Evaluating Baseline Biological Data Bases in National Park Units in Arizona

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Abstract. As part of the National Park Service Inventory and Monitoring Project (Phase I), Biological Inventory Status data bases were created that were used in assessing the completeness of information on vascular plants, amphibians, reptiles, birds, and mammals for 12 national park units in Arizona. We evaluated the taxonomic, geographic, and ecologic completeness of existing data for each biological group. Information on birds was the most complete, followed by plants and mammals. Data on reptiles and amphibians were the least complete. Database structure and content in each park unit and among park units lacked standardization. Various data management practices made it difficult to readily access resource information. Lack of ready access emphasizes the importance of standardizing the methods used to record, catalog, and store baseline data among the various National Park Service units and across regional boundaries. The Colorado Plateau National Park Service units could improve future inventory programs by standardizing their methods of data collection.

Key words: Arizona park baseline, fauna, flora, inventory monitoring.

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Congress established the National Park Service (NPS) in 1916 to conserve the resources within its jurisdiction in such a manner as to leave them unimpaired for the enjoyment of future generations (National Park Service Organic Act 1916). The importance of the inventory and monitoring of natural resources has been recognized at all levels of NPS management as an important management tool to accomplish this NPS mission. The NPS has, therefore, set forth an action program developed by both research and resource management personnel to address the needs of the Inventory and Monitoring (I & M) program.

The National Park Service will assemble baseline inventory data describing the natural resources under its stewardship and will monitor those resources at regular intervals to detect or predict changes. The resulting information will be analyzed to detect changes that may require intervention and to provide reference points for comparison with other, more altered environments (National Park Service 1987).

To be successful, however, monitoring programs must be based on accurate natural resource baseline data. Stohlgren and Quinn (1991) conducted an inventory and evaluation of the available natural resources data for 40 Western Region National Park Service units. They found that most Western Region national park units are missing large segments of information about biological resources. Most existing information was not readily available, and historic records and vouchers were, in general, poorly maintained. Park units also lacked standardized reporting procedures, which makes it difficult to compare information among different NPS units. For example, inventory data on birds were not comparable for any 2 of 16 national park units in California because of inconsistencies in ways data were collected and categorized (Sauvajot et al. 1990).

The fundamental project goal was to assess the completeness of park unit checklists of vascular plants, amphibians, reptiles, birds, and mammals. Here we evaluate the completeness of the existing natural resources information at 12 NPS units in Arizona by assessing information, as reported by park unit personnel, on the biological groups noted above.

Methods

A computerized Biological Inventory Status (BIS) data base was designed to address questions concerning the status of information on the park

units' species. Data collection and reporting standards for BIS were developed to insure consistency among the park units. The database structure and the biological information codes (Appendix) were reviewed in a week-long training session. We report on the taxonomic, geographic, and ecologic completeness of available data collected for five biological groups: vascular plants, amphibians, reptiles, birds, and mammals.

Taxonomic completeness refers to the percentage of species found (or expected) in the park unit that have received significant attention in past inventories. Geographic completeness represents the percentage of the entire park unit that has been included in previous inventories. Ecologic completeness represents the percentage of the total number of ecologic communities in the park unit that have been previously sampled. These categories were recorded numerically, from a 1 for an inventory that is probably complete to a 7 for an inventory status that is unknown (Appendix). These estimates represent a subjective assessment by the park unit staff, based on their current knowledge of park unit research. No attempt was made to verify staff assessment by checking for quality of reporting or by additional field work.

Superintendents, whenever available, were notified that we would be reviewing species lists, searching park unit libraries for pertinent biological group data, perusing specimen collections, and, most importantly, tapping the current knowledge of the park unit staffs. The BIS data were entered directly into a lap top computer, with copious notes taken to document comments and other pertinent information.

