seabirds.net—a permanent record of who did what, and the basis for adding or finalizing information on contributors and roles in the data inventories. Although every ADU would have to be covered by a DPA, a single agreement would often encompass a large body of data.

More than a simple list of contributors and roles, the DPA should be clear on the question of *prerogatives*. Decisions on how, where and when to release data are career choices with consequences, as discussed in the next topic.

Tracking data contribution and usage

In the new paradigm, a researcher's productivity and professional standing will depend substantially on conventional publications, but also on the creation and contribution of high-quality, reusable scientific data. On the data-creation side, performance can be further parsed and quantified according to *amount* of data contributed and *use* of data by others. By analogy, a scientist's publication record is often considered in terms of *number* of publications and *citation* of those publications (that is, apparent significance and use) by other scientists.

The WSC's Professional Metrics Working Group should create and implement a Professional Contributions Tracking System (PCTS) to record and quantify scientific productivity of all types. Several metrics are available for quantifying a researcher's published output and its impact. One that seems to be gaining popularity is the Hirsch Index (or h-index) (Hirsch 2005). What follows here are suggestions for quantifying and crediting *unpacked* data—data that may or may not be reflected in publications authored by those who collected them.

TABLE 3
Units of data suitable for tracking in a WSC-managed Professional Contributions Tracking System (PCTS)

Data category (global database)	Accountable data unit (ADU)
Colony inventory	Species status record ^a
Monitoring	Observation ^b
Pelagic surveys	Cruise, aerial mission
Trophic studies	Trophic study ^c
Seabird telemetry	Device deployment

^a Current estimate of a species' population at a specified breeding location (see Hatch [2010] Appendix 1).

^b Annual measurement of a seabird population parameter for a given species and location (see Hatch [2010] Appendix 1).

^c Equivalent to a time series observation (as in footnote b) for colony-based sampling; alternative units needed for non-colony-based studies.

The process begins with practitioners ensuring that all their applicable data are accounted for in the global inventories of seabird data. There would be no way for a worker to receive any credit in the WSC tracking system for undocumented data. For its part, the WSC would award “points” based on the amount of data in the inventory, each ADU being weighted according to a worker’s role in generating the data (Fig. 2). Next, data *owners* would decide

whether to become data *contributors* by adding their data to a public database. In doing so, there would be further options to weigh—do I place my data in a globally shared database, adhering to formats developed and sanctioned by the WSC, or do I leave them in a locally managed system that requires extra work on the part of prospective users to access the data? Am I willing to share my quantitative results, or am I comfortable in making only summary statistics or a qualitative version of my data available online? The WSC would award points in a manner that favors the global perspective and full disclosure. Finally, contributors might choose to place restrictions (presumably temporary) on the possible uses of their data by others. For example, the PSMD employs a system of data release codes (“Restricted,” “Unrestricted,” and “Provisional;” see Hatch 2010, Appendix 3 for details), which contributors use to authorize or circumscribe the use of every ADU in the system. Fewer conditions placed on the release of data would earn more points in the PCTS.

