RECOVERY PLAN FOR

PANICUM FAURIEI VAR. CARTERI (HOSAKA) DAVIDSE

(CARTER'S PANICGRASS)

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THIS IS THE COMPLETED RECOVERY PLAN FOR PANICUM FAURIEI var. CARTERI. IT DELINEATES REASONABLE ACTIONS THAT ARE BELIEVED TO BE REQUIRED TO RECOVER AND/OR PROTECT THE SPECIES. OBJECTIVES WILL BE ATTAINED AND ANY NECESSARY FUNDS MADE AVAILABLE SUBJECT TO BUDGETARY AND OTHER CONSTRAINTS AFFECTING THE PARTIES INVOLVED, AS WELL AS THE NEED TO ADDRESS OTHER PRIORITIES. THIS RECOVERY PLAN DOES NOT NECESSARILY REPRESENT OFFICIAL POSITIONS OR APPROVALS OF THE COOPERATING AGENCIES, AND IT DOES NOT NECESSARILY REPRESENT THE VIEWS OF ALL INDIVIDUALS WHO PLAYED A ROLE IN PREPARING THE PLAN. IT IS SUBJECT TO MODIFICATION AS DICTATED BY NEW FINDINGS, CHANGES IN SPECIES STATUS, AND COMPLETION OF TASKS DESCRIBED IN THE PLAN.

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This recovery plan for Panicum fauriei var. carteri was prepared by Ms. Patricia C. Welton, Makawao, Hawaii. Modifications have been made by the U.S. Fish and Wildlife Service.

EXECUTIVE SUMMARY OF THE RECOVERY PLAN

FOR *Panicum fauriei* var. *carteri*.

Current Species Status: *Panicum fauriei* var. *carteri* is federally listed as endangered. Currently, four populations exist, one on Mokolii Islet off of Oahu, one near Maliko Gulch on Maui, one near Makamakaole Stream on Maui, and one near Kukaiwaa Point on Molokai. The estimates for each of these populations, based on field work conducted in 1992, range from 40 to 200 plants.

Habitat Requirements and Limiting Factors: All populations occur on the basalt substrate of windward coastal cliffs well within the salt spray zone. The surrounding vegetation is mostly that of a windswept herb and low shrub coastal community. Limiting factors, depending on the population, include: competition from alien plants; direct human disturbance; damage by feral ungulates and livestock; and catastrophic events, such as fire, hurricane or tsunami. Other possible limiting factors are damage by rodents and insects.

Recovery Objectives: Downlist to threatened status.

Recovery Criteria: To downlist this species to threatened status, two populations of at least 500 reproductive plants each should exist on each of the three islands where, or near where, it presently exists. All populations should be naturally-reproducing and should have maintained themselves at these numbers for a minimum of ten years.

Actions Needed:

1. Protect and stabilize existing populations.

2. Conduct studies necessary to better manage the taxa.

3. Identify or establish additional populations.

4. Expand populations, if necessary.

5. Validate recovery objectives.

Total Estimated Cost of Recovery ($1,000):

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Total
1994	3.5	0	0	0	0	3.5
1995	81.5	12	0	0	0	93.5
1996	11	23	0	0	0	34
1997	26	18	0	0	0	44
1998	24	23	15	0	0	62
1999	24	5	4	0	4	37
2000	19	0	8	0	4	31
2001	19	0	18	0	0	37
2002	19	0	20	0	0	39
2003	19	0	4	0	0	23
2004	19	0	4	0	0	23
2005	19	0	4	0	0	23
2006	19	0	4	0	0	23
2007	3	0	4	0	0	7
2008	3	0	4	0	0	7
2009	3	0	4	0	0	7
2010	3	0	4	0	0	7
2011	3	0	4	0	0	7
2012	3	0	4	0	0	7
Total	321	81	105	0	8	515

Date of Recovery: 2012

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PANICUM FAURIEI var. CARTERI (POACEAE)
RECOVERY PLAN

I. INTRODUCTION

1. Brief Overview

Panicum fauriei var. carteri (Hosaka) Davidse, or Carter's panicgrass, is a variety of one of 11 Hawaiian species of the genus Panicum in the Grass Family Poaceae. These species are small annual grasses that occur in the coastal zone around the islands.

Panicum fauriei var. carteri (Hosaka) Davidse (then known as Panicum carteri Hosaka) was federally listed as an endangered species on October 12, 1983 (USFWS 1983); the effective date of the listing was November 14, 1983. At the time of listing, the islet of Mokolii off the coast of Oahu was designated as critical habitat for the species. Subsequent revision of the taxonomic group reclassified Panicum carteri Hosaka as a variety of Panicum fauriei and increased the known populations of this taxon from one to four by incorporating three previously recognized taxa into this variety. There are presently four known populations of Panicum fauriei var. carteri: one on Mokolii Islet off Oahu, two on Maui, and one on Molokai.

2. Taxonomy

The genus Panicum, in the Grass family, Poaceae, consists of about 500 species occurring in warm and temperate regions (Davidse 1990a). Clark and Gould (1978) separated out the wet forest and bog plants that had been accepted as Panicum species by Hitchcock (1922) into the genus Dichanthelium. A revision of the Hawaiian species of Panicum merged eleven previously described species into the Panicum fauriei complex based on the uniform stem, leaf, and

inflorescence morphology (Davidse 1990b). Three varieties were described by Davidse because of the variable shape and degree of pubescence of the glumes (bracts that subtend each flower in the grasses). At this time, Panicum carteri Hosaka, Panicum annuale St. John, Panicum kukaiwaaense St. John, and Panicum malikoense St. John, were placed in synonomy under Panicum fauriei var. carteri (Hosaka) Davidse.

Of the 11 species of Hawaiian Panicum (Davidse 1990a), five are perennial and six are annual. All are caespitose plants of mesic to dry, open, and disturbed sites. These habitats are the most degraded and threatened by alien species. This makes the remaining populations of Hawaiian Panicum particularly vulnerable.

The affinities of the Hawaiian species of Panicum are obscure (Fosberg 1948). These endemic species differ from most other members of this genus in that all but one species exhibit a first glume as long as the spikelet (or nearly so) (Davidse 1990a). In addition, the second floret of many of the Hawaiian species have the tendency to disarticulate from the rest of the spikelet when the fruit is mature while other Panicoid grasses tend to disarticulate below the glumes. The native species also have uncommonly variable apices of the glume, even within the same inflorescence. This accounts for the wide range of spikelet length in the descriptions.

3. Description

Panicum fauriei var. carteri is a low, tufted annual grass that is 2 to 30 centimeters (0.8 to 11.8 inches) tall (Figure 1). The stem, leaf, and inflorescence morphology are uniform in the Panicum fauriei complex, which includes two additional varieties; P. fauriei var. fauriei and P. fauriei var. latius. The aerial stems are usually branched and puberulent. The leaves are

