

# A MAP to manage palaeontology

by Scott E. Foss<sup>1</sup>

<sup>1</sup>Bureau of Land Management, Washington D.C., United States, [sfoss@blm.gov](mailto:sfoss@blm.gov)

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Managing palaeontological resources requires the development of a program that fits the needs of science and society. Here, I present a road map to manage palaeontology that should fit any bureaucracy or governing structure. This involves a mission (M) that articulates the purpose for managing palaeontological resources. The mission might be simple or complex, but it always must be consistent and attainable. The mission must also be framed in a legal context of authorities (A). Authorities include statutes, laws, written rules, and policy. The primary statute that authorises palaeontology programs on public lands in the United States is the Palaeontological Resources Preservation Act of 2009 (PRPA), but there are many other statutes and policies that also authorise and guide these programs. Finally, managing palaeontology requires a detailed structure or program (P). A palaeontology program must have a mission that is consistent with statutes and authorities and consist of the following program components: Inventory, Monitoring, Planning, Mitigation, Collection, Curation, Education and Protection. The road map, or MAP, presented here provides a rational structure for developing a palaeontological management program that can be transposed to any governing structure.

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## Introduction

Those of us who manage fossil resources are bureaucrats, not politicians. The politicians who make laws are generally people who know little, if anything, about palaeontology. In many countries existing legislation that provides for the preservation of fossils is nested in laws that are directed at antiquities, but not fossils. To many public servants, both elected and non-elected, palaeontology is often synonymous with archaeology, and because of this confusion archaeologists are often asked to manage palaeontological resources. Archaeological laws and practice are often inappropriate when applied to problems of palaeontology, which is a completely different discipline and associated with a completely different science. Archaeologists are exposed to the converse when the subject of archaeology is construed to include dinosaurs. Both archaeologists and palaeontologists need to clearly articulate to decision-makers that archaeologists should not be managing palaeontology and palaeontologists should not be managing archaeology.

Land managers interpret laws to develop and enact policy. Consider this paper to be palaeocrat 101. The format of the Palaeontology MAP can be applied to implement palaeontological laws in any jurisdiction. The MAP consists of three parts: Mission, Authority, and Program.

## Mission

The mission articulates the purpose for managing palaeontological resources and is guided by resource values,

which are not the same in every country or state. Values may include protection, access for science, recreational collecting, commercial enterprise, etc. The stated mission must be attainable and rational and be based on values that reflect the collective need. Suppose the mission is to provide access for scientific investigation. Then what are the overarching scientific questions and what needs to happen to facilitate that investigation? The mission must establish why palaeontological resources need to be managed and be accompanied by a clear strategy to accomplish that goal, usually accomplished in an accompanying statement of goals. For example, the Bureau of Land Management (BLM) program mission is “to preserve and provide access to fossils that contain important information about the history of life on Earth in order to better understand climate change and ecosystem diversity through time.” This mission statement is accompanied by a list of specific goals or actions that the bureau will take to fulfil the stated mission. These goals must be articulated in a way that allows an evaluation of success.

Implementation of the mission is wholly dependent upon laws and policy.

## Authorities

Authorities are statutes, laws, written rules, and policy that allow for the mission to be realised. It is best when the laws are written to specifically address fossil resources, though this rarely happens. In the best of circumstances, the laws will articulate a mission by which to manage palaeontological resources. More often a palaeontolo-

gy resource management program must be based on a patchwork of laws that incidentally apply to fossils. In all cases it is necessary to know the broad range of laws that apply to the land. This includes understanding the system of government, knowing which lands are affected by various laws (federal, crown, state, or private lands), assessing the range of popular and political support for the stated mission, and whether the organisation has the financial or workforce capacity to implement a palaeontology program.



*Figure 1. Allosaurus skeleton on display at the Jurassic National Monument visitor center, Cleveland, Utah. An attainable mission is necessary in order to establish a palaeontology program. Photo by Scott Foss, Bureau of Land Management.*

The primary authority to support the mission may be a fossil preservation statute, an antiquities law, a general land law, or a series of laws that impose various levels of precedence over palaeontology, but still provide for its management. Additional laws, policy, and practices allow a palaeontology program to achieve its mission. We take all these laws and knit them into a fabric that is the palaeontology program we enact.