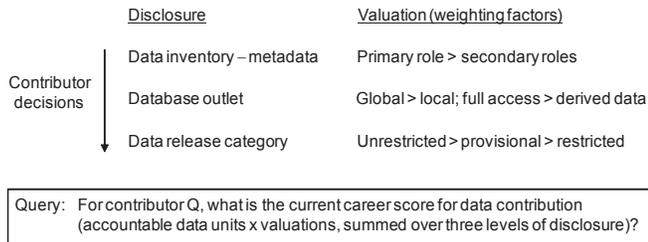
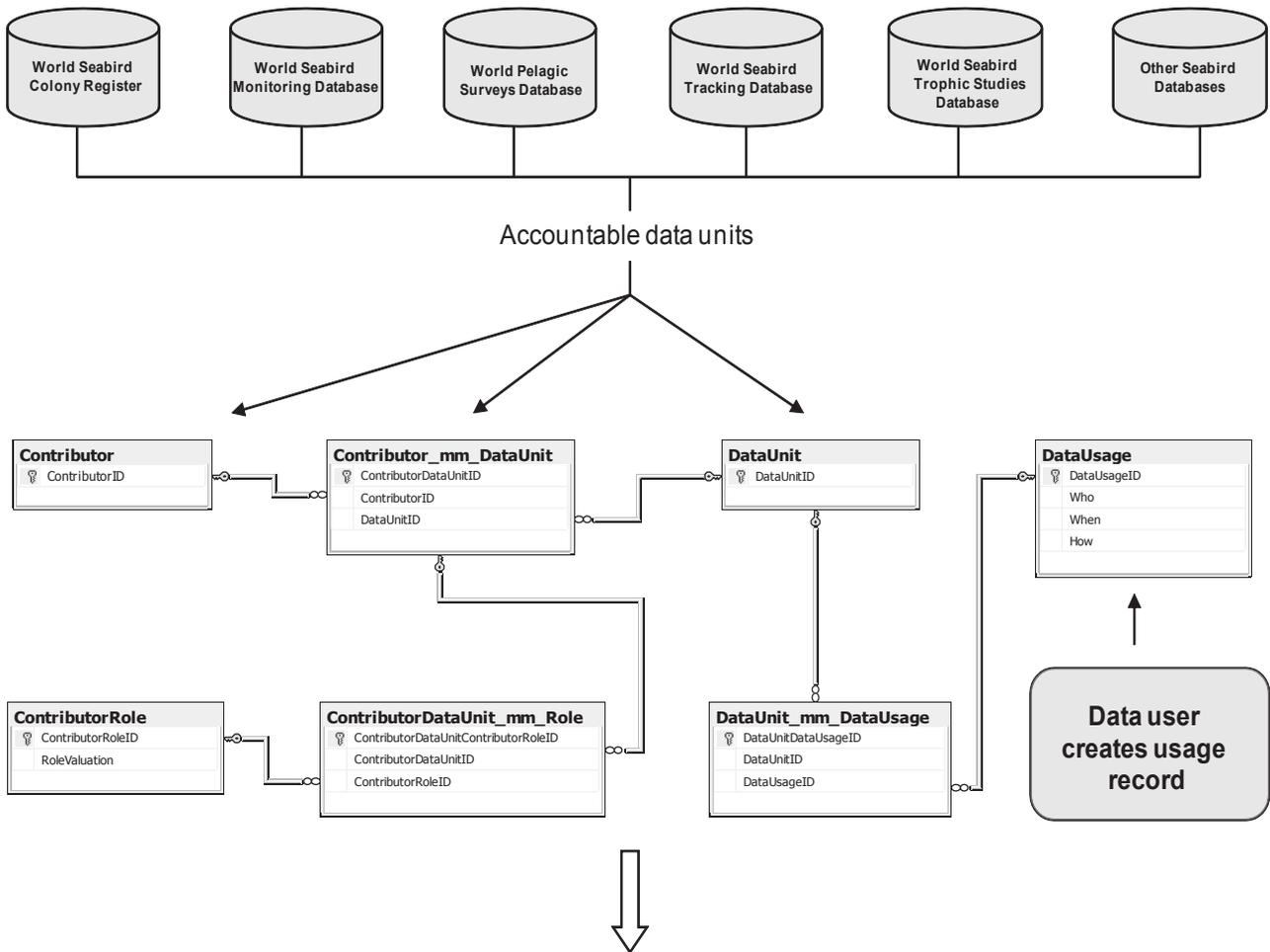


Fig. 2. Model for a WSC-sanctioned Professional Contributions Tracking System (PCTS)—Data Contribution component.

With this information collected and continually updated, it would be possible for the WSC to furnish at any time a score for data



Query: For contributor Q, how many data units (total and/or by contributor role) were used (for any purpose and/or by usage category) during interval X?

