

Arid Land Reclamation Research in Glen Canyon

By Jim Holland and Dennis Schramm

Glen Canyon National Recreation Area (GLCA) is one of five national recreation areas in the National Park System where the enabling legislation authorized continued federal mineral leasing. Since its establishment in 1972, no new leases have been issued; however, many oil and gas lease applications are awaiting National Park Service review and several valid existing oil and gas leases issued prior to 1972 remain. In addition, the Combined Hydrocarbon Leasing Act of 1981 provided for conversion of existing oil and gas leases to combined hydrocarbon leases within special tar sand areas (STSA) identified in the act. The Tar Sand Triangle, partially within GLCA, is one of these STSA's.

Before a lease can be issued, the NPS must make a finding that development of the lease will not result in significant adverse effects on the resources of the park. An important element of this "significance" determination is an assessment of the reclamation potential of the affected land.

During the recent review of tar sand lease conversion proposals at GLCA, conflicting statements emerged concerning the area's reclamation potential. Estimates of complete recovery of disturbed lands varied from 5 to 100 years. Some even questioned the feasibility of any reclamation in the arid lands of the Tar Sand Triangle. These concerns raised fundamental questions in the review of all mineral development proposals, prompting the Service to investigate the potential for reclaiming disturbed lands to predisturbance conditions.

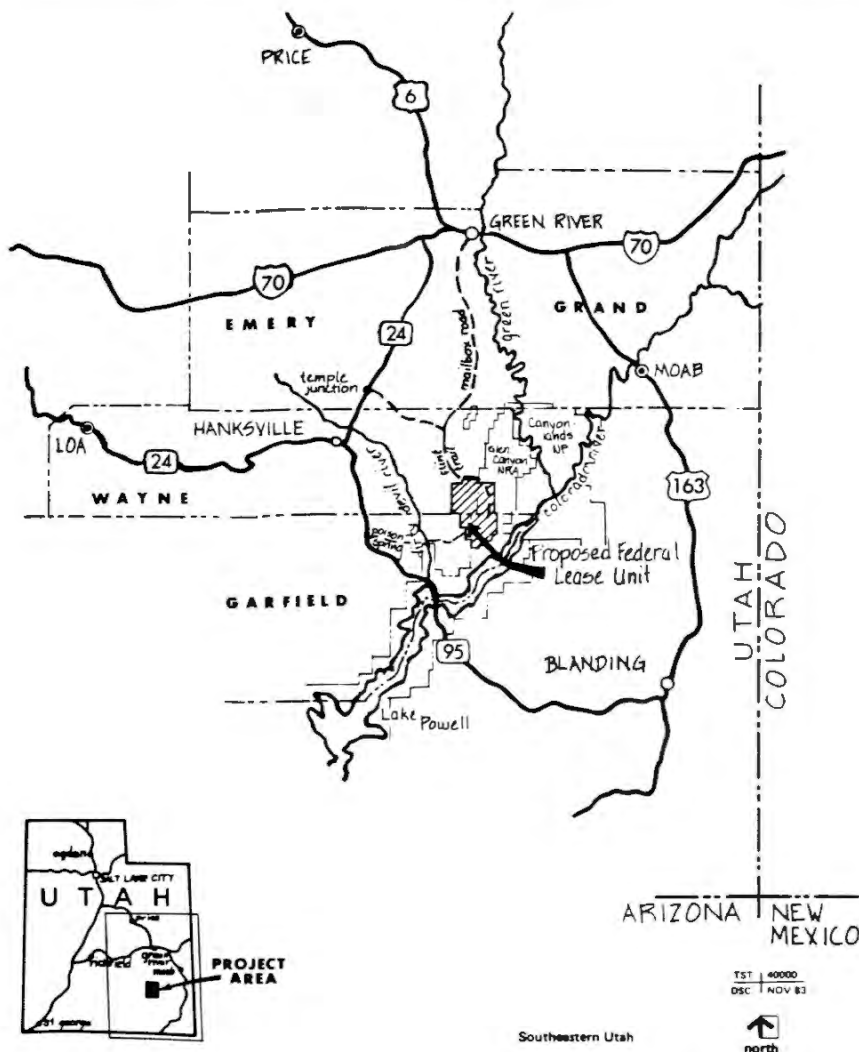
In 1984, faced with potentially 22,000 acres of tar sand development and 160,000 acres of pending oil and gas lease offers, Glen Canyon requested the support of the Washington Office - Energy, Mining and Minerals Division, in investigating reclamation potential of lands disturbed by mineral activity. Of primary concern were the pinyon-juniper woodlands and sagebrush shrublands in the Tar Sand Triangle, located within the Orange Cliffs portion of the GLCA, just west of Canyonlands NP. (see regional map).