In the United States different laws apply to different Federal lands. Some laws that apply to the Bureau of Land Management (BLM) do not apply to the National Park Service (NPS), and still different laws apply to the Forest Service, and so on. For the purpose of managing palaeontology there are two types of laws that apply to the management of palaeontology, primary and secondary. The primary laws are ones that provide specific mandates or require actions to manage palaeontological resources. The Palaeontological Resources Preservation Act of 2009 (PRPA), for example, requires three actions: 1) manage palaeontological resources using scientific principles and expertise, 2) inventory and monitor palaeontological resources on Federal lands, and 3) develop programs to educate the public about the importance of palaeontological resources. Secondary laws are ones that do not specifically

call out palaeontology but provide procedures that must be followed in the pursuit of a palaeontology program, such as evaluating potential effects to the environment, providing tribal notification and consultation, following budgetary or spending requirements, or facilitating the greater mission of a bureau like extraction of certain resources and preservation of others. In other words, we must construct the palaeontology program within the context of the procedural laws that are already in place.

Finally, there are policies that direct what must be accomplished and subsequent guidance that provides best practice on how things should be done. Policy establishes how the palaeontology program will be implemented, such as what information will be collected or which best practices should be employed in a given area or in specific situations.

Directives outline what must be accomplished, whereas procedural guidance establishes how it will be done. For example, the NPS provides a series of director's orders that establish what must be accomplished by providing policies, procedures, and specific instructions, and by delegating a clear line of authority. Guidance, the how, is subsequently communicated through handbooks and reference manuals. A similar structure is provided by the BLM through a series of manuals and handbooks.

<p><b>Subtitle D—Paleontological Resources Preservation</b></p> <p><b>SEC. 6301. DEFINITIONS.</b></p> <p>In this subtitle:</p> <p>(1) <b>CASUAL COLLECTING.</b>—The term “casual collecting” means the collecting of a reasonable amount of common invertebrate and plant paleontological resources for non-commercial personal use, either by surface collection or the use of non-powered hand tools resulting in only negligible disturbance to the Earth’s surface and other resources. As used in this paragraph, the terms “reasonable amount”, “common invertebrate and plant paleontological resources” and “negligible disturbance” shall be determined by the Secretary.</p> <p>(2) <b>FEDERAL LAND.</b>—The term “Federal land” means— (A) land controlled or administered by the Secretary of the Interior, except Indian land; or (B) National Forest System land controlled or administered by the Secretary of Agriculture.</p> <p>(3) <b>INDIAN LAND.</b>—The term “Indian Land” means land of Indian tribes, or Indian individuals, which are either held in trust by the United States or subject to a restriction against alienation imposed by the United States.</p> <p>(4) <b>PALEONTOLOGICAL RESOURCE.</b>—The term “paleontological resource” means any fossilized remains, traces, or imprints of organisms, preserved in or on the earth’s crust, that are of paleontological interest and that provide information about the history of life on earth, except that the term does not include— (A) any materials associated with an archaeological resource (as defined in section 3(1) of the Archaeological Resources Protection Act of 1979 (16 U.S.C. 470bb(1)); or (B) any</p>
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*Figure 2. Image of first page of Section 6301 Paleontological Resources Preservation Act. Authorities are statutes, laws, written rules, and policy that allow for the mission to be realised. Graphic created by Scott Foss, Bureau of Land Management.*