We summarized the perception of park unit personnel of data completeness for each biological group by calculating the mean of the three completeness categories (taxonomic, geographic, and ecologic). We then tallied the number of park units with inventories greater than 95% complete (sum = 1), 80–95% complete (sum = 2), 50–80% complete (sum = 3), less than 50% complete (sum = 4), and poor-to-nonexistent or unknown (sum = 5–7). For comparison, these calculations also were applied to 16 national park units in California (Appendix).

Results

Biological Groups

Vascular plants

Eight percent of the vascular plant inventories were reported greater than 95% complete by park unit staff. None of the 12 park units reported complete inventories for all three categories (taxonomic, ecologic, geographic). Only Organ Pipe Cactus National Monument (NM) reported having a plant list that was probably taxonomically complete. Forty-one percent of the plant inventories were reported from 50 to 80% complete (Figure). None of the

inventories was reported as poor to nonexistent. Tuzigoot NM reported not having a plant list—the park unit herbarium serves as their only record.

Amphibians and Reptiles

None of the amphibian or reptile inventories was reported greater than 95% complete. No park units reported complete inventories for all three categories. Organ Pipe Cactus NM and Saguaro NM reported having amphib-

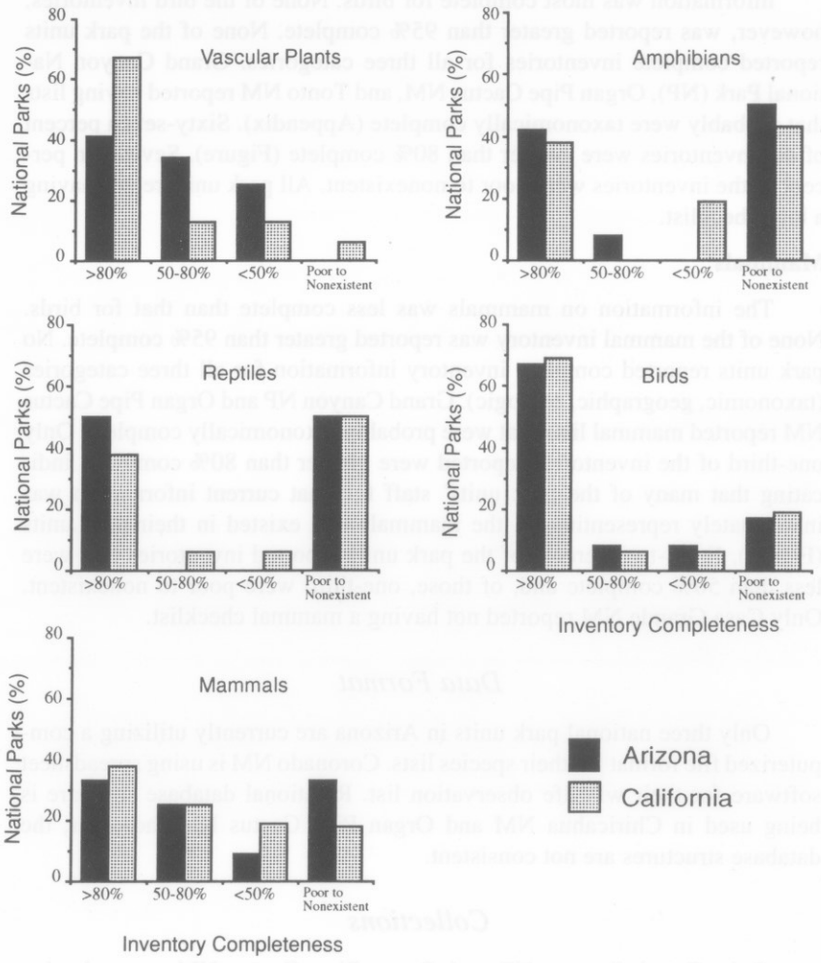

Figure. The perceived overall taxonomic, geographic, and ecologic completeness of existing biological inventory data for national park units in Arizona (n = 12) and California (n = 16). Values represent the percentage of park units classifying their data into each of the four completeness categories (>80%, 50–80%, <50%, and poor to nonexistent).

ian lists that were probably taxonomically complete, while only Organ Pipe Cactus NM reported a reptile list that was probably taxonomically complete. Fifty-eight percent of the park units reported amphibian inventories that were less than 80% complete, and of that, half were reported poor to nonexistent (Figure). Casa Grande NM, Tuzigoot NM, and Walnut Canyon NM reported that no amphibian lists exist. Only Casa Grande NM reported having no reptile list.

