APPENDIX J PALEONTOLOGY

Fossil Yield Potential Classification - (FYPC)

Introduction

This is a planning tool wherein geological units, usually at the formation or member level, are classified according to the probability of yielding paleontological resources that are of concern to land managers. Existing statutes and policies regulate the collection and disposition of scientifically significant fossils, but do not impact the recreational use of common variety fossils. Therefore, this classification is based largely on how likely a geologic unit is to produce scientifically significant fossils. The fossil yield potential classes are described below, with some examples of corresponding management considerations or actions. Useful references are the Scientific Significance Criteria for Fossil Resources, Locality Sensitivity Ranking, and the Paleontological Survey Process.

NOTE: This system only applies to Forest acres where geologic bedrock is exposed or in the shallow subsurface (covered by less than 1 meter of surficial material). This system is based on **probabilities**, not certainties or special circumstances. There may be exceptions to each criterion used as the basis for classification, and one particular geologic unit may be given different FYPC values in different places. Such instances are to be expected given the complexity of the system being modeled.

FYP Class 1

Description: Igneous and metamorphic (volcanic ashes are excluded from this category) geologic units that are not likely to contain recognizable fossil remains.

Basis:

- Fossils of any kind not known to occur except in rare circumstances.
- Igneous or metamorphic origin.
- **Example:** Vishnu Schist

Management examples:

1. After initial designation as FYP Class 1, such acres are no longer included in Geologic Services Outputs.
2. No FYP Class 1 acres included in paleontological reconnaissance work plans.
3. Class 1 acres documented as nonfossiliferous and then excluded from the remainder of the NEPA process.

The land manager's concern for paleoresources on Class 1 acres is negligible. Ground-disturbing activities will not require mitigation and/or monitoring for paleontology except in rare circumstances. Plans and budgets do not need to address the range of potential uses, availability or management options. Much of the acreage of high altitude, mountainous districts (mountain cores) will be determined Class 1. Significant fossil deposits are known to occur within caves or fissure fills developed in Class 1 units (Unwiley Coyote Site, Black Hills, South Dakota).

FYP Class 2

Description: Sedimentary geologic units that are not likely to contain vertebrate fossils or scientifically non-significant fossils.

Basis:

- Non-significant fossils of low diversity occur in relative abundance.
- Vertebrate fossils known to occur *very rarely or not at all*.
- Age greater than Cambrian.
- Diagenetic alteration.
- Deep-water marine or eolian origin.

Example: Madison Limestone; Navajo Sandstone

Management examples:

1. After initial designation as FYP Class 2, such acres are not included in Geologic Services Outputs.
2. Class 2 acres *generally not* included in paleontological reconnaissance work plans, there may be rare exceptions.
3. Recreational (hobby) collecting of non-significant fossils in Class 2 acres allowable unless otherwise prohibited by Forest Plan or special designation.
4. Consideration under NEPA not likely to be necessary.

The land manager's concern for paleoresources on FYP Class 2 acres should be weighted towards high access or availability and low risk management. For example, Class 2 acres may be designated as open to recreational collecting once cleared by an assessment. Ground-disturbing activities are not likely to require mitigation and/or monitoring. In some cases, Class 2 acres may be relatively abundant with non-significant, nonvertebrate fossils.

Class 3

Description: Fossiliferous geologic units whose fossil content varies in significance, abundance, and predictable occurrence. Also sedimentary units of unknown fossil potential.

Basis:

- Marine units with sporadic known occurrences of vertebrate fossils (fish scales and shark teeth, occasionally more significant specimens).
- Terrestrial units containing dominantly widespread and well-known plant remains.
- Vertebrate fossils and significant nonvertebrate fossils known to occur inconsistently--predictability known to be low.
- Poorly studied and/or poorly documented, FYPC cannot be assigned without ground reconnaissance.

Example: Chinle Formation, Greenhorn Limestone

Management examples:

1. FYP Class 3 acres are implemented into a program of cyclical survey and salvage with a Geologic Services Outputs accompanying each cycle.
2. Recreational (hobby) collecting of common variety fossils in class 3 acres allowable unless otherwise prohibited by Forest Plan or special designation.