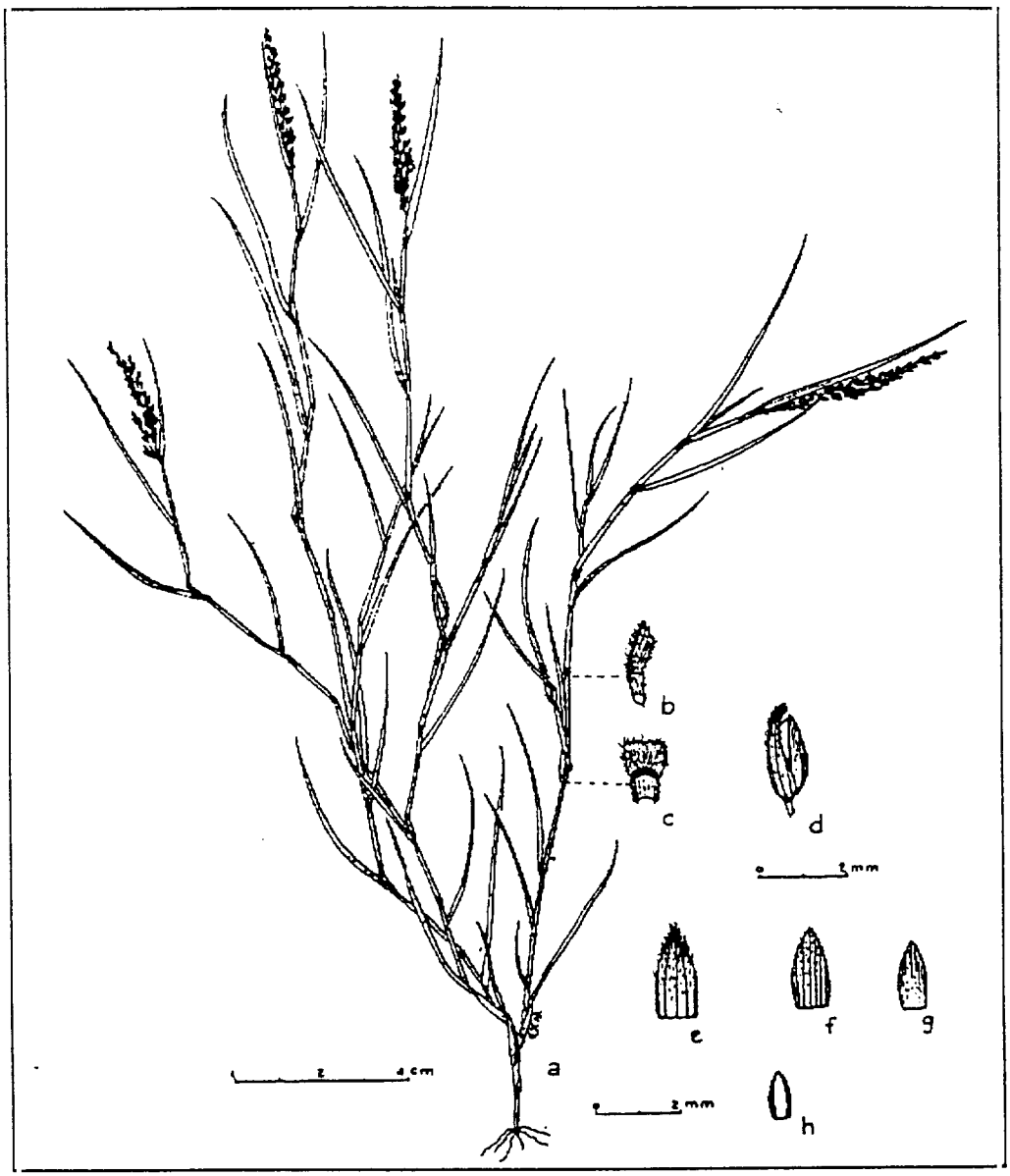

Figure 1. Panicum fauriei var. carteri (Hosaka 1942) a. habit; b. node enlarged; c. ligule enlarged; d. spikelet; e. first glume, dorsal view; f. second glume, dorsal view; g. sterile lemma, dorsal view; h. floret.

attached to the stem above the ground. The blades are 1.5 to 12 centimeters (0.6 to 4.78 inches) long and 0.1 to 0.4 centimeters (0.04 to 0.16 inches) wide, loosely involute, upper surface pilose (long hairs), lower surface puberulent (short hairs). The flowers are arranged in a tightly branched inflorescence which is 1 to 11 centimeters (0.4 to 4.3 inches) long. The axis and branches of the inflorescence are puberulent to sparsely pilose (short to longer hairs). The recognition of three varieties is based on spikelet morphology, particularly glume length and pubescence. The spikelets in P. fauriei var. carteri are 1.8 to 2.3 millimeters (0.07 to 0.09 inches) long, acute, and shortly pubescent. In P. fauriei var. fauriei the spikelets are 1.5 to 2.3 millimeters (0.06 to 0.09 inches) long, usually acute and glabrous. In P. fauriei var. latius the spikelets are 2 to 4.2 millimeters (0.08 to 1.68 inches) long, acuminate to acute, short-pubescent with short to long tufts of hair at the apex of the glumes (Wagner et al. 1990).

4. Historic Range and Population Status

(1) Oahu. The first specimen of Panicum fauriei var. carteri was collected by Joseph F. Rock on April 21, 1917, on Mokolii Islet (Chinaman's Hat), windward Oahu, and was deposited at the Bishop Museum (Rock 12,766, BISH). Hitchcock (1922) included this specimen with his description of Panicum nubigenum Kunth. (Panicum nubigenum sensu Hitchc.(1922), non Kunth is a synonym for Panicum fauriei var. latius (St. John) Davidse.) The second collection was made by Ray Fosberg & V.O. Fosberg (Fosberg 13,593, BISH), from the same location on January 31, 1937. Hosaka collected specimens from the same location on November 6, 1941, and described these as a new species, Panicum carteri Hosaka (Hosaka 1942). Hosaka's collections (Hosaka and Maneki 2611, BISH) are the isotype and holotype. Other collections from this location were made by Herb Rogers on May 17, 1947 (Rogers s.n.,

BISH), and Derral Herbst on May 24, 1978 (Herbst 1604, 1605, BISH).

In November 1941, the population on Mokolii Islet, Oahu, was determined by Hosaka (1942) to be comprised of only 12 individuals. They were on a rocky ledge frequently drenched by salt spray. In May 1978, Herbst (1978) observed a single disjunct population with two colonies about 15 meters (49 feet) apart. One subunit had about 180 plants, the other had 27 plants.

(2) Maui. Two collections from Maui described by St. John (1987) as separate species are now merged into Panicum fauriei var. carteri (Hosaka) Davidse, and are in the type collection at the Bishop Museum. These are Panicum annuale St. John (Sylva and Clark s.n., BISH), collected on July 7, 1978, near the south side of Makamakaole Stream on the east coast of West Maui, and Panicum malikoense St. John (Sylva s.n., BISH), collected on December 19, 1976, on a sea headland west of Maliko Gulch on the north coast of East Maui.

The population near Maliko Gulch from which Panicum malikoense was described is possibly extinct (Rene Sylva, Maui Zoological and Botanical Gardens, personal communication 1992). Sylva noted that the population near the bluff existed until the early 1980's when the number of cattle grazing in the area increased. The population subsequently disappeared. The direct effects of grazing as well as erosion accelerated by grazing animals may have contributed to this population's decline. Although Sylva has looked for this population, he has not seen it since the middle 1980's. It appears that all of the native vegetation is gone, and the topsoil is eroding on a regular basis into the ocean. Any seedbank may already be washed away.

Two additional populations of Panicum fauriei var. carteri have been found by Rene Sylva on Maui at Mokolea Point and Watercress

Point (personal communication 1992). In the early 1980's, Sylva located numerous individuals at Mokolea Point, West Maui, but has been unable to find a robust population recently. Only one vegetative plant was seen on February 16, 1992, at the edge of a grove of Casurina equisitifolia. The other population was discovered around 1974 on a headland northeast of Maliko Gulch called Watercress Point, East Maui (Rene Sylva, personal communication 1992). There is no historical documentation describing its former range.

(3) Molokai. One specimen from Molokai is deposited in the type collection at the Bishop Museum. Panicum kukaiwaaense St. John (Hobdy 2184, BISH) was collected on August 29, 1984, in bare dirt just above a sea cliff on Kukaiwaa Point on the north coast of East Molokai.

5. Current Range and Population Status

As of 1992, four populations of Panicum fauriei var. carteri were known to exist in the wild. These are the population on Mokolii Islet off the coast of Oahu, the population on Molokai, and two populations on Maui; Makamakaole Gulch and Watercress Point east of Maliko Gulch (Figure 2). The Recovery Priority Number assigned to the taxa by the U.S. Fish and Wildlife Service is nine on a scale of 1-18.

In the spring of 1992, the number of individuals within each population ranged from about 40 to 200. Population size may be limited by the amount of seasonal rain and the degree of habitat disturbance. Table 1 summarizes the population status of Panicum fauriei var. carteri at these four sites during the spring of 1992. Over 400 individual plants were counted.