Birds

Information was most complete for birds. None of the bird inventories, however, was reported greater than 95% complete. None of the park units reported complete inventories for all three categories. Grand Canyon National Park (NP), Organ Pipe Cactus NM, and Tonto NM reported having lists that probably were taxonomically complete (Appendix). Sixty-seven percent of the inventories were greater than 80% complete (Figure). Seventeen percent of the inventories were poor to nonexistent. All park units report having a bird checklist.

Mammals

The information on mammals was less complete than that for birds. None of the mammal inventory was reported greater than 95% complete. No park units reported complete inventory information for all three categories (taxonomic, geographic, ecologic). Grand Canyon NP and Organ Pipe Cactus NM reported mammal lists that were probably taxonomically complete. Only one-third of the inventories reported were greater than 80% complete, indicating that many of the park units' staff felt that current information was inadequately representing all the mammals that existed in their park units (Figure). Forty-two percent of the park units reported inventories that were less than 50% complete and, of those, one-third were poor to nonexistent. Only Casa Grande NM reported not having a mammal checklist.

Data Format

Only three national park units in Arizona are currently utilizing a computerized file format for their species lists. Coronado NM is using spreadsheet software for their wildlife observation list. Relational database software is being used in Chiricahua NM and Organ Pipe Cactus NM; however, the database structures are not consistent.

Collections

Only Grand Canyon NP and Organ Pipe Cactus NM report having voucher specimens for all five biological groups within their park unit; however, these park units do not have voucher specimens for all of their recorded species. All park units, with the exception of Coronado NM, have plant vouchers located within their park unit. Four units (Chiricahua NM, Grand Canyon NP, Organ Pipe NM, and Saguaro NM) report having amphibian vouchers. The Petrified Forest NP Resource Management Plan (1966, unpublished data) stated that there were two amphibians and four reptiles in their collection, but they were given to a local elementary school because of poor condition of the specimens. Chiricahua NM, Fort Bowie National Historic Site, Grand Canyon NP, and Organ Pipe Cactus NM report having some reptile collections. Fort Bowie National Historic Site, Montezuma Castle NM, and Tuzigoot NM do not have bird collections. Five national park units in Arizona report having mammal vouchers in the park unit. In many cases, vouchers are also housed at local universities.

Discussion

Completeness

Although most Arizona park units have compiled species lists for at least some of the biological groups, the vast majority of these lists was reported to be less than 80% complete. This was also the case for national park units throughout the Western Region (Stohlgren and Quinn 1991) and represents a disturbing lack of information regarding important biological resources. We found, as did Stohlgren and Quinn (1991), that large park units often benefited from larger inventory and monitoring funds, such as nationwide or regional initiatives. For example, Organ Pipe Cactus NM is the only national park unit in Arizona that is involved in a nationwide monitoring program, and this is reflected by how confidently they reported the completeness of their baseline data. Organ Pipe Cactus NM is also the only national park unit in Arizona reporting systematic surveys for amphibians and reptiles.

National park units in Arizona and California show remarkably similar results regarding completeness of available data for the five biological groups. In both states, bird lists were reported to be the most complete, followed by the vascular plants. High levels of completeness for these groups is not surprising, because most birds and plants are relatively visible, aesthetically pleasing, popular with both the general public and amateur observers (i.e., birdwatchers and native plant societies), and have a long history of recorded observations and inventories. National park units in California, though, had vascular plant inventories that were more complete (67% of park units reported >80% complete) than park units in Arizona (41% were >80% complete). This greater completeness for vascular plant data in California park units may be because the 18 national park units in California have had a complete master list of vascular plants (Robinson et al. 1990). Park unit managers in California may also have more and better access to their vascular plant data, and therefore rated their data more complete.