## Program

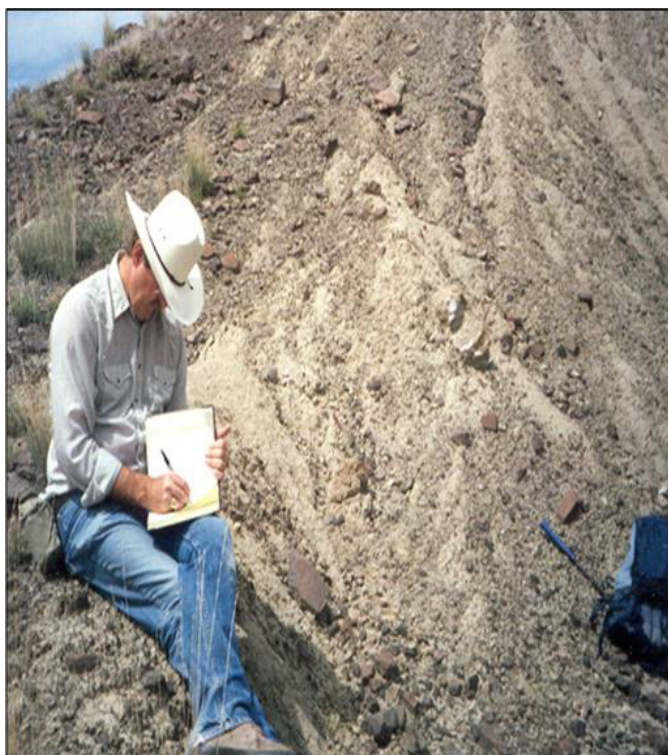
If authorities are the what, then the program is the how. First and foremost, the program must be an outgrowth of both the mission and the authorities. As stated above, different authorities may apply to different agencies within a single government, so it is not always possible to have a one-size-fits-all approach to enacting a program. Because what is allowed in one bureau may not be allowed by another bureau, one-size-fits-all management, includ-



ing permitting across bureaus, is difficult or impossible to realise.

For example, the BLM and the NPS are both part of the U.S. Department of the Interior, but the bureaus are managed differently. The BLM is mandated by PRPA to allow casual collection of reasonable amounts of common non-vertebrate fossils to the public without a permit. Such collecting is an anathema to the NPS, which not only forbids the casual collection of fossils, but does not allow collecting of any kind without a permit. This difference is not only present in the law that authorises the management of palaeontology, but is also inherent in the enabling legislation, and thus the primary mission, of each bureau. The BLM is established to “manage the public lands and their various resource values so that they are utilised in the combination that will best meet the present and future needs of the American people” (Federal Land Policy and Management Act of 1976). This is generally referred to as the bureau’s multiple use mandate. The NPS, on the other hand, was established with a single mission to “conserve the scenery and the natural and historic objects and the wildlife therein and to provide for their enjoyment in such manner and by such means as will leave them unimpaired for the enjoyment of future generations” (NPS Organic Act of 1916).

The result of different enabling legislation and separate bureau mandates is that the program for each agency will be unique, though PRPA does provide for the land management bureaus to coordinate to the extent practical.



*Figure 3. Paleontologist recording field notes near Logan Butte, Oregon. If it isn't documented, it doesn't exist Photo by John Zancanella, Bureau of Land Management.*

Regardless of the size of the bureaucracy, its mission, or the content of its enabling authorities, a palaeontology program must address eight program categories, although a smaller program may reasonably group these categories. The eight categories are: inventory, monitoring, planning, mitigation, collection, curation, education and protection.

## Inventory

Inventory is basic to any management program, regardless of the mission. It is impossible to manage any resource without knowing what resources exist and where they are located. A systematic program of inventory is necessary to develop a realistic understanding of location, abundance, and nature of fossil resources, and documentation needs to follow a consistent data standard so that new discoveries can be assessed and previous discoveries relocated. It is not enough to only anecdotally “know” that fossils are out there; occurrences must be documented. Bureaucratically speaking, if it isn't documented, it doesn't exist.

## Monitoring



*Figure 4. Monitoring palaeontological resources. BLM paleontologists recording close-range photogrammetry near Las Vegas, Nevada. Photo by Neffra Matthews, Bureau of Land Management.*

A program of monitoring is necessary to address any known inventory. It is necessary to revisit the original inventory to see what has changed, what has stayed the same, and what else can be discovered given the passage of time and the development of new recording techniques. It is irresponsible to inventory resources but fail to monitor their condition over time. Ultimately, we need monitoring in order to evaluate the success of our management plans and strategies.

In the case of the BLM, we rely on palaeontology permittees and partners to provide inventories of palaeontological resources and to monitor over time, so it is important for bureau palaeontologists to review these reports and





*Figure 5. Competing values for the land. Top left-to-right, A. prehistoric dwellings that represent cultural values, B. moose and two calves represent wildlife values, C. mountain bike representing recreational values. Bottom left-to-right, D. hunters representing hunting values, E. sheep representing grazing values, F. oil well representing energy production values. All photos from the BLM public affairs library, Bureau of Land Management.*

use the information in support of the mission. When permit reports are not reviewed by a program palaeontologist or go directly to the file cabinet the bureau denies itself knowledge that it is required to both collect and act upon. We can't manage palaeontological resources using scientific principles and expertise when the inventory is filed away or we lack the funding or staff to use the information.