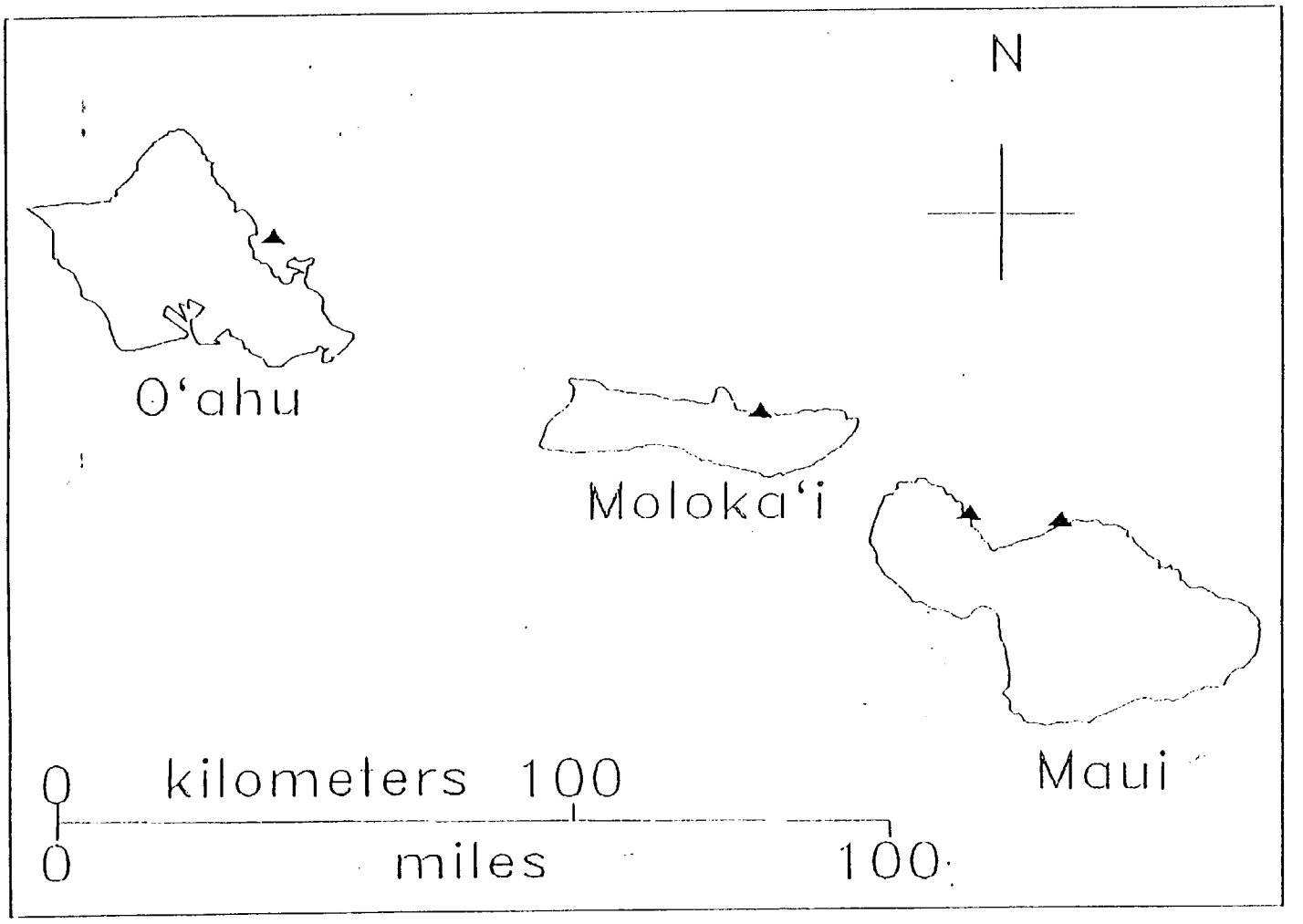

Figure 2. Location of the four extant populations of Panicum fauriei var. carteri.

Table 1. Population status of *Panicum fauriei* var. *carteri* at four sites in the spring of 1992.

AREA	LOCATION	DATE	# SEEN	LIFE STAGE VEG	FL/FR	DEAD
Oahu	Mokoli'i Islet	1-8-92	13	13		
		2-5-92	45	45		
		4-4-92	43	25	4	14
		4-26-92	40	10	22	8
		7-11-92	10	0		10
Molokai	Kukaiwaa Point	4-24-92	200*		most	
West Maui	Makamaka'ole Gulch	2-16-92	28	some	some	
		5-3-92	29		25	4
		7-3-92	44	20	3	21
East Maui	E. of Maliko Gulch	2-16-92	55*	some	some	
		5-3-92	120*	some	some	40
		7-9-92	80*		most	

* estimated

Key: VEG = vegetative
FL/FR = Flower/Fruit

Following is a brief description of the habitat and status of each population:

(1) Mokolii Islet, Oahu. Mokolii Islet is a basalt rocky outcrop located in the northern portion of Kaneohe Bay on the windward side of Oahu. It's commonly referred to as Chinaman's Hat. The two subpopulations described by Herbst (1978) were relocated in 1992. The first subpopulation covered an area of 16 square meters (172 square feet) and had no more than 30 plants at any one time. The other colony covered only one square meter (10.8 square feet) area, with no more than 15 plants observed at any one time. Both were located approximately 10 to 12 feet (3 to 3.7 meters) above sea level, on the northeast corner of the island.

(2) Makamakaole Gulch, West Maui. The population is at the base of a steep slope at 3 to 10 meters (10 to 33 feet) above sea level, near the rivermouth. Three clusters of the plant occur in a 400 square meter (4303 square foot) area just upslope from the boulder-strewn beach.

(3) Watercress Point, east of Maliko Gulch, East Maui. The population is 20 to 40 meters (66 to 131 feet) above sea level on a steep, east-facing slope of a peninsula west of Pauwela point. This peninsula is called Watercress Point by local fishermen (Rene Sylva, personal communication 1992). There is a watercress farm in the gulch immediately to the south. Five clusters of plants are in an area of 400 square meters (4303 square feet).

(4) Kukaiwaa Point, northeast Molokai. This population was visited on April 24, 1992 (P. Welton, personal observation 1992). It consisted of two disjunct subpopulations separated by approximately 250 to 300 meters (820 to 984 feet). Most of the 200 plants seen were in flower or fruit.

One subpopulation, consisting of about 80 plants, is distributed along 50 meters (164 feet) of the west-facing perimeter of the peninsula. The plants occur where the vegetation cover of Fimbristylis cymosa stops at the sea cliff edge. Many plants have been grazed and uprooted, apparently by goats, pigs or deer. It appears that Panicum fauriei var. carteri presently occurs at the edge of the cliff because it is most difficult for feral animals to graze in this area.

The second subpopulation is in the largest gulch to the east of the point. About 120 plants are clustered in a 25 square meter (269 square foot) area half-way down the gully on a 30 to 40 degree slope facing southwest.

6. Life history

The population dynamics of Carter's panicgrass are dependent on seasonal climatic conditions, because it is an annual and germinates after heavy rains which occur primarily in the winter months (USFWS 1981). It is believed that population sizes increase in years with heavier rains (Rene Sylva, personal communication 1992).

Because Panicum fauriei var. carteri is an annual plant, successive generations are dependent on yearly seed production. The seedbank is particularly vulnerable to any ground disturbances which accelerate topsoil erosion.

Little is known about the reproductive biology, survival rates, and nature of mortality of plants at each lifestage. However, during 1992, most of the plants recorded and revisited in 1992 appeared to produce seeds. It is not known whether outbreeding, inbreeding, apomixis or other asexual reproduction occurs.

natural areas have all contributed to the habitat destruction and subsequent decline of native Hawaiian species (Cuddihy and Stone 1990).

Planting of pineapple and sugar cane, for instance, may have contributed to destruction of Panicum fauriei var. carteri by fragmenting habitat. These disturbances also deteriorated the existing habitat by accelerating the erosion of topsoil. The seedbank is particularly vulnerable to any ground disturbances which accelerate topsoil erosion.