Relatively few of the national park units in Arizona (33%) or California (38%) reported mammal inventories that were greater than 80% complete. Interestingly, twice the percentage of park units in Arizona (33%), as compared with California (18%), felt that their mammal inventories were poor to

nonexistent. The overall lack of completeness for mammal data is surprising because mammals often receive significant scientific attention. Perhaps, because mammal species are often of management concern or are used as indicator species, lack of data on mammals is readily noticed and perceived by park unit management as a high inventory priority.

Unfortunately, many park units use generalized mammal range maps from field guides or mammal texts to estimate the number of mammals that may be present in their park unit. Use of such general range data can lead to inaccurate information regarding the number of species that should, or do, occur in that specific park unit.

Inventories of amphibians and reptiles were considered the least complete for national park units in Arizona and California. In both states, approximately half of the park units reported their amphibian and reptile data to be poor to nonexistent. One might expect these groups to be the least well known because of their secretive habits, relatively low public appeal, and the difficulty of performing thorough surveys. The lack of baseline information is disturbing, however, in that

1. amphibians and reptiles play important roles in natural ecosystems (American Society of Ichthyologists and Herpetologists 1987; Blaustein and Wake 1990);
2. there is evidence that amphibian populations have undergone significant declines since the early 1900's (Blaustein and Wake 1990); and
3. many amphibian and reptile populations are rare, endangered, or threatened (Ashton 1976).

Our surveys of existing data show that, of the five biological groups, the greatest inventory needs seem to be for mammals, amphibians, and reptiles. This is consistent with results reported in the Western Region and throughout the park service (Stohlgren et al. 1991). Additional emphasis on systematic biological surveys can help remedy the current lack of information. It is improbable, however, that even extensive surveying will ensure 100% complete species inventories for a park unit (Stohlgren and Quinn 1991), because additional species likely will be found with expanded search efforts.

Data Format

Even though three park units use computerized data bases for their bird species lists, none were designed for compatibility with other park units. By using different data structures and recording procedures, the park units are perpetuating a lack of standardization. This incompatibility results in exorbitant difficulties in making the data comparable among park units or at the regional and national levels.

Although NPFLORA (COMMON) is a standard National Park Service flora data base, only Petrified Forest NP reported using this program. Staff at

many NPS units are not trained in its use. We suggest that standardized data sets are needed to compare species data and, by using computerized technology in the most responsive way, park service managers will be able to quickly and accurately address natural resource issues.

The accessibility of information varied considerably between park units. Each park unit has a different system of storing research information. In most cases, access to these data was not systematic, making data retrieval difficult. Some park units have not accurately archived historic information. For example, Casa Grande NM had evidence of bird banding data from the 1940's, but the data were not locatable and may be lost forever.

Because of a high turnover of park unit staff, much information, including original data and voucher collections from past inventories, has been misfiled or lost, and often little or no institutional knowledge has been established. Staff turnover in the last fiscal year (1990) showed that one out of three permanent rangers were transferring from one national park unit to another (M. R. Fraire, NPS, Washington, D.C., personal communication). Often, experienced rangers have a good feeling for what work has been done in their park unit, such as at Montezuma Castle NM and Coronado NM. Interested seasonal rangers who are amateur botanists and wildlife biologists also have contributed heavily to the existing checklists. However, these people leave little record of their work behind when they move on. During our data collection, park unit administrators relied heavily on the experience of these employees. Even though they could recall various past studies, many times administrators or replacement personnel were unable to relay accurate study results. Often, researchers must be reminded to leave a report of their findings with the park units.