## Planning

Planning is the process of evaluating all the values of the land, not just palaeontology. Whether considering multi-state resource management plans, or evaluating a single parcel of private property, planning is important. This means evaluating all the values of the land. In the case of palaeontology, it means evaluating both the palaeontology of the planning area and its relationship to all non-palaeontology resources that have value to the public. This is how organisations develop a strategy to focus the appropriate amount of attention to each resource.

When planning how to manage palaeontological resources it is necessary to appreciate that different land users are going to recognise different uses of the land as important, and each land user is tempted to believe that their values are the most justified and therefore should be the most influential. These values rarely align, which is why plan-

ning can be so complex but is also critical to managing multiple resources. Some BLM management plans, with appendices, can be in the thousands of pages. As palaeontological resource professionals we contribute to plans, we read those plans, we follow those plans, and we develop priorities. What happens when there is a dinosaur skeleton where someone wants to drill an oil well? The plan will set out procedures for evaluation and pre-set actions. Can we move the well to avoid the dinosaur? Can the proponent drill a directional well? If the fossil cannot be avoided, can we mitigate (collect the fossils and record the context of the surface before it is removed)? Similar questions apply to a mountain bike race, or an off-road vehicle rally, or a power line, or a wilderness area. The various uses of the land represent the variety of values that must be accommodated by each land use plan.

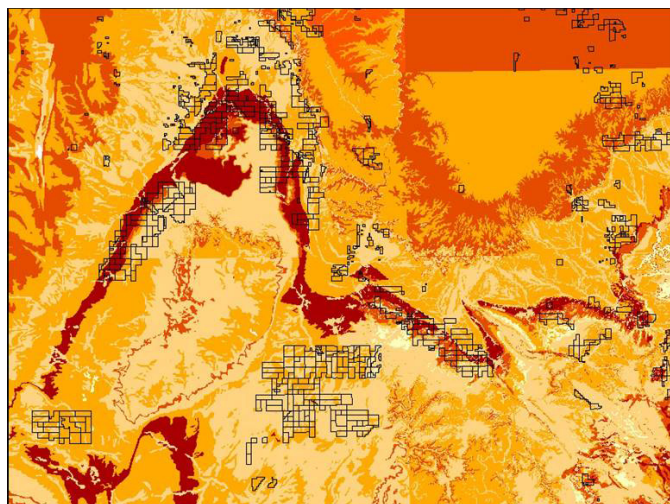
When done correctly, planning will chart strategies for management that maximise the attention that may be given to each resource. In many cases priorities will synergise (such as science, education, and recreation). Project locations can be moved to avoid palaeontological resources, but in some situations it might be desirable to move a proposed use, such as an event or trail, closer to a palaeontological resource in order to provide the public with interpretation and access the fossils, which in turn satisfies the BLM palaeontology mission to educate the public about the importance of palaeontology. In this way,



the proposed resource use may synergise with the needs of the palaeontology program. In other cases, priorities conflict (such as resource extraction vs. preservation). This is where planning comes in. Uses don't always need to conflict. For example, an oil company may pay to excavate a dinosaur skeleton that is in a pipeline right-of-way. The company gets the positive press and the palaeontology program benefits by the discovery and excavation of an important fossil. In an exceptional example from our colleagues in Canada, an exquisitely preserved plant-eating nodosaur (dinosaur) was discovered at a mine in the oil sands of northern Alberta. This dinosaur was first mummified, and then fossilised, preserving both skin and gut contents. The fossil was discovered by an equipment operator and subsequently recovered by palaeontological resource management staff from the Royal Tyrrell Museum of Palaeontology (RTMP) in Drumheller, Alberta. This unique fossil is now preserved at the RTMP and is on display to the public and is available for research.

BLM planning documents occasionally state that approving ground-disturbing actions on public lands is good for palaeontological resources because it results in the discovery of fossils that would not have otherwise been discovered. This statement is occasionally true, as illustrated above, but is not true when fossils are lost, destroyed or not recorded. If a plan is not well thought out, or is not implemented, resource management will be arbitrary.