3. NEPA assessment is a necessity as such acres have unknown/unpredictable fossil potential.
4. FYP Class 3 units may be given another classification as more geologic and paleontologic knowledge is acquired.

The land manager's concern for paleoresources on Class 3 acres may extend across a wide variety of management actions. Some areas will require very little budget and management while providing high levels of availability and unregulated access. The land manager should be concerned with this classification because significant locations may be discovered, thus requiring budget and management attention. Depending upon degree of significance/re-classification, these units may require mitigation and/or monitoring for ground-disturbing activities.

FYP Class 4

Description: Class 4 geologic units are Class 5 units (see below) that have lowered risks of human-caused adverse impacts and/or lowered risk of natural degradation.
Basis:

- Significant vegetative cover; (outcrop is poorly exposed).
- Outcrop area is small, and not easily accessed or visible from road/trail.
- Vertical and/or inaccessible outcrops.
- Areas that historically produced significant fossils but have since been degraded by intense fossil collecting and/or other inadvertent destructive recreational activities.
- Other characteristics that lower site sensitivity (see Locality Sensitivity Ranking).

Example: Covered acres of Morrison Formation.

Management examples:

1. FYP Class 4 acres are implemented into a program of cyclical survey and salvage with a Geologic Services Outputs accompanying each cycle.
2. Due to the sensitive nature of significant fossil resources occurring on Class 4 acres, recreational (hobby) collecting of non-significant fossils requires a permit.
3. Designate as a Paleontological Special Interest Area.
4. NEPA assessment is a necessity; as such acres are known to yield significant fossil resources.

The land manager's concern for paleoresources on Class 4 acres may extend across a wide variety of management actions. Some areas will require very little budget and management attention until ground disturbing activities are identified. Detailed NEPA assessment and mitigation closely monitored by a paleontologist is required during ground disturbing activities in Class 4 areas. Depending upon the mitigation recommendations, reclamation including reseeding of the disturbed area may be a necessity.

FYP Class 5

Description: Fossiliferous geologic units that regularly and predictably produce vertebrate fossils and/or scientifically significant nonvertebrate (plant and invertebrate) fossils, and that are at risk of natural degradation and/or human-caused adverse impacts.
Basis:

- Vertebrate fossils and/or scientifically significant nonvertebrate fossils are *known and documented* to occur consistently, predictably, and/or abundantly.
- Known for high fossil yield, numerous sites per section of land.
- Known for high risk of theft and/or vandalism.
- Outcrop area is well exposed, little or no vegetative cover.
- Roads/trails provide easy access to geologic exposures (increased potential for illegal collection; damage by vandals and thieves).
- Other characteristics that increase site sensitivity (see Locality Sensitivity Ranking).

Example: White River Formation/Group
Management examples:

1. FYP Class 5 acres are implemented into a program of cyclical survey and salvage with a Geologic Services Outputs accompanying each cycle.
2. Due to the sensitive nature of significant fossil resources occurring on Class 5 acres, recreational (hobby) collecting of non-significant fossils requires a permit.
3. Designate as a Paleontological Special Interest Area.
4. NEPA assessment is a necessity; as such acres are known to yield significant fossil resources.
5. Paleontological reconnaissance work should focus on poorly known areas of Class 5 acres.

The land manager's highest concern for paleoresources should focus on Class 5 acres. Most illegal, un-authorized collection of fossil resources on National Forest System Lands will occur in Class 5 areas. Mitigation of ground disturbing activities is required and may be intense. Frequent use by the entire spectrum of interested publics is to be expected. Areas of special interest and concern should be designated and intensely managed. Field-based, technical training in paleoresource management should be provided to Forest and District staff and to Law Enforcement Officers. Memoranda of Understanding, Challenge-Cost Share, and/or Participating agreements with professional academic paleontologists should be sought and maintained in order to provide a consistent source of outside expertise. Curation Agreements should be maintained with area museums so that there is always a repository for collected fossils. Class 5 acres are likely to yield appropriate recreational and educational opportunities, though it is more difficult to isolate opportunity acres from surrounding critical acres and therefore access must be more intensely regulated. These areas should be identified and utilized under recreation fee authorities, but the delicate balance between opportunity and potential degradation of critical Class 5 paleoresources must be recognized and addressed in planning for such use.