Vouchers and Nomenclature

The lack of standardized recording procedures for plant species lists results in the use of varying taxonomic nomenclatures. Most plant species lists and collections for the national park units in Arizona do not use standard taxonomic nomenclature, making comparisons among park units difficult (Robinson et al. 1990). Many of the species lists are incomplete because taxonomic references are not listed, and the methods and locations of collections are missing. The validity of this information is questionable under these circumstances. Also, many park unit herbaria need to be examined by experts for proper identification. For example, one park unit has an extensive plant collection, but many of their voucher specimens have not been reidentified in more than 50 years.

Many park units are unaware of unit-specific data that universities possess. The reptile vouchers for Grand Canyon NP are located at universities in Illinois, California, and Arizona. The park unit curator believes specimens exist at other locations and is in the process of trying to locate them. Organ Pipe Cactus NM has their known herpetofauna documented at the

University of Arizona. The inherent difficultly in identification of herpetofauna makes such documentation a valuable tool.

Solutions

As the biological inventories of each of the park units were assessed, it became clear that the information used to complete many BIS data sets was incomplete. The actual status of the biological inventory information is difficult to assess due to the lack of standardized recording procedures and missing or poorly maintained voucher specimens. This emphasizes the need for a standardized approach to future inventory efforts and research and emphasizes the need for a readily accessible literature reference data base where unit data can be archived and that can be searched by personnel at national park units. For example, the many problems associated with data entry for curated specimens, including classification and description, could be eliminated by requiring that researchers record the technical data on a common data base or spread sheet for entry into the Automated National Catalog System. Also, by placing park unit collections in better storage facilities that provide an adequate level of curatorial care, scientists will be able to examine specimens and record any nomenclature changes with ease. Placement in centralized curatorial facilities will alleviate the burden on individual park units of allocating the physical space, time, and funds for extensive museum collections.

The Cooperative Park Studies Unit at the University of Arizona is developing a standardized reference data base for national park units in Arizona. Thus, in the future, all national park units in Arizona will have a simplified way to exchange information. The Cooperative Park Studies Unit at the University of Idaho developed a reference data base that includes almost 3,000 reports related to NPS animal life studies (Wright 1991) and will make resources information more readily available. Other areas would benefit from similar efforts.

Regional and Cooperative Park Studies Unit staff can help by training employees in database management and by standardizing recording procedures. Units can become a central clearinghouse for research information and documentation. This is a starting point to a more complete inventory and monitoring program.

Future Inventory and Monitoring Programs in National Park Units in Arizona

From the information gathered as part of the Biological Inventory Status project, it is apparent that lack of staffing and funding are playing a major role in the I & M program for national park units in Arizona. Individual park units are able to gather baseline data only when funds and personnel become available. The lack of communication, coordination, and standardization among park units is causing the units to waste time repeating research. We

suggest that in the future, clusters of smaller units (as in the many units on the Colorado Plateau) can attract research efforts similar to those at the larger, more popular units. Also, by viewing the Colorado Plateau as an ecosystem, each unit can benefit in a hierarchical fashion from inventory and monitoring work accomplished at the other Colorado Plateau units. Clustering could enable the smaller units to compete with the larger park units for personnel and research funding.

As part of the servicewide I & M program, the Cooperative Park Studies Unit at Northern Arizona University is in the process of collecting species lists for 11 Colorado Plateau units. These floral and faunal data bases will be a central repository for species data for ready access and comparison of species occurrence between park service units by scientists and resource managers.

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Appendix. Biological Inventory Completeness Categories[a] From 12 Arizona and 16 California National Park Units.