## Mitigation



*Figure 6. Potential Fossil Yield Classification map of central Utah showing the position of proposed energy development over highly fossiliferous areas. Graphic created by Scott Foss, Bureau of Land Management.*

Mitigation satisfies planning objectives and is often necessary to balance the values on the land. As non-renewable resources, fossils are subject to impact from land use and development. Assessment and mitigation are necessary where proposed land development would conflict with fossil resource uses or preservation. Mitigation includes

pre-project surveys and inventory, monitoring during land-disturbing activities (including excavation), salvage of important fossils and transfer to a museum or other appropriate repository, and the production of detailed reports and educational materials for both proponents and bureaus. Mitigation palaeontology is so complex on BLM and Forest Service lands that a specialised profession of mitigation palaeontologists exists within the ranks of professional palaeontology. The state of California also has policy under the California Environmental Quality Act (CEQA) that is implemented through the California Department of Transportation (CalTrans) that also requires the services of mitigation palaeontologists. The results of palaeontological mitigation partially satisfy all three parts of the BLM palaeontology mission (science, inventory, and education).

Mitigation is a logical outgrowth of planning, so not all organisations need to implement a separate program of mitigation. For example, the NPS has a preservation mandate and therefore generally follows a program of avoidance, so only occasionally needs address mitigation as part of the planning process.

## Collection



*Figure 7. Image of an ammonite fossil with a rock hammer for scale. Palaeontology is a collections-based discipline. Bureau of Land Management.*

Palaeontology is a collections-based discipline, so anyone who manages fossil resources will need to manage collecting. However, there are many reasons to collect ranging from research purposes to hobby collecting. The different reasons for collecting mean that each permit authorisation may be unique.

Currently, the BLM recognises three broad categories of permitted collecting, survey and limited surface collecting, excavation, and consulting. Survey and limited surface collecting results in minimal-to-no damage to the land and so does not require pre-work analysis, whereas

excavation does require a multidisciplinary analysis on the effects that excavation will have to non-fossil resources. An excavation may be a simple disturbance of a few meters over a few days, or may be as complex as including heavy equipment, pneumatic tools, or explosives, and continue for periods of years. A consulting permit is granted to professional palaeontologists who conduct fossil surveys and record and salvage palaeontological resources during other approved land-disturbing activities, such as land clearing for road building or energy projects.

Collection for commercial purposes is not allowed on public lands in the United States but is allowed on private lands (at the discretion of the land-owner) and on some state lands. Commercial collecting is a complex undertaking that is subject to many, often conflicting, laws. Any program of collecting needs to establish where commercial collecting is or is not authorised.

## Curation

When fossils are collected for scientific purposes curation in an approved repository is necessary. However, what constitutes an approved repository must be defined. Will fossils remain in the public trust? If so, what standards must be met by a repository? Will a geology department collection qualify as an approved repository? Are private collections of publicly owned fossils allowable? Who will keep track of collections? Who is responsible for the care and maintenance of publicly owned fossil collections?



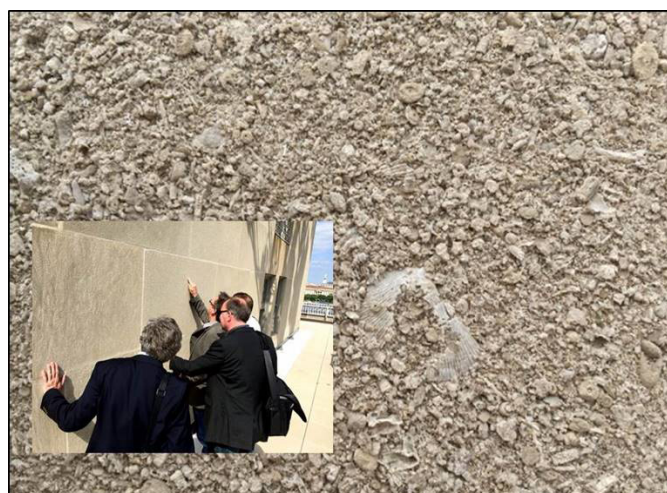
*Figure 8. Image of a paleontologist preparing a fossil at John Day Fossil Beds National Monument, Kimberly, Oregon. Photo by Scott Foss, Bureau of Land Management.*