Fig. 3. Model for a WSC-sanctioned Professional Contributions Tracking System (PCTS)—Data Use component. Lines connecting tables depict relationships (primary and foreign keys). Field names ending in ID take globally unique identifiers (GUIDs) as values.

contribution—in essence, the sum of a practitioner’s ADUs in the system, weighted according to data provenance and several tiers of contributor choice or levels of disclosure (Fig. 2).

The second part of the tracking system would monitor data usage. Again, the items under watch would be the ADUs residing in publicly shared seabird databases (Fig. 3). At the completion of a project, data users would create (with simple-to-use online tools) a record that credits the ADUs put to work and identifies products resulting from the work. The collection of tables at the center of the system diagram (Fig. 3) is essentially the combined content of seabird data inventories. Obviously, no credit for public usage could accrue unless data are also made available in one of the corresponding databases.

Having created the database depicted in Figure 3, it would be possible for the WSC (or anyone else, as the system should be openly shared online) to gauge the contributions of a seabird researcher in terms of data furnished and data used by others. The combined assessment of data shared and data used would be a new metric of individual achievement in an era of routine data sharing via the Internet.

Applying the tracking system: WSC accreditation

In the new paradigm, it should be possible for a practitioner to gain considerable stature by favoring either of two possible career tracks. The WSC would use information from the PCTS to compute, for each seabird professional in the world directory, component scores for data contribution and data usage. It would blend those with a component score for publications (e.g., the Hirsch Index) and dispense a combined score reflecting overall performance (Fig. 4). The algorithm for computing combined scores might reflect a policy that the highest ranked individuals should be those who demonstrate high achievement on both the data-generation and data-interpretation scales of professional activity. Just as, in the U.S., the Federal Reserve Board adjusts monetary policy to nudge the U.S. economy, the WSC could use the PCTS to influence the collective behavior of seabird scientists over time. Policy development, and the details of implementation, would be the work of the Professional Metrics Working Group.

Results of WSC accreditation—component scores and overall rankings—could be posted on Seabirds.net under the entries for seabird professionals in the world directory (Appendix 1). Rank scores would be ever-changing. The WSC might choose to honor high achievers by maintaining an honor roll on Seabirds.net (Appendix 1), publishing highlights periodically in *Marine Ornithology*, or bestowing special recognition at World Seabird Conferences. Individuals and employers could include WSC input usefully in the context of job performance assessment. Organizations that fund seabird-oriented research could look to curricula vitae for assurance of an applicant’s professional standing, as conveyed by WSC accreditation and ranking.

CONCLUSIONS

In February 2010, a number of prominent journals in ecology and evolution released a joint policy statement on data archiving. Starting in 2011, authors submitting papers to *The American Naturalist*, *Evolution*, the *Journal of Evolutionary Biology*, *Molecular Ecology*, *Heredity* and other leading journals will be required, as a condition

of publication, to make all supporting data available in “an appropriate public archive” (Whitlock *et al.* 2010). In announcing the new policy, its advocates lamented the fact that so much legacy data has already been irretrievably lost to science. Data archiving is seen as urgently needed to prevent continued losses in the future.

Databases discussed here (and in Hatch 2010) provide seabird researchers with the tools needed to minimize data losses going forward. Moreover, as seabird professionals we need not concede the loss of our legacy of the past 50 years or so. Consider, for example, that most seabird monitoring in the North Pacific has occurred since the early 1970s (Hatch *et al.* 1994). In the North Pacific, as elsewhere, persons who collected the data, or others acting as curators of the data, are still around to work on preserving and sharing the legacy.

To succeed fully, global seabird databases will have to be developed under the auspices of a global seabird organization. Furthermore, the new paradigm compels us to examine and reinvent our reward system to accommodate routine data sharing. The proposed World Seabird Consortium can fulfill both of those vital functions. At the outset, it will be necessary to resolve carefully the issues of contributor roles, data provenance and ownership. Otherwise, we risk merely substituting “data ownership inflation” for authorship inflation and promoting a system that is neither credible nor fair.