Predictive Modeling and the Designation of Paleo Classes

The Region 2 Paleontological Program will continue to test and refine the FYPC model in subsequent years. This mission is being performed in conjunction with numerous professional paleontological institutions from all 5 states in the Rocky Mountain Region. The successful implementation of the FYPC model requires accurate geologic maps. Those Forests/Ranger Districts for which detailed geologic data is not available should be considered high priority for reconnaissance efforts. The specific FYPC model for any Region/Forest/District should be accompanied by a Fossil Yield Potential Map (FYPM), which depicts the surface distribution of FYP classes for a particular area. The ultimate FYP maps that develop out of the FYPC model will dictate where paleoresource management and dollars should be concentrated in the Rocky Mountain Region.

FYP classes are assigned to geologic units in the Rocky Mountain Region on the basis of empirical data gathered through literary survey and field experience of R2 paleontologists and other ground-based personnel. This method does not allow designation of Class 4 acres, because in most cases the depth to bedrock will not be accurately known. Therefore, we can only accurately predict the occurrence of Class 4 units in and around Class 5 exposures. The existing FYPC model can be refined a level further by use of detailed surficial geologic maps. Detailed surficial information will yield a much more realistic FYPM, allowing accurate prediction of unseen class 4 units in the shallow subsurface (Class 5 units covered by less than 1 meter of surficial material and which will be impacted by shallow surface disturbance).

The management examples and narrative recommendations are not to be considered directives, or standards and guidelines for planning purposes. They are informal guidelines to supplement policies, regulations, and directions in draft for the national paleontology program. These guidelines are not exhaustive; many other factors are considered in management decisions. The criteria given as the basis for classification are not exhaustive either. They are designed to guide the outside expert who may be recommending classification as part of a partnership, contract, or permit. A reviewing Forest Service paleontologist or a qualified colleague will make designations from another Federal agency. Designations are not final and are expected to change as we gain understanding about the paleoresources of National Forests and Grasslands.

Significance Criteria for Paleontological Resources -- Vertebrate, Invertebrate, and Plant Fossils, including Ichnofossils

Scientific significance may be attributed to a fossil specimen or trace and/or to its context (e.g., location in time and space; or association with other relevant evidence.
The scientific significance of a paleontological specimen or trace and/or its context is determined by meeting any one of the following criteria:
Specimen-based criteria:

- Represents an unknown or undescribed/unnamed taxon.
- Represents a rare taxon, or rare morphological/anatomical element or feature. The "rareness" criterion comprises either absolute rareness in the fossil record, or relative or contextual rareness as described below.
- Represents a vertebrate taxon.
- Exhibits an exceptional type and/or quality of preservation.
- Exhibits remarkable or anomalous morphological/anatomical character(s) or taphonomic alteration.
- Represents "soft tissue" preservation or presence.

Context-based criteria:

Is associated in a relevant way with other evidence of scientific interest, providing taphonomic, ecologic, environmental, behavioral, or evolutionary information.
Is evidence that extends and/or constrains the stratigraphic, chronologic and/or geographic range of a species or higher-level taxonomic group.

Locality/Site Sensitivity Rankings For Fossil Resources

Paleontological sensitivity rankings are composite evaluations derived from individual consideration of the following factors. Sensitivity rankings apply to paleontological sites and localities, not to individual specimens.
Each factor should be ranked individually on a scale of 1 to 5, where **1** is the **lowest** sensitivity ranking and **5** the **highest**. The composite ranking of sensitivity for a locality or site is the arithmetic mean of the individual rankings.