Park unit[b]	Vascular plants				Amphibians				Reptiles				Birds				Mammals			
	T[c]	G[c]	E[c]	M[c]	T	G	E	M	T	G	E	M	T	G	E	M	T	G	E	M
Arizona																				
Casa Grande NM	3	2	6	4	7	6	6	6	7	6	6	6	2	1	6	3	7	6	6	6
Chiricahua NM	2	2	3	2	2	6	6	5	2	6	6	5	2	2	2	2	2	2	2	2
Coronado NM	2	1	2	2	4	4	6	5	4	4	6	5	2	2	2	2	3	3	3	3
Fort Bowie NHS	3	3	2	3	2	2	3	2	2	2	3	2	2	2	3	2	3	2	3	3
Grand Canyon NP	2	3	3	3	3	2	2	2	3	2	2	2	1	4	1	2	1	5	1	2
Montezuma Castle NM	3	4	6	4	2	3	3	3	2	3	2	2	3	5	6	5	7	5	6	6
Organ Pipe Cactus NM	1	2	1	1	1	3	1	2	1	3	1	2	1	3	1	2	1	3	1	2
Petrified Forest NP	2	3	6	4	4	5	5	5	4	5	5	5	2	3	6	4	4	4	5	4
Saguaro NM	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	4	4	3
Tonto NM	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2
Tuzigoot NM	3	3	3	3	7	6	6	6	7	6	6	6	2	2	2	2	7	6	6	6
Walnut Canyon NM	3	3	3	3	7	6	6	6	6	6	6	6	3	6	6	5	4	5	5	5
California																				
Cabrillo NM	1	6	6	4	1	5	6	4	7	4	4	5	1	1	1	1	1	5	6	4
Channel Islands NP	1	1	1	1	1	2	2	2	1	2	2	2	1	1	1	1	1	1	1	1

Appendix. *Continued.*

Park unit[b]	Vascular plants				Amphibians				Reptiles				Birds				Mammals			
	T[c]	G[c]	E[c]	M[c]	T	G	E	M	T	G	E	M	T	G	E	M	T	G	E	M
California (Continued)																				
Death Valley NM	1	2	1	1	7	5	5	6	7	5	5	6	2	4	3	3	3	4	2	3
Golden Gate NRA	6	5	5	5	4	5	5	5	6	4	4	5	3	4	4	4	4	4	4	4
John Muir NHS	3	4	4	4	6	6	6	6	6	6	6	6	7	4	4	5	6	6	6	6
Joshua Tree NM	2	2	1	2	1	2	1	1	1	2	1	1	1	3	1	2	2	3	2	2
Lassen Volcanic NP	2	3	3	3	4	6	6	5	3	6	6	5	1	1	1	1	1	3	1	2
Lava Beds NP	1	2	3	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Muir Woods NHS	3	1	3	2	6	6	6	6	6	5	5	5	2	1	1	1	6	5	5	5
Pinnacles NM	1	2	1	1	7	6	6	6	2	4	2	3	2	4	1	2	1	4	3	3
Point Reyes NS	1	1	1	1	1	5	5	4	1	5	5	4	7	6	6	6	1	5	5	4
Redwood NP	3	2	3	3	5	4	4	4	7	6	6	6	2	1	3	2	2	3	3	3
Santa Monica Mountains NRA	1	1	1	1	1	3	2	2	1	3	2	2	1	1	1	1	1	1	1	1
Sequoia–Kings Canyon NP	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	5	3
Whiskeytown–Shasta–Trinity NRA	2	1	1	1	7	6	6	6	7	6	6	6	6	6	6	6	6	5	5	5
Yosemite NP	1	2	1	1	1	2	1	1	1	2	1	1	1	2	1	1	2	4	1	2

[a] Inventory completeness sum values: 1 = inventory >95% complete; 2 = inventory 80–95% complete; 3 = inventory 50–80% complete; 4 = inventory <50% complete; 5–7 = inventory poor to nonexistent.

[b] NM = national monument; NHS = national historic site; NP = national park; NRA = national recreation area; NS = national seashore.

[c] Numerical listings: T = taxonomic completeness; G = geographic completeness; E = ecological completeness; and M = mean completeness.