We should recognize that making a smooth transition to the new paradigm is something our profession needs to do, and that it is *all-inclusive*. The transition may seem like a lot of work, and it is, especially the retrospective part. Thankfully, we have to do it only once; when new institutions and protocols are in place, the added burden of accounting will be handled mainly in the background, by computers, with little intervention from humans. The hardware and software tools available to us are easily up to the job.

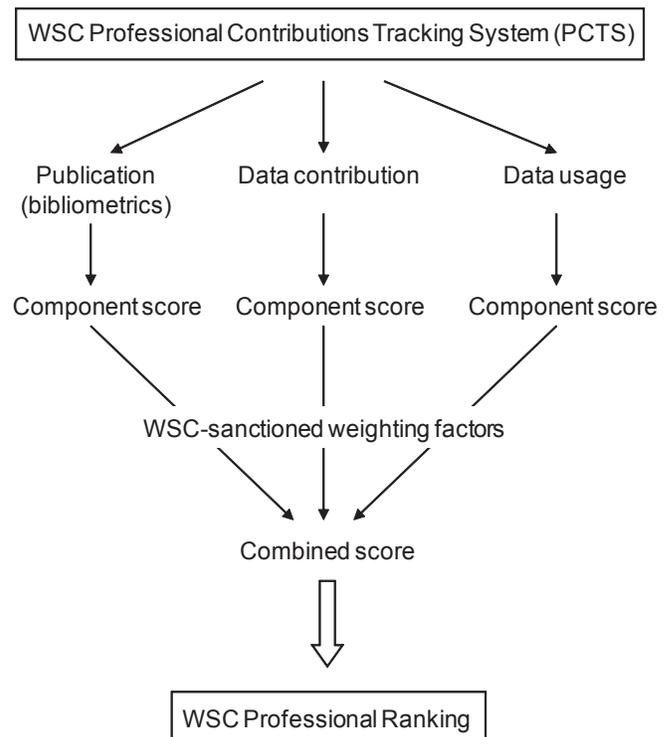


Fig. 4. Evaluating and ranking seabird research professionals in a WSC-sanctioned Professional Contributions Tracking System.

On the occasion of any *second* World Seabird Conference (2015, say), reasonable metrics for gauging whether seabird professionals are meeting the challenge of the new paradigm would include the following: (1) The World Seabird Consortium has been formally established and has adopted an appropriate mission statement; (2) The Internet domain “Seabirds.net” is owned and managed by the WSC and is on track to furnish rapid, well-structured access to all seabird-related information; (3) The WSC has adopted *Marine Ornithology* as its organizational journal, kindling rapid growth in readership and an increased reliance on the journal among seabird professionals worldwide; (4) Working groups chartered by the WSC are facilitating data sharing, in part by promoting SRML, a common markup language for seabird data; (5) Comprehensive inventories of world seabird data are nearing completion; and (6) Protocols and software for quantifying and crediting the contribution and use of seabird data are being engineered and increasingly applied.

From individuals, the new paradigm calls for the following actions: (1) Ensure that all relevant data collected over your career are accounted for in the WSC inventory of global seabird data; (2) Participate in developing Data Provenance Agreements that are accurate and collectively free of gaps; (3) Commit your qualifying data, provisionally or not, to one or more of the global databases established by the WSC; and (4) Embrace a WSC-administered system for professional ranking and accreditation and use it in advancing your own career and our profession as a whole.

The Internet and the new paradigm of scientific communication it has spawned offer exciting possibilities. Scientists everywhere can best adapt to the new environment by shaping their own future proactively. Those of us fascinated by seabirds and the sea itself—and committed to their protection—have the authority and the obligation to manage a changing scientific landscape to the best advantage of seabirds and seabird professionals worldwide.

APPENDICES

Readers are referred to the following supplementary materials available on the *Marine Ornithology* website (<http://www.marineornithology.org>):

Appendix 1: Expanded content model for Seabirds.net

Appendix 2: Beating the bushes: a “wiki” approach to building seabird data inventories

Appendix 3: Collegial reaction to the essay

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