1. **Scientific significance** of specimens associated with the site (see above).
2. **Fossil Yield Potential Classification** based on likelihood that geologic strata at the site are fossiliferous. This factor may be evaluated by pedestrian inventory, literary survey, and consultation with professional specializing in the particular geologic interval/area in question..
3. **Values** of an educational, interpretive, and/or recreational opportunity.

   Public education, interpretive, and recreational values are those that utilize the power of fossil resources to provoke insight into ancient life forms and ancient ecology, and to reveal their connections to the present and future. Educational values also enhance a stewardship ethic towards legacy resources, and stress the importance of environmental and scientific literacy.
4. **Risk** of resource degradation at the site.

   Risk factors include:

   Biotic agents: vandalism, theft, ground disturbance; grazing impact; trail-use impact.

   Abiotic agents: chemical and mechanical destruction of fossils exposed by erosion; landslides; inundation; fluvial transport, etc.

Example 1. A *category: vertebrate site* is identified in rocks of the White River Formation on the Pawnee National Grassland. Resources at the surface include fragments of horse and oreodont skeletons.

1. Scientific Significance ranking = **5**.

   See Scientific Significance Criteria above. The site is composed of vertebrate fossils, the likelihood of excellent preservation is expected, and it may produce a rare skeletal element or specimen. Context-based criterion-2 is met--the mammalian fauna of the Pawnee NG is important for better defining the biostratigraphic ranges within the Chadronian and Orellan Land Mammal Ages.

2. Fossil Yield Potential Classification = **4**.

   The formation is known to produce scientifically significant fossils. Mammal fossils are likely to be found following erosional events.

3. Values ranking = **4**.

   The mammalian fauna of the White River Formation in this area is informative to questions of paleoecology and biogeography. Interpretive materials that utilize this paleontological resource would be good examples of the way scientists interpret ancient ecosystems, and how that information can be applied to modern-day problems of global change.

4. Risk factor ranking = **5**.
   Biotic agents: Significant and sensitive sites are located near or on trails. These trails are advertised in area guides as "good places to pick up fossils."
   Abiotic agents: Sites are located in geologic strata that erode very easily and rapidly, especially during the spring and early summer. Fossils may be easily washed out of their informative context, or removed altogether and re-buried downstream. The site occurs within a grazing allotment, and cattle have trampled the site in the past.

1. Composite ranking: 5 + 4 + 4 + 5 = 18; divide by 4 = **4.5 sensitivity ranking for this site.**

   Appropriate management strategies for this site would include: designation as a Special Interest Area; cost-share initiated collection of exposed resources by a professional paleontological institution (museum/university; and fencing off the geologic exposures to prevent cattle from damaging the site. Potential recreational activities would include participation in research/field excavation by qualified investigators, technical educational field work by non-specialists overseen by qualified FS personnel,, and guided interpretive tours for the public.

Example 2: A *category: invertebrate site* is identified in Cretaceous marine rocks (Turner Sandy Member, Carlile Shale) on the Buffalo Gap National Grassland. Resistant layers containing ammonites form a capping layer along ridges in many parts of the district.

5. Scientific Significance ranking = **3**.

   Ammonites within the Turner Sandy Member are relatively abundant, and the majority of specimens are either *Scaphites whitfieldi* or *Prionocyclus wyomingensis*. These two

particular taxa occur over a wide geographic range and their occurrence is well documented within the particular unit.

6. Fossil Yield Potential Classification = **5**.

   Ammonites are relatively abundant; occur in many areas of the Grassland

7. Values ranking = **3**.

   The recreational public is likely to enjoy picking up ammonites in this area, and to consider the past environment in which they were deposited --without interpretive aids. The ammonites provide an invaluable biostratigraphic teaching tool for schools and universities. The distribution of this resource does not lend itself to formal interpretive displays or activities.

8. Risk factor ranking = **5**.
   Biotic agents: Commercial fossil hunters have significantly impacted some areas searching for the ammonites, overturning the cap-rock layer along many ridges. The likelihood that sufficient collecting by the general public will deplete the supply of ammonites is low for the foreseeable future; however, the possibility that other, more significant fossils will be found and carried away exists and cannot be easily monitored.