Even when fossils are owned by the public, control is not clear. Nearly everyone who touches a fossil will feel some level of personal connection to it. Imagine an important fossil from public land in the United States that is on display at a major museum that exhibits it as their own with their own catalogue number in full view. The team of fossil preparators who cleaned and exposed the fossil over the period of years has invested sweat equity into

the specimen and feels a kinship, if not ownership of the specimen. The exhibit team that mounted the specimen also feels some level of connection, as does the field crew that excavated it, and the individual who discovered it. Then there is the public land bureau that produced the environmental assessment, authorised the excavation, and issued the permit. There is the researcher who studied the fossil and published a paper naming the fossil as a new species, and through their authorship have forever associated their name with the identity of the fossil. Perhaps they assigned the new species by naming it after the field crew member who discovered the fossil, or perhaps they give it a name using another Latin superlative, perhaps both. And finally, there is the actual owner of the fossil, the general public.

The story of a fossil's journey after it is out of the ground is often as interesting as the story of how it got into the ground in the first place. Nearly everyone who touches the fossil feels some level of personal connection. Those feeling should be respected. Public agencies manage fossils on behalf of the public that owns the fossils, so public land managers need to ensure that museums acknowledge every level of contribution that is associated with important fossils, and that they inform visitors to museums that most or all objects that are curated at that facility originated somewhere else. In the United States most dinosaurs on display were discovered on public lands.

## Education



*Figure 9. Paleontologists from the executive committee of the Society of Vertebrate Paleontology discovering fossils entombed in the stone walls of government in Washington, DC. Nearly everyone who touches a fossil feels some level of ownership Photos by Scott Foss, Bureau of Land Management.*

Most fossils belong to the public and so sharing discoveries with that public is a primary responsibility for any palaeontology program. In addition, engagement serves



to educate people about the importance of understanding our shared history and of the fascinating natural history of extinct organisms. Palaeontology addresses questions of biological evolution and provides a necessary deep time perspective into everything from the changes of life over time to the cycles of climate change on planet Earth. Understanding palaeontology is both interesting and important. If the importance of the science of palaeontology and the fascinating history of individual fossils can be shared, the public will appreciate the resource more, hopefully sharing those values with politicians and convincing them that palaeontological resources are worth preserving.

Training and teaching each other is just as important to the health of the profession. There need to be career ladders that allow provide access to and inclusion within to the profession, and opportunities for future generations of "palaeocrats" to find their way into managing palaeontological resources. We need to continue to share what we discover and explain why it is important.

## Protection

The term "fossil protection" normally refers to the actions taken to prevent or else respond to theft or vandalism, whereas the term "preservation" refers to the entire suite of management choices that result in ensuring access to palaeontological resources and the information they offer for present and future generations. Thus, protection is one of the eight categories of palaeontological resource management presented here.



*Figure 10. BLM law enforcement receive a tour of the fossil preparation laboratory at the Natural History Museum of Utah in Salt Lake City, Utah. Law enforcement intervention will always be necessary but should be a last resort. Photo by BLM staff, Bureau of Land Management.*

When people are engaged in the preservation of fossil resources they will protect them. That is why the MAP associates fossil protection with palaeontological educa-

tion. A good education program will result in protection of fossils because the public is invested in the resource. In this way they will not only protect the fossils from people who would do damage or harm to them, but they will understand the value of protecting the resource for the future. If they share that value, they will understand the importance of the laws because they respect and agree with them. Rather than view public land rules as limiting personal freedoms, a good program will inspire the public to support practices that would preserve palaeontological resources.

Of course, there will always be a need to protect fossil resources from people who would vandalise, harm, or steal them, so palaeontology programs will always need to partner with law enforcement. However, if the public is invested in preserving palaeontological resources and shares that value with those who manage palaeontological resources, they can work with law enforcement as a partner rather than as an antagonist.

## Conclusion

A comprehensive palaeontology resource management program must address inventory, monitoring, planning, mitigation, collecting, curation, education and protection. It would therefore be most constructive for any legislation for the preservation or management of palaeontological resources to provide appropriate authority for these eight program areas, with special emphasis on any specific needs. The Palaeontology MAP, consisting of Mission, Authority, and Program, provides a rational palaeontological management structure that can be applied to any palaeontological legislation and subsequent bureaucracy in any country or state.

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