National Park Service
U.S. Department of the Interior
SFAN Inventory and Monitoring Program
Research Project Summary April 2008

Paleontological Resource Inventory and Monitoring for the San Francisco Bay Area Network (SFAN)

The Question: *What paleontological (fossil) resources are present in San Francisco Bay Area Inventory and Monitoring Network (SFAN), and what should be done to preserve and manage this non-renewable resource?*

Fossils have taught us much of what we know about the history of life on Earth. Body fossils such as shells, bones or leaves reveal when and where organisms lived and died, new species arose and changes in climate and vegetation occurred. Trace fossils, including burrows, footprints and trails, allow us to "see" the behavior of long extinct organisms. On a grander scale, fossils tell us about the age of the rocks they are in, the movement of land masses and the formation of mountains and seas. This information not only allows us understand the past, but can also help us predict what might happen under similar conditions in the future.

Will Elder

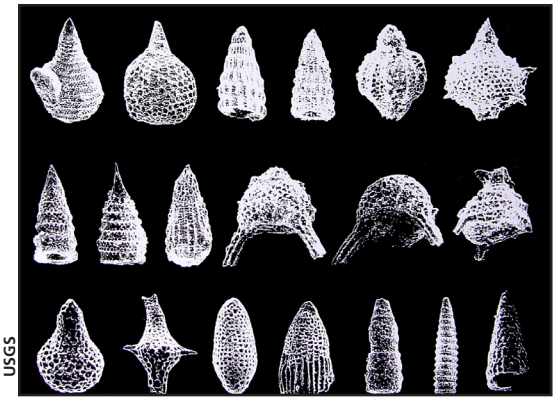
(Top) A modern whale skull similar to fossils found at Point Reyes. (Right) Bivalve and gastropod fossils from Fort Funston.

Despite the wealth of scientific and interpretive value fossils provide, in most cases parks do not have enough baseline data to adequately manage these resources. A complete paleontological survey for the nearly 178,000 acres in SFAN would be a huge task. Therefore, an important starting point for prioritizing future inventory and management efforts is a summary of known fossil resources, and an assessment of what areas are at the greatest risk of losing fossils to unauthorized collection or environmental changes.

The Project: *Synthesize existing information on the paleontological resources in SFAN to support stewardship and educational efforts.*

The recently completed report, *Paleontological Resource Inventory and Monitoring—San Francisco Bay Area Network*, chronicles the fossil resources at each SFAN park. Notable fossils from geologically similar areas proximate to each park are also included. Data are from literature reviews and interviews with park staff, geologists and paleontologists, and have been peer reviewed. This valuable information is now available to support management decisions, and to spur further research, education and interpretation.

The Results: *Pinnacles National Monument, Golden Gate National Recreation Area and Point Reyes National Seashore all contain paleontological resources. Although no fossils have been documented in Eugene O'Neill or John Muir National Historic Sites, fossils have been found nearby so it is likely that similar resources exist within these parks as well.*



USGS

Radiolarian fossils from the Marin Headlands

Pinnacles National Monument (PINN)

Volcanic ash deposits in PINN contain remnants of a small ostracod crustacean that indicates some of that the area was under water during the Miocene. Nearby geologic formations and streambeds are rich in fossils, and a few fossils have been found in sedimentary deposits within the park. A field-based survey is recommended.

Golden Gate National Recreation Area (GOGA)

A recent survey of the parks within GOGA found abundant fossil resources, many of which have provided valuable information about the geological history of the area (Table 1). Notably, tropical and sub-tropical species of zooplankton found in the chert of the Marin Headlands indicate that these rocks formed between 100-200 million years ago, and traveled to their current location from as far away as the equator.

The paleontological resources within GOGA are at risk from unauthorized collection. A field-based inventory and interviews with specialists familiar with the park should be conducted to document these resources. Park staff should also watch for fossil material during fieldwork, especially in areas prone to erosion.