   Abiotic agents: The sandstone layers are relatively resistant and slow weathering, thus the threat of resource loss due to the elements is low. Composite ranking: 3+5+3+5= 16; divide by 4 = **4 sensitivity ranking for this site.**

   Appropriate management strategies for this site might include: 1) educational and interpretive field trips to promote understanding of represented ancient environment; 2) posting signage near un-impacted sites stating that commercial collecting of fossil material is not allowed, and that no unweathered rock should be over-turned; 3) request that the public report any unusual fossil finds; 4) occasional reconnaissance to determine if collecting of ammonites is threatening other resources in the area or affecting the scenic and aesthetic values of the site.

Paleontological Survey Process

Once a ground-disturbing project is identified to take place and during the NEPA process, a series of steps are taken to determine if paleontological resources will be impacted and what process will be needed for mitigation:

Step 1. Determine if the area to be disturbed will impact paleontological resources:

Each unit will determine if the project area contains fossils by consulting the maps delineating the geologic formation classifications.

If the formation is Class 1, fossils are not likely to be discovered; document in NEPA project file.

If the formation is Class 2, significant fossils are not likely to be discovered; notify the Forest Service Paleontologist and proceed with Step 2.

If the formation is Class 3-5, significant fossils will likely be discovered; notify the Forest Service Paleontologist and proceed with Steps 2-5.

Step 2. The Forest Service Paleontologist will conduct a literature search of paleontological information for the project area that may be contained in permitting documents, scientific literature, geological maps, libraries, and museums. This information will become of the NEPA project file. Surveying will not be required when no scientifically important specimens or sites are discovered in the literature. Go to Step 3 if the literature review indicates scientifically important fossils may be impacted.
Step 3. Forest Service Paleontologist, and/or qualified consultant will conduct a pedestrian survey of proposed project area and document findings. If paleontological sites are discovered then go to Step 4. If survey reveals no surface indication of fossils, then document in the NEPA project file.
Step 4. The Forest Service Paleontologist or qualified consultant will determine the sensitivity ranking for the sites to be impacted. (A Class 5 geologic formation may contain sites of low sensitivity.) The paleontologist on site will have to make this determination based on professional judgment and according to the process outlined in the Sensitivity Ranking.
Step 5. In sites with Class 3, 4, or 5 and a high sensitivity ranking, a Forest Service Paleontologist shall develop a protection and mitigation plan prior to project initiation and periodically monitor for compliance with the mitigation plan throughout the project.
Note: Units with formations ranked, as Classes 3-5 should have repository agreements in place with agencies or institutions collecting fossils as part of mitigation in order for the fossils to be cared for in perpetuity.

Qualifications for a Paleontologist

"PROFESSIONAL PALEONTOLOGIST"

A. Formal education resulting in a graduate or professional degree in paleontology, OR in a closely related field such as geology, biology, botany, or anthropology with a **major emphasis** in paleontology; OR
B. Equivalent training including at least 36 months of pertinent, professionally supervised experience with increasing responsibility leading to professional duties similar to those required by the instrument of record; AND
    - Demonstrated experience in collecting, analyzing, and reporting paleontological information of the type and in the scope of the work required by the instrument of record; AND
    - Demonstrated experience in planning, equipping, staffing, organizing, and supervising crews of persons performing paleontological work of the type and in the scope of that required by the instrument of record; AND
    - Demonstrated experience in carrying through to completion projects of the type and in the scope of the work required by the instrument of record, as evidenced by timely completion and/or publication of theses, research reports, scientific papers.

"PARAPROFESSIONAL PALEONTOLOGIST"

A paraprofessional paleontologist must present evidence of passage in good standing in a paraprofessional training course in paleontology such as that offered through the Denver Museum of Nature and Science. Graduate students working toward an advanced paleontological degree may be designated paraprofessionals by cooperating professional paleontologists.