A research proposal was developed by the authors to determine reclamation potential in the Orange Cliffs, using only native plant species without irrigation. The primary objective was to test the effectiveness of various reclamation treatments on establishment of native plants from seed and transplant survival. Results will be used to develop reclamation prescriptions for returning an area to predisturbance conditions and to develop appropriate bonding levels for proposed operations. Experience and information gained in this project also will be incorporated into Service-wide reclamation guidelines and standards currently being developed by the Energy, Mining and Minerals Division.

The project consists of four integrated phases: (1) reviewing recent arid land reclamation literature, (2) preparing a reclamation research plan for four disturbed sites in the Tar Sand Triangle, (3) implementing the plan and (4) preparing a field monitoring manual that outlines monitoring procedures and statistical analysis methods for evaluating the success of various reclamation treatments.



Pinyon-juniper woodlands and sagebrush shrublands typical of the area surrounding the research sites.



NPS contracted with Thorne Ecological Institute of Boulder, Colo., to do the literature review, develop the plan and prepare a research monitoring manual. Field implementation of the reclamation plan was conducted by Thorne and three subcontractors.

The Environment

The Orange Cliffs are located on the Colorado Plateau, in south-central Utah, northwest of the Colorado River (see map), an area of flat-topped mesas, vertical cliffs, and deep canyons resulting from differential erosion of geologic strata. Mesa tops vary from 6774 ft. to 7866 ft. and are composed of reddish-brown Wingate sandstone capped by Kayenta formation (a buff brown, coarse sandstone with minor shale and limestone interbeds). Navajo sandstone, characterized by large-scale, tangential cross-bedding, overlies the Kayenta and outcrops occasionally in the project area.

The semi-arid environment retards weathering of the sandstone parent material, so soils are formed and deposited chiefly by wind and water erosion. Soils on the mesa tops were formed from wind deposited sands and are generally quite shallow (less than 50 cm). Soils of the Orange Cliffs are composed primarily of shallow Mellenthin series, which are loamy Calciorthids that support pinyon-juniper woodlands. A small percentage of the mesa top is covered with deeper (115-180 cm) Begay soils - coarse-loamy Camborthis, typically supporting sagebrush and grassland vegetation.

Cryptogamic soil crusts are found on all soil types in the project area. These crusts are composed of nitrogen-fixing bacteria, algae, fungi, mosses and lichens that bind soil particles into lumpy, blackish crusts, resistant to wind and water erosion.

The semi-arid environment of the area is modified locally by topography and elevation and soil characteristics. Three-year averages (1982-1983) for precipitation and temperature at the Hans Flat Ranger Station reflect the climate of the project area. Average annual precipitation for the three year period was 30 cm, with 10 percent falling in March and 62 percent in July through November. Approximately half of the annual precipitation falls as snow. The driest portion of the year occurs from December through February, averaging only 3.2 cm. Lowest average mean minimum temperatures of 22°F occur in December and January. Average mean maximum temperatures in the summer months range from 80°F to 85°F.

Native vegetation on the mesa tops consists primarily of pinyon-juniper woodland and big sagebrush-blue grama shrublands. Table 1 lists the primary native species found in these communities that were utilized in this study.

Site Selection

Fifteen oil and gas and uranium core hole drilling pads and several access roads were examined for potential use in the reclamation research. The drilling pads are from mineral exploration activities which pre-date the GLCA act. Most of the drilling sites are approximately 1 acre in size and were scraped to level the pad and remove native vegetation. Prior to our reclamation effort the disturbed drill sites were typically vegetated with a sparse mixture of native pioneer species including: rabbitbrush, snakeweed, globe-mallow, yellow bee plant, lobeleaf groundsel, and fineleaf hymenopappus. Non-native species such as Russian thistle and pigweed were present on the disturbed pads in small numbers.

Three drilling pads and a section of access road eventually selected for use in the research project provided a sample of typical soil and vegetation types.

All site locations are within 5 miles of the Hans Flat Ranger Station, minimizing travel and simplifying implementation and monitoring.

Experimental Design

Establishment of reclamation research plots on the disturbed sites began in the fall of 1984 with removal of existing vegetation, redistribution of berms and grading to approximate surrounding topography. The drilling pads and road section were then cross-ripped to a depth of 40-60 cm. Attempts at smoothing the surface after ripping by pulling an I-beam behind the bulldozer were not entirely successful; a harrow pulled behind a pickup completed the job.