Table 1. Fossil resources found in GOGA, or in geologically similar areas nearby.

Site (mya=million years ago)	**Fossils**
Marin Headlands and points north Jurassic-Cretaceous (199.6-65.5 mya)	zooplankton (radiolaria), mollusks (ammonite, belemnite, bivalve)
Alcatraz Island Cretaceous (145.5-65.5 mya)	bivalve mollusk
Mori Point Cretaceous (145.5-65.5 mya)	zooplankton (radiolaria, foraminifera)
Near Devil's Slide Paleocene (65.5-55.8 mya)	zooplankton (foraminifera), mollusk (gastropod, bivalve), crustacean, sea star-like animals (echinoid)
Fort Funston Pliocene-Pleistocene (5.3 mya – 11,477 yrs)	mollusk (gastropod, bivalve), sand dollar, crustacean, marine worm (polychaete), woolly mammoth, giant ground sloth, mastodon, horse, camel, canid and split-toed ungulate
Phleger Estate Pliocene-Pleistocene (5.3 mya – 11,477 yrs)	mollusk (freshwater gastropod, bivalve), unnamed vertebrates, plants, woody debris
Presidio and vicinity Pleistocene (1.8 mya - 11,477 yrs)	microscopic algae (diatom), pollen, mammoth, bison, ground sloth

Point Reyes National Seashore (PORE)

Although there has been no formal paleontological resource inventory for PORE, numerous fossils have been found in or near the park (Table 2). Given the richness of the resource—and the high potential for additional discoveries and unauthorized collection—a field-based inventory and interviews with experts who have worked in the park are recommended. The museum's collection could also be augmented with molds of specimens that are currently housed elsewhere.

Table 2. Fossil resources found in PORE, or in geologically similar areas nearby.

Site (mya=million years ago)	**Fossils**
Far western part of the peninsula Eocene (55.8 - 33.9 mya)	zooplankton (foraminifera), plants, seeds
Point Reyes Beach Miocene (23 - 5.3 mya)	mollusk (bivalve), sea star-like animals (echinoid)
Duxbury Point to Abalone Point Miocene (23 - 5.3 mya)	microscopic algae (diatom), zooplankton (foraminifera), sea star-like animals (echinoid), crustacean, whale bone and skull
Drakes Beach Miocene-Pliocene (23 - 1.8 mya)	microscopic algae (diatom), mollusk (gastropod, bivalve), sea star-like animals (echinoid), crustacean (isopod, crab, shrimp), otarioid seal, walrus, balaenopterid whale, dugongid sea cow, fish and mammal bones
The sea cliffs at Bolinas Pliocene-Pleistocene (5.3 mya – 11,477 yrs)	microscopic algae (diatom), zooplankton (radiolaria, foraminifera), sponge, crustacean, sea star-like animals (echinoid), mollusk (gastropod, bivalve), whale skull, sea lion, porpoise, bony fish, sharks, feathers, plant, carbonized wood
Tomales Bay and Olema Creek Pleistocene (1.8 mya - 11,477 yrs)	microscopic algae (freshwater diatom), mollusk (bivalve, gastropod, scaphopod), arthropod, plants

Eugene O'Neill National Historical Site (EUON) and John Muir National Historic Site (JOMU)

Although there has been no paleontological survey for EUON, there are a number of areas nearby that are rich in fish and invertebrate fossils. Similarly, there has been no formal survey for JOMU, but a diverse array of invertebrate and microfossils such as mollusks and zooplankton have been found nearby. Because it is likely that similar resources also exist within these parks, field surveys and careful monitoring of any excavations are recommended.

Additional Resources:

Elder, W. P., T. Nyborg, J. P. Kenworthy, and V. L. Santucci. 2007. Paleontological Resource Inventory and Monitoring—San Francisco Bay Area Network. Natural Resource Technical Report NPS/NRPC/NRTR—2008/078. National Park Service, Fort Collins, Colorado.

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