The discontinuous nature of the remaining native lowland and coastal natural areas increases a species' vulnerability to extinction, particularly those with few individuals or few populations (Schonewald-Cox 1985) such as Carter's panicgrass. Chance disasters such as fires, hurricanes and tsunamis, or continual events that degrade a species habitat, such as invasion of alien species, can extirpate one or more populations.

1) Competition from Alien Plants. Most of the alien plants around Panicum fauriei var. carteri are perennials and compete for limited resources such as space and nutrients. They can displace and replace the native vegetation. The alien grass species that is most threatening at all sites is Digitaria ciliaris. Stenotaphrum secundatum threatens the population on East Maui. Casuarina equisetifolia may have contributed to the demise of the population at Mokolea Point because the fallen needles decompose slowly and build up a smothering ground layer.

2) Direct Human Disturbance. This is a small and delicate grass, and is particularly vulnerable to human trampling and biking. On Mokolii Islet, which is frequented by recreational users, trampling is a major threat. At the East Maliko Gulch population, tracks left by dirt bikes or mountain bikes indicate that they uproot the vegetation. The native vegetation disturbed at the

latter site includes Fimbristylis cymosa, Bidens hillebrandiana subsp. polycephala and Chamaesyce degeneri as well as Panicum fauriei var. carteri. This site also appears to be used as a rubbish tip.

3) Feral Ungulates and Livestock. The hooves of ungulates accelerate soil erosion processes which deplete the seedbank as topsoil washes into the ocean. Their trampling may also adversely compact the soil, disperse alien species propagules, and disturb the native vegetation thus facilitating alien invasion. It is likely that the West Maliko Gulch population is extinct due to cattle. Erosion is also evident throughout the Makamakaole, West Maui population, probably because of cattle in the area, although goats may be more of a threat due to the location of the plants on a bluff. The Kukaiwaa, Molokai population is threatened by the presence of feral goats, pigs and deer.

4) Fire or Other Catastrophic Events. Arson or accidental fire, hurricanes or tsunami have the potential to severely deplete or potentially destroy any of these populations.

5) Rodents and Insects. Rats appear to be gnawing on the stems of Scaevola sericea, particularly in the Mokolii population. This is detrimental to Panicum fauriei var. carteri because, at this site, it is the only other native perennial species stabilizing the soil. Many ants have also been observed around the Mokolii population, which may cause damage to seeds or the reproductive capacity of the plants.

9. Conservation Efforts

1) Federal actions. The U.S. Fish and Wildlife Service listed Panicum carteri as an endangered species on October 12, 1983 (USFWS 1983). The decision was based principally on a status report (Herbst 1978) and comments from the public. The entire

islet of Mokolii, Oahu, was designated as critical habitat at the time of listing. The status of the populations and habitats of the three additional populations are discussed in detail in a status survey prepared by Welton (1992).

2) State of Hawaii actions. (a) All Hawaiian species listed as endangered by the Federal government are automatically listed as endangered under State law pursuant to Chapter 195D of the Hawaii Revised Statutes. However, this taxon was listed and its critical habitat designated as Panicum carteri Hosakae. Because the taxonomic name change to Panicum fauriei var. carteri involved combining the listed taxon with other varieties, the State of Hawaii does not recognize all populations as endangered. The only population currently recognized by the State is that occurring on Mokolii islet off of the island of Oahu.

(b) A project between July 1990 and June 30, 1991 was sponsored by the State of Hawaii using $500.00 of USFWS section 6 funds to grow this taxon from seed. Bill Garnett, who at the time was with the Waimea Arboretum, collected seed from Mokolii Island. No germination occurred.

3) Nongovernmental actions. (a) Waimea Arboretum attempted to propagate this taxon on several occasions between 1979 and 1984. All attempts were unsuccessful. Currently, no cultivated specimens are known.

(b) The National Tropical Botanical Garden (NTBG) attempted to propagate this taxon in the early 1990s. Seeds from the Mokolii Islet were collected by NTBG in February of 1992 and by DOFAW in September of 1993 for propagation by NTBG. Attempts to propagate these were unsuccessful since neither seedlot germinated.

10. Strategy of Recovery

The strategy of recovery calls for protection and stabilization of existing populations. Protection of populations is necessary for the populations on West Maui and Oahu, and may be accomplished by entering into cooperative agreements or, in the case of the Oahu population, a change in land status. Stabilizing the existing populations may be accomplished via developing fire response and repression plans, controlling direct human disturbance (at the Mokolii, Oahu and East Maui populations), controlling ungulates (at the two Maui and the Molokai populations), controlling alien plants, and controlling possible threats of rodents and insects (particularly at the Mokolii, Oahu population). In order to accomplish these goals, research will need to be conducted on the control of alien plants, and the threats and control of rodents and insects near the Oahu population. Research will also need to be conducted on the life history of, and propagation and introduction techniques for, this taxon. A survey for additional populations should be conducted and, if found, the habitat protected and threats controlled around such populations. Populations will then need to be expanded, if they are not already expanding naturally, and new populations established on Oahu and Molokai to reach the recovery goal of a minimum of two populations on each island in the taxon's historic range (if extant populations have not been found on these islands). Finally, recovery objectives will need to be validated and the recovery plan revised as necessary.

II. RECOVERY

1. Recovery Objectives

Target objectives for recovery of Panicum fauriei var. carteri are: (1) to stabilize existing populations by removing existing threats from each population wherever possible; (2) to downlist to threatened status; and (3) to delist with the complete removal of all federal protective status.

Stabilization of Populations

In order to stabilize existing populations of Carter's panicgrass, threats must be controlled. These threats may be addressed in the following ways: alien plants via manual weeding and other methods to be determined by research; ungulate damage (at the East Maui and Molokai populations) via fencing; human disturbance via classification of land as a Seabird Sanctuary (at the Mokolii, Oahu population), and via signs and other measures (at the Mokolii, Oahu and East Maui populations); fire via developing fire prevention, response and suppression plans; and possible threats of rodents and insects (particularly at the Mokolii, Oahu population) via means to be determined by research.

Downlisting to Threatened Status

Downlisting to threatened status may be considered when "stabilization" targets are realized, and there are two populations per island (for a total of six populations) with an average population of 500 reproductive plants per population per year. The number of individuals of this annual plant is believed to be necessary to maintain a seedbank adequate for survival of the population during years when germination is low due to drought or other causes, and the number of populations is believed necessary to adequately preserve genetic diversity and to protect against extinction due to catastrophic events. Additional populations need to either be discovered or established by

reintroduction on Oahu or Molokai in order to reach the goal of six populations. The six populations should be secure, protected from threats, and the numbers stable or increasing for a minimum of 10 years. Human assistance may be required to meet these criteria.

Delisting

This taxon may be considered for delisting when there are a minimum of six populations (two populations per island) with an average population of 500 reproductive plants per population per year, and each population is stable or increasing without human manipulation or assistance for a minimum of 10 years.

2. Step-down Outline

1. Protect and stabilize the four known populations of Carter's panicgrass.

    11. Protect and stabilize the population on Mokolii Islet, Oahu.

        111. Protect habitat.

        112. Control threats by humans.

        113. Control alien plant species.

            1131. Monitor invasion of alien plants.

            1132. Control invasion of alien plants via restoration of habitat.

        114. Control threats by rodents, if necessary.

            1141. Monitor damage caused by rodents.

            1142. Apply control measures, if necessary.

        115. Investigate threats by insects, and control if necessary.

            1151. Monitor damage caused by insects.

            1152. Apply control measures, if necessary.

        116. Develop a fire prevention, response and suppression plan.

        117. Monitor population.

    12. Protect and stabilize Kukaiwaa population, Molokai.

        121. Protect habitat.

        122. Control threats of feral animals.

            1221. Fence habitat.

            1222. Maintain fence.

        123. Control alien plant species.

            1231. Monitor invasion of alien plants.

1232. Control invasion of alien plants.

124. Develop a fire prevention, response and suppression plan.

125. Monitor population.

13. Protect and stabilize Makamakaole population, West Maui.

131. Protect habitat.

132. Control alien plant species.

1321. Monitor invasion of alien plants.

1322. Control invasion of alien plants.

133. Control cattle and other ungulate damage.

134. Develop a fire prevention, response and suppression plan.

135. Monitor population.

14. Protect and stabilize East side of Maliko gulch population.

141. Protect habitat.

142. Discourage public from disturbing habitat.

143. Control alien plant species.

1431. Monitor invasion of alien plants.

1432. Control invasion of alien plants.

144. Develop a fire prevention, response and suppression plan.

145. Monitor population.

15. Establish and maintain a propagule bank.

2. Conduct studies necessary to better manage the taxa.

21. Conduct research for controlling aggressive alien plants.

211. Determine which plant species pose a threat to Panicum fauriei var. carteri.

212. Develop techniques that will control aggressive alien plants.

22. Study requirements to propagate.

221. Study life history.

222. Determine appropriate propagation techniques.

223. Determine appropriate introduction techniques.

23. Research genetic diversity, if necessary.

3. Identify or establish additional populations.

31. Survey for additional populations.

32. Establish additional Oahu population, if necessary.

321. Identify site for additional population.

322. Protect and stabilize additional Oahu population.

3221. Protect population.

3222. Control threats to population.

3223. Establish population.

33. Establish additional Molokai population, if necessary.

331. Identify site for additional population.

332. Protect and stabilize additional Molokai population.

3321. Protect population.

3322. Control threats to population.

3323. Establish population.

34. Monitor new populations.

4. Augment populations, if necessary.

5. Determine/verify recovery objectives.

51. Determine minimal viable population size.

52. Determine number of sites needed for each population.

3. Narrative

1. Protect and stabilize the four known populations of Carter's panicgrass.

The habitat for Panicum fauriei var. carteri is a coastal dry shrub and herb community. Most of these areas have been altered by a variety of land uses. To secure the populations of this taxon the habitat needs to be protected and managed so that existing threats can be deterred. Known threats to each population are noted here.

11. Protect and stabilize the population on Mokolii Islet, Oahu.

The primary threats to this population are trampling of plants by recreational users of the island, killing of plants by campfires, possibility of an accidental fire, invasion by alien plants, and disturbance of the associated native vegetation by rodents.

111. Protect habitat.

Mokolii islet has already been designated as critical habitat. This habitat should now be classified as a State of Hawaii Seabird Sanctuary. Preliminary discussions concerning classifying Mokolii islet as a State Seabird Sanctuary have been held between the State of Hawaii's Division of Forestry and Wildlife and the City and County of Honolulu (Ron Walker, Division of Forestry and Wildlife, personal communication 1994). Rather than remaining a highly utilized recreation area, this status would emphasize protection of the islet's biota through measures such as a prohibition against picking of any plants and the option to close off the area to recreational users.

112. Control threats by humans.

The population is threatened by the foot traffic of humans using the island. As an initial step, signs should be posted to discourage traffic in the area. If this measure is determined to be unsuccessful (as noted during the annual survey of the population) further steps should be immediately undertaken.

Should this islet be made a Seabird Sanctuary, the option of closing off recreational uses of the area should be considered.

113. Control alien plant species.

At present the only two native plant species growing in the rocky area are Panicum fauriei var. carteri and Scaevola sericea. The alien plant species within or close to the population are Digitaria ciliaris, Reichardia picroides, Sonchus oleraceus, Emilia sonchifolia, Portulaca oleracea, Anagallis arvensis, and Oxalis corniculata. Because there is little soil on the rocky outcrop where the population exists, weeding alien species could accelerate erosion and destroy the seedbank. Therefore action to control alien species should be taken after research has been conducted (See task #21).

1131. Monitor invasions of alien plants..

Biannual observations are needed to monitor and quantify the invasive threat of the alien plants nearby.

1132. Control invasion of alien plants via restoration of habitat.

Apply control measures using the results of task #212. Schedule periodic weedings and routine surveys to determine the effectiveness of control methods. Adjust scheduling as needed.

114. Control threats by rodents, if necessary.

Gnawing marks by rodents have been observed on surrounding native vegetation, Scaevola sericea (USFWS 1983; Welton 1992). Because this vegetation stabilizes the soil in the area, rodent damage may threaten the habitat of Panicum fauriei var. carteri.

1141. Monitor damage caused by rodents.

The gnawing by rodents on the associated native vegetation such as Scaevola sericea should be monitored to determine: (1) the extent of damage to the vegetation, (2) levels at which control should be initiated, and (3) what natural controls of rodent populations are already present. Low levels of rodent damage may be minimally harmful to the P. fauriei var. carteri population.

1142. Apply control measures, if necessary.

Methods to control rodent populations should be applied if monitoring reveals that damage is sufficiently harmful to warrant action.

115. Investigate threats by insects, and control if necessary.

Many ants have been observed in the area of the Mokolii population. It is possible that these ants, not native to Hawaii and detrimental to other plant species, adversely affect Carter's panicgrass on Mokolii.

1151. Monitor damage caused by insects. .

An investigation should be undertaken to determine whether the ant's foraging habits damage seeds, other plant parts or the reproductive capacity of the plants.

1152. Apply control measures, if necessary.

If ants are found to be harmful to the population, appropriate action should be determined and taken for their control.

116. Develop a fire prevention, response and suppression plan.

Fire poses a potential threat to the population of Carter's panicgrass. Campfires may directly impact plants or cause a wildfire during dry months of the year. More than likely there is little or no awareness of the presence of this endangered species by persons and/or agencies most likely to fight a fire. Removal of alien species upslope from the population would reduce the fuel load and decrease the threat of fire. Actions to control these species, however, should utilize the results of task #21.

The City and County of Honolulu should institute a "no fire, no smoking" policy for the island. As a part of this policy, signs would be posted stating that fires and smoking are prohibited.

A site-specific fire management plan should be developed and coordinated with the Fire Management Plan for the City and County of Honolulu. The plan should specify the exact location of the population in order to ensure protection of the population.

117. Monitor population.

Monitor the population on an annual basis after the rainy season (4-6 weeks after a heavy rain) when plants are in flower and seedlings are evident. Monitoring should identify: size of population (number of live and dead plants); number of seedlings; identification of any additional threats or damage to the population and control of these threats; species of associated vegetation; and extent of invasion of alien species. Seeds may be collected at this time as available for use in ex situ propagation and for use in establishing new populations on Oahu, if available in sufficient numbers. This task may be conducted in conjunction with tasks #1131, 1141, and 1151.

12. Protect and stabilize Kukaiwaa population, Molokai.

The primary threats to this population are the damage to it and associated vegetation by feral goats, deer and pigs, ensuing invasion of alien plant species, and fire.

121. Protect habitat.

The population is within the jurisdiction of the Kalaupapa National Historic Park. The land is leased from the State of Hawaii to the National Park Service. The National Park Service is obligated under the Endangered Species Act to protect all federally listed species under their jurisdiction and should assume the responsibility for protecting this population.

122. Control threats of feral animals.

Goats, deer, and pigs are adversely impacting the vegetation on the peninsula directly by chewing on the plants and trampling on them, and indirectly by digging into the soil and introducing seeds into the area in their feces. Trampling and rooting accelerates soil erosion and the invasion of alien plant species. Their access needs to be restricted.

Numerous other native plant species, including Bidens hillebrandiana subsp. polycephala, Bacopa monnieri, Fimbristylis cymosa and Pilea peploides, are being impacted by the feral animals in addition to panicgrass. In 1984, Tetramolopium sylvae was present and abundant (Robert Hobdy, Hawaii Department of Land and Natural Resources, personal communication 1992), but in April 1992, T. sylvae was not seen. On the slopes behind the population is a dry lowland forest

with native species of Tetraplasandra, Reynoldsia, Diospyros, Canthium, and Wikstroemia.

1221. Fence habitat.

Protection for this area will require construction of a fence across the back of the peninsula which is less than a mile long. Natural barriers can be used to augment the fencing. A thorough survey of the area should be conducted at least once prior to fencing of the habitat in order to assess the changes in plant composition after fencing (see task #1231).

1222. Maintain fence.

Once construction of the fence is completed, it will be necessary to schedule periodic maintenance of the fence. Inspection should take place after storms because of the possibility of treefalls on the fence. Brushing may be required to keep the fence clear of vegetation.

123. Control alien plant species.

Once the area is fenced, there may be an increase in the vigor and subsequent spread of alien plants due to the absence of disturbance from the feral animals. Therefore, active steps will be crucial to control and remove the alien plants after the area is fenced.

The most threatening alien grass present is Digitaria ciliaris. This species is a perennial bunch grass forming a low-lying rosette which expands into a mat. It has a dense, expansive root system. This grass could interfere with resource uptake and displace Panicum fauriei var. carteri.

1231. Monitor invasions of alien plants.

Monitoring alien plant species before and after the area is fenced should determine if invasive plant species pose a threat to the population of Panicum fauriei var. carteri. Monitoring should determine: (1) seasonality of alien species, (2) competition between alien and native species, (3) rate of spread of alien species, (4) levels at which control should be initiated.

1232. Control invasion of alien plants.

See narrative under task #1132.

124. Develop a fire prevention, response and suppression plan.

A site-specific fire prevention and management plan should be developed and coordinated with the Fire Management Plan for the Kalaupapa National Historic Park. The plan should specify the exact location of the population to ensure a speedy response to fire and that the population will not be severely impacted by those fighting fire.

125. Monitor population.

See narrative under task #117. This task may be conducted in conjunction with task #1231.

13. Protect and stabilize Makamakaole population, West Maui.

The primary threats to this population are invasion of alien plant species and possible damage to the population and associated vegetation by cattle and goats, and the ensuing erosion.

131. Protect habitat.

The population is on State of Hawaii land which was leased for cattle grazing in the recent past. The population is located on an approximately 1000 square meter (10,764 square feet) area which contains the highest diversity of native lowland and coastal plant species in the area. Alien species have not yet reached uncontrollable numbers in this area. Native species present are Scaevola sericea, Sesuvium portulacastrum, Bacopa monnieri, Fimbristylis cymosa, Heliotropium curassavicum, Lycium sandwicense, Jacquemontia ovalifolia subsp. sandwicensis, Sida fallax, Portulaca lutea, Schiedea globosa, Chenopodium oahuensis, Lipocheta succulenta, and Lysimachia mauritiana.

The land is not presently being used and the permit for this lease is pending. Two options for use of the land are presently being discussed. One option is to allow the land to be used by a recreational camp, Camp Maluhia (Alan Tokunaga, Hawaii Department of Land and Natural Resources, personal communication 1994). If Camp Maluhia takes over the area, the Camp should be

encouraged to assume responsibility for maintaining this population's habitat, and use the opportunity to provide natural history awareness and environmental education. A cooperative agreement between the camp, the State of Hawaii, and the U.S. Fish and Wildlife Service should be negotiated.

The other option involves including the lower Makamakaole area in the state's Natural Area Reserve System (R. Hobdy, personal communication 1994). If this is done, efforts should be made to ensure that the population lies within the boundary of the Reserve and that the area is actively managed.

132. Control alien plant species.

Because cattle have recently been removed from the area, there may be an increase in the vigor and subsequent spread of alien plants. Active management to control and remove the alien plants is crucial following the removal of cattle.

The most threatening alien grass present is Digitaria ciliaris. However, many alien grasses are established in the area because the area has been used as a pasture. These alien grasses need to be controlled because they increase the fuel loading and risk of fire.

1321. Monitor invasions of alien plants.

See narrative under task #1131.

1322. Control invasion of alien plants.

See narrative under task #1132.

133. Control cattle and other ungulate damage.

Goats are present in the area and cattle grazed in the area until recently. Trails along the bluffs indicate the route utilized by ungulates to enter the gulch. Any damage resulting from ungulate grazing, trampling, rooting or resulting erosion should be identified (see task # 135) and steps taken to control the problem. Cattle grazing should not be allowed to resume in the immediate area.

134. Develop a fire prevention, response and suppression plan.

A site-specific fire prevention and management plan should be developed and coordinated with the Fire Management Plan for the County of Maui. The plan should specify the exact location of the population to ensure a speedy response to fire and that the population will not be severely impacted by those fighting fire.

135. Monitor population.

See narrative under task #117. This task may be conducted in conjunction with task #1331.

14. Protect and stabilize East side of Maliko gulch population.

The primary threats to this population are disturbance by people and the ensuing erosion and invasion of alien plant species.

Among the native species present on the east facing slope of the peninsula are Sesuvium portulacastrum, Bacopa monnieri, Fimbristylis cymosa, Heliotropium curassavicum, Lycium sandwicense, Jacquemontia ovalifolia subsp. sandwicensis, Bidens hillebrandiana subsp. polycephala, and Chamaesyce degeneri.

141. Protect habitat.

The land is owned by Alexander and Baldwin who lease it to Maui Land and Pine. Steps should be taken to protect the population through a long-term conservation agreement among the landowner, the lessee, the U.S. Fish and Wildlife Service, and Hawaii Department of Land and Natural Resources.

142. Discourage public from disturbing habitat.

In order to control the threat of human disturbance, the public should be informed that there are endangered species in the area via signs and discouraged from disturbing habitat in the proximity of the taxon by fencing or other obstacles. The site is presently most frequented by fishermen. Their access to the shoreline does not pass through the population so their direct impact is minimal. However, people who wander from the lookout area are likely to disturb the population. In addition, mountain bike or motor-bike tracks where their riders

have left the path have been observed. These actions disturbed native plants above the Panicum fauriei var. carteri population.

143. Control alien plant species.

The most threatening alien species present are Digitaria ciliaris and Stenotaphrum secundatum which now are mainly above the population. Stenotaphrum secundatum is a low mat-forming grass and could grow over the slopes and smother the population.

1431. Monitor invasion of alien plants.

See narrative under task #1131.

1432. Control invasion of alien plants.

See narrative under task #1132.

144. Develop a fire prevention, response and suppression plan.

A site-specific fire prevention and management plan should be developed and coordinated with the Fire Management Plan for the County of Maui. The plan should specify the exact location of the population to ensure a speedy response to fire and that the population will not be severely impacted by those fighting fire.

145. Monitor population.

See narrative under task #117. This task may be conducted in conjunction with task #1431.

15. Establish and maintain a propagule bank.

Utilizing the propagation techniques established in task #23, develop a protocol for seed collection and storage techniques. Seeds should be collected from all portions of the remaining range of Panicum fauriei var. carteri during annual surveys and maintained for potential use in propagating plants. Attempts should be made to retain as much genetic diversity as possible within each population, but to maintain a distinct seed bank for each population so as to preserve the genetic integrity of the populations.

2. Conduct studies necessary to better manage the taxa.

The following studies to determine and control the primary threats identified for each population should be conducted simultaneously

with management actions. After controlling primary threats, if expansion of existing populations and/or establishment of new populations is unsuccessful, further studies to determine less obvious limiting factors such as disease, parasites, and other predators should be undertaken. New information gained from these studies should be used to develop additional management strategies and the recovery plan should be adjusted accordingly.

21. Conduct research for controlling aggressive alien plants.

As habitat is protected and large mammals are removed, i.e. cattle, goats, pigs and deer, appropriate methods for removing aggressive alien plants need to be developed. Effective control of alien plants is difficult. Constant monitoring is necessary to determine if control efforts are effective.

211. Determine which plant species pose a threat to Panicum fauriei var. carteri.

At each site a thorough survey is necessary to determine which alien species should receive priority for removal based on their ability to displace Panicum fauriei var. carteri. Preliminary suggestions are made in the discussion above for each population. Criteria for removal are based on: high reproductive capacity, a smothering mat-forming capability (eg. Stenotaphrum secundatum), aggressive root system (eg. Digitaria ciliaris), dense canopy (eg. Schinus terebinthifolius), source of allelopathic suppression, and fuel source for fire (i.e. Digitaria insularis).

The most threatening alien grass present at three of the populations is Digitaria ciliaris. This species is a perennial bunch grass forming a low-lying rosette which expands into a mat. It has a dense, expansive root system. This grass could interfere with resource uptake and displace P. fauriei var. carteri. Another threatening grass at the Maui sites is Stenotaphrum secundatum. It is a low mat-forming grass and could grow over the slopes and smother the population.

212. Develop techniques that will control aggressive alien plants.

Control techniques need to be developed. Weeding is one method, yet care must be taken not to accelerate erosion and destroy the seedbank. Test plots of removing the aliens are needed to determine the possibility of restoring the native qualities of the surrounding areas and expanding the habitat for the

population. After restoring the native habitat, the native species may reclaim their habitat and suppress alien plant invasion.

22. Study requirements to propagate.

Studies are needed to determine aspects of the life history and propagation of Panicum fauriei var. carteri, and to determine feasibility of and techniques for outplanting. Presently, the available seed source is limited. Smaller populations, i.e. Oahu and West Maui, are more fragile than the two larger populations, i.e. Molokai and East Maui. Seeds should be collected from these larger populations to experiment with propagation, ie. seed dormancy and germination requirements.

221. Study life history.

The amount and variation in annual seed set, the seed viability and longevity, dormancy requirements, and seed dispersal mechanisms are unknown. In addition, its edaphic and other habitat requirements are poorly understood (although it appears to be restricted to areas with heavy salt spray). Study of these requirements needs to be undertaken.

222. Determine appropriate propagation techniques.

Successful propagation techniques must be developed to ensure efficient cultivation of the plant and minimum impact on the reproduction of parental populations.

223. Determine appropriate introduction techniques.

Techniques for reintroduction need to be developed. It will be necessary to determine how the reintroduction site should be prepared for Panicum fauriei var. carteri, if seed or transplant is better, and how they should be cared for once established.

23. Research genetic diversity, if necessary.

If populations are not expanding naturally after identified threats are controlled, genetic research may be necessary. This research might include evaluation of genetic diversity within and among populations of this taxon, as well as the genetic similarity of this taxon with other closely related taxa. This would provide an understanding of the

genetic integrity of this taxa and propagule variation available for reestablishment.

3. Identify or establish additional populations.

Until the recovery goal of two large, naturally reproducing populations per island is reached, this taxon remains vulnerable to catastrophic disturbance. Additional populations need to be found via surveys or new populations established on the islands of Oahu and Molokai in order to reach this goal.

31. Survey for additional populations.

Coastal areas of suitable habitat on Oahu, Molokai and Maui should be searched for previously unidentified plants of this taxa (giving priority to searches on Oahu and Molokai which each have only one population). Location of additional populations would not only help ensure against extirpation due to catastrophic events but would assist in preserving genetic diversity of the species. If previously undiscovered populations are not found, establishment of new populations on Oahu and Molokai will be necessary. During surveys for additional populations, appropriate sites for establishing new populations should be noted in the case that this is necessary.

32. Establish additional Oahu population, if necessary.

In the case that no additional populations are located in the survey, an additional population on Oahu is needed to reach the recovery goal of two populations per island.

321. Identify site for additional population.

Historical distribution of Panicum fauriei var. carteri on Oahu is unknown, although its presence on the islet of Mokolii suggests that it did occur on Oahu. Based on habitat requirements identified in task #223, sites that would fulfill the plant's needs should be located. Care should be taken to ensure that other varieties of this species are not present in any such site. Initial identification of appropriate sites should have taken place during surveys for additional populations, carried out in task #31.

322. Protect and stabilize additional Oahu population.

Habitat for a new (or newly discovered) population needs to be protected, threats identified and controlled, and the population established.

3221. Protect habitat.

The additional population will need to be protected via long-term easement, cooperative agreement, lease, or fee purchase.

3222. Control threats to population.

Primary threats to the additional population should be identified and controlled as per task #11 through task #14 prior to the establishment of a new population.

3223. Establish population.

Establishment of a new population can be achieved by introducing plants and/or propagules to a new site. Propagules should be collected from the existing population on Mokolii and conducted so as not to reduce the genetic diversity that the existing population maintains. When establishing an additional population, trial plantings in several likely localities before final site selection may be beneficial. This task should be undertaken utilizing the results of task #223.

33. Establish additional Molokai population, if necessary.

In the case that no additional populations are located in the survey, an additional population on Molokai is needed to reach the recovery goal of two populations per island.

331. Identify site for additional population, if necessary.

Historical distribution of Panicum fauriei var. carteri on Molokai is unknown. Based on habitat requirements identified in task #232, sites that would fulfill the plant's needs should be located. The highest priority would be the windward coastal cliffs, peninsulas, and islets of Molokai. Care should be taken to ensure that other varieties of this species are not present in any such site. Initial identification of appropriate sites should have taken place during surveys for additional populations, carried out in task #31.

332. Protect and stabilize additional Molokai population.

Habitat for a new (or newly discovered) population needs to be protected, threats identified and controlled, and the population established.

3321. Protect population.

The additional population will need to be protected via long-term easement, cooperative agreement, lease, or fee purchase.

3322. Control threats to population.

Primary threats to the additional population should be identified and controlled as per task #11 through task #14 prior to the establishment of a new population.

3323. Establish population.

Establishment of a new population can be achieved by introducing plants and/or propagules to a new site. Propagules should be collected from the existing population on Molokai and conducted so as not to reduce the genetic diversity that the existing population maintains. When establishing an additional population, trial plantings in several likely localities before final site selection may be beneficial. This task should be undertaken utilizing the results of task #223.

34. Monitor new populations.

New populations should be monitored on a regular basis. Monitoring should take place after the rainy season when plants are in flower and seedlings are evident. Monitoring should identify: size of population (number of plants); number of seedlings; identification of any additional threats or damage to the population and control of these threats; species of associated vegetation; and extent of invasion of alien species.

4. Augment populations, if necessary.

All populations of Panicum fauriei var. carteri need to be expanded in order to reach the recovery goal of an average of 500 reproductive plants per population. If controlling threats to each population does not result in sufficient natural expansion of the populations, populations may need to be augmented. In doing

so, propagated plants should be returned to the same population from which they were derived, thus protecting the genetic integrity of the population. Site preparation to control threats should take place prior to expansion of the each population.

It is possible that these populations, particularly the smaller of the four, have experienced a genetic bottleneck. If augmentation is unsuccessful, inbreeding effects should be considered and research conducted on the genetic diversity within and among populations (see narrative for task #23). Results of this research may be used to justify crossing of populations.

5. Determine/verify recovery objectives.

The scientific validity of the stated recovery objectives in this plan needs to be evaluated. Upon completion of this examination, downlisting and delisting objectives can be reexamined.

51. Determine minimal viable population size.

The recovery objectives set minimal population levels of 500 naturally reproducing plants for each population. Minimal viable population size needed to ensure long-term survival needs to be verified for the populations. The recovery plan should be changed to reflect the results of this determination if necessary.

52. Determine number of sites needed for each population.

A population whose plants are all found at a single site is very susceptible to extinction from random environmental and natural catastrophic events, as well as human-induced impacts eg. cattle grazing. The recovery objective of two populations per island needs to be evaluated to ensure that it is adequate to safeguard against catastrophic events over the next 200 years. The recovery plan should be changed to reflect the results of this determination if necessary.

4. Literature Cited

Clark, C. A. and F.W. Gould. 1978. *Dichanthelium* subgenus *Turfosa* (Poaceae). Brittonia 30:54-59.

Cuddihy, L.W., and C.P. Stone. 1990. Alteration of Native Hawaiian Vegetation. University of Hawaii Press, Honolulu.

Cuddihy, L.W. and W.C. Gagné. 1990. Vegetation. Pp. 45-114 *in* W.L. Wagner, D.R. Herbst, and S.H. Sohmer (eds.), Manual of the Flowering Plants of Hawaii. Bishop Museum and Univ. of Hawaii Presses, Honolulu.

Davidse, G. 1990a. *Panicum* L. Pp. 1565-1574 *in* Wagner, W.L., D.R. Herbst, and S.H. Sohmer. Manual of the Flowering Plants of Hawaii. Bishop Museum and Univ. Hawaii Press, Honolulu.

Davidse, G. 1990b. Notes and new combinations in Hawaiian *Panicum* (Poaceae:Paniceae). Ann. Missouri Bot. Gard. 77:588-590.

Fosberg, F.R. 1948. Derivation of the flora of the Hawaiian Islands: *in* E.C. Zimmerman, Insects of Hawaii. Vol.1. Univ. Press Hawaii, Honolulu.

Herbst, D. 1978. Unpublished status report on *Panicum carteri* Hosaka. Technical Report for U.S. Fish and Wildlife Service.

Hitchcock, A. S. 1922. The grasses of Hawaii. Mem. Bernice P. Bishop Mus. 8:101-230.

Hosaka, E.Y. 1942. A new Hawaiian *Panicum* (Gramineae). Occas. Pap. Bernice P. Bishop Mus. 17(5):67-69.

Schonewald-Cox, C. 1985. Genetics, Minimum Population Size, and the Island Preserve. Pp. 432-458, *in* C.P. Stone and J.M. Scott (eds.), Hawai'i's terrestrial ecosystems: preservation and management. Univ. Hawaii Coop. Natl. Park Resour. Stud. Unit. Univ. of Hawaii Press, Honolulu.

St. John, H. 1987. Diagnoses of *Panicum* species (Gramineae). Hawaiian Plant Studies 149. Phytologia 63:183-184.

USFWS. 1983. Endangered and Threatened Wildlife and Plants; Rule to List *Panicum carteri* (Carter's panicgrass) as an Endangered Species and Determine Its Critical Habitat. Department of the Interior, Fish and Wildlife Service 50 CFR Part 17, 13 October 1983. Federal Register 48(198):46328-46332.

USFWS. 1981. Proposal to List *Panicum carteri* (Carter's panicgrass) as an Endangered Species and Determine Its Critical Habitat. Department of the Interior, Fish and Wildlife Service 50 CFR Part 17, 30 January 1981. Federal Register 46(20):9976-9979.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1990. Manual of the Flowering Plants of Hawaii. Bishop Museum and Univ. of Hawaii Presses, Honolulu.

Welton, P. 1992. Status report on Panicum fauriei var. carteri Hosaka. Prepared under contract to U.S. Fish and Wildlife Service.

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III. IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows outlines actions and estimated cost for the recovery program for Panicum fauriei var. carteri, as set forth in this recovery plan. It is a guide for meeting the objectives discussed in Part II of this Plan. This schedule indicates task priority, task numbers, task descriptions, duration of tasks, agencies responsible for committing funds, and lastly, estimated costs. The agencies responsible for committing funds are not, necessarily, the entities that will actually carry out the tasks. When more than one agency is listed as the responsible party, an asterisk is used to identify the lead entity.

The actions identified in the implementation schedule, when accomplished, should protect habitat for the species, stabilize the existing population, and increase the population size and numbers. Monetary needs for all parties involved are identified to reach this point.

Priorities in Column 1 of the following implementation schedule are assigned as follows:

Priority 1 -	An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.
Priority 2 -	An action that must be taken to prevent a significant decline in species population/habitat quality, or some other significant negative impact short of extinction.
Priority 3 -	All other actions necessary to provide for full recovery of the species.

Key to Acronyms Used in Implementation Schedule

A&B - Alexander and Baldwin

DLNR - Hawaii Department of Land and Natural Resources

ES - Fish and Wildlife Service, Ecological Services, Honolulu

HFD - Honolulu Fire Department

HON - City and County of Honolulu

MFD - Maui Fire Department

NPS - National Park Service

NBS - National Biological Survey

NTBG - National Tropical Botanical Garden

Key to Other Codes Used in Implementation Schedule

C - Continuous

O - Ongoing (already begun as of writing of plan)

TBD - To Be Determined

Recovery Plan Implementation Schedule for Carter's Panicgrass (Panicum fauriei var. carteri)

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY	TOTAL COST	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	Comments
Need 1 (Protect existing populations)											
1	111	Protect Mokolii habitat	O	HON	1	1					
				DLNR*	1	1					
1	112	Control threats by humans at Mokolii	5	DLNR*	3		1.5	0.5	0.5	0.5	
1	1131	Monitor alien plants on Mokolii	5	DLNR*	2		0.5	0.5	0.5	0.5	
				ES	2		0.5	0.5	0.5	0.5	
1	1132	Control alien plants at Mokolii	10	DLNR*	4				2	2	
				ES	4				2	2	
1	1141	Monitor damage by rodents at Mokolii	2	DLNR*	2		1	1			
				ES	1		0.5	0.5			
1	1142	Apply rodent control at Mokolii	2	DLNR*	0			TBD	TBD		
				ES	0			TBD	TBD		
1	1151	Monitor damage by insects at Mokolii	2	DLNR*	2		1	1			
				ES	1		0.5	0.5			
1	1152	Apply insect control at Mokolii	C	DLNR*	0			TBD	TBD		
				ES	0			TBD	TBD		
1	116	Develop fire plan for Mokolii	1	DLNR*	1		1				
				ES	0		0				
				HFD	0		0				
1	117	Monitor population at Mokolii	C	DLNR*	2		0.5	0.5	0.5	0.5	
1	121	Protect habitat at Kukaiwa	O	ES*	0						
				NPS	0						
				DLNR	0						
1	1221	Fence Kukaiwaa population	1	NPS*	30		30				
				ES	30		30				
1	1222	Maintain fencing at Kukaiwaa	C	NPS*	1.5			0.5	0.5	0.5	
1	1231	Monitor alien plants at Kukaiwaa	5	NPS*	2		0.5	0.5	0.5	0.5	
				ES	2		0.5	0.5	0.5	0.5	

Recovery Plan Implementation Schedule for Carter's Panicgrass (Panicum fauriei var. carteri)

PRIOR-ITY #	TASK #	TASK DESCRIPTION	TASK DURA-TION (YRS)	RESPONSIBLE PARTY	TOTAL COST	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	Comments
1	1232	Control alien plants	10	NPS*	4				2	2	
				ES	4				2	2	
1	124	Develop fire plan for Kukaiwaa	1	NPS*	1		1				
				MFD	0						
1	125	Monitor population at Kukaiwaa	C	NPS*	2		0.5	0.5	0.5	0.5	
1	131	Protect habitat at Makamakaole	O	DLNR*	1	1					
				ES	0.5	0.5					
1	1321	Monitor alien plants at Makamakaole	5	DLNR*	2		0.5	0.5	0.5	0.5	
				ES	2		0.5	0.5	0.5	0.5	
1	1322	Control alien plants at Makamakaole	10	DLNR*	4				2	2	
				ES	4				2	2	
1	133	Control ungulate damage	C	DLNR*	0		TBD				
				ES	0		TBD				
1	134	Develop fire plan for Makamakaole	1	DLNR*	1		1				
				MFD	0						
1	135	Monitor population at Makamakaole	C	DLNR*	2		0.5	0.5	0.5	0.5	
1	141	Protect habitat at Maliko gulch	1	ES*	1		1				
				A&B	0.5		0.5				
				DLNR	0.5		0.5				
1	142	Discourage public from disturbing habitat	1	ES*	2		2				
				DLNR	1		1				
				A&B	1		1				
1	1431	Monitor alien plants at Maliko gulch	5	ES*	2		0.5	0.5	0.5	0.5	
				DLNR	2		0.5	0.5	0.5	0.5	
				A&B	2		0.5	0.5	0.5	0.5	
1	1432	Control alien plants at Maliko gulch	10	DLNR*	4				2	2	
				ES	2				1	1	
				A&B	2				1	1	

Recovery Plan Implementation Schedule for Carter's Panicgrass (Panicum fauriei var. carteri)

PRIOR-ITY #	TASK #	TASK DESCRIPTION	TASK DURA-TION (YRS)	RESPONSIBLE PARTY	TOTAL COST	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	Comments
1	144	Develop fire plan for Maliko gulch	1	ES*	1		1				
				A&B	0		0				
				DLNR	0		