Experimental sites were established on a small portion of the ripped area after surface preparation. Experimental study plots (3m x 3m) were located within fenced exclosures; the area outside the fence was seeded and harrowed. The experimental sites were fenced with 5-strand barbed wire and chicken wire to exclude cattle and rabbits. Exclosures on the abandoned drilling pads are one-half acre each and the

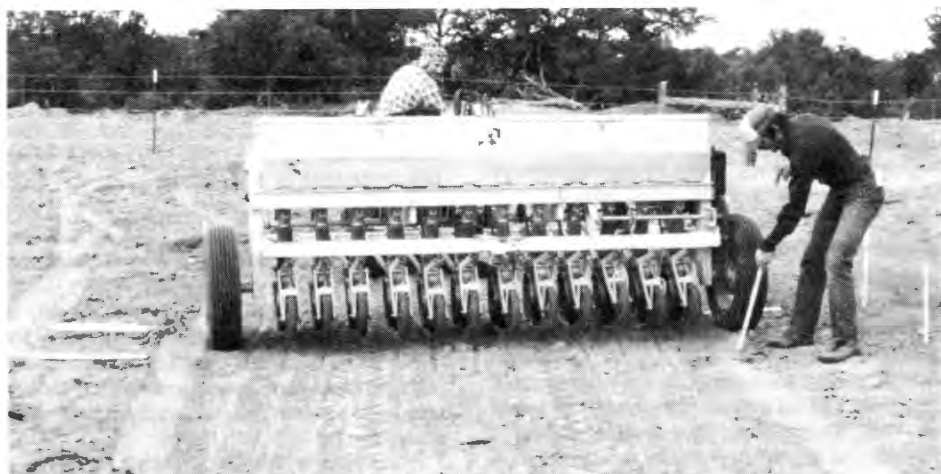
access road exclosure is one-quarter acre.

Three-meter-square study plots, separated by half-meter wide walking paths, were established in a grid pattern within the fenced exclosures. In all, 180 study plots were established on the 4 research sites, representing ten replications of each combination of experimental treatments.

Surface preparation, fencing, seeding, and transplanting of containerized seedlings were completed in November 1984 in a two-week period. Spring transplanting was conducted in April 1985.

Reclamation treatments selected for experimentation were based on results of the literature review and include the following: **seeding/planting methods** - drill seeding, broadcast seeding, and hand planting of containerized plants were tested; **seeding rates** - drill seeding and broadcast seeding were each tested at two different rates; **mulching** - the use of sterile straw mulch, juniper slash and no mulch were tested; **water retention** - the use of hand-dug furrows for

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Drill seeder being used to seed a study plot. Glen Canyon National Recreation Area.

Table 1: Native species used in reclamation research at Glen Canyon National Recreation Area

Scientific Name	Common Name	Transplanted	Seeded
Shrubs/Perennial Herbs			
<i>Artemisia tridentata</i>	big sagebrush	•	•
<i>Ephedra viridis</i>	green mormon tea	•	•
<i>Atriplex canescens</i>	fourwing saltbush	•	•
<i>Amelanchier utahensis</i>	Utah serviceberry	•	
<i>Cercocarpus montanus</i>	true mountain mahogany	•	•
<i>Sphaeralcea coccinea</i>	scarlet globemallow	•	•
<i>Cowania mexicana</i>	cliffrose	•	•
<i>Ceratoides lanata</i>	wintertat	•	•
Trees			
<i>Pinus edulis</i>	pinyon pine	•	•
Grasses			
<i>Bouteloua gracilis</i>	blue grama	•	•
<i>Hilaria jamesii</i>	galleta grass	•	•
<i>Oryzopsis hymenoides</i>	indian ricegrass	•	•
<i>Sporobolus cryptandrus</i>	sand dropseed	•	•

accumulating moisture versus no furrows was tested on the transplant plots; **planting season** – planting of containerized seedlings in spring versus fall was tested on the transplant plots.

Utah juniper, co-dominant in the pinyon-juniper woodland, was not available commercially for use in this study. Several other native species, common in the area and possibly desirable for reintroduction on disturbed sites, are not normally available through commercial suppliers. Species notable in this group include roundleaf buffaloberry, narrowleaf yucca, sandhill muhly, single-leaf ash, and Torrey's ephedra.

Two experimental plots also were established to evaluate the potential recovery of cryptogamic soil crusts common in the area. Soil crusts containing cryptogams were collected nearby and spread over the surface of the study plots. The cryptogams then were mixed with the soil to a depth of 5 cm and raked smooth. The plots will be monitored for recovery of soil crusts and compared to control plots where no soil crusts were added. The crusts appear to be a significant component of an undisturbed native site and re-establishment of them would be desirable.

Monitoring of the study plots will be done annually in July after maximum leaf expansion and prior to seed development. Biennial sampling will occur after the first two years, for approximately eight more years. One square meter of each study plot will be sampled in 10 randomly selected subplots (0.1 m² each).

Monitoring results should be available near the end of each calendar year following the data collection and analysis. Results can be obtained by contacting Jim Holland at (602) 645-2471. Limited copies of the final reclamation plan are available from Dennis Schramm at FTS 776-8780 or (303) 236-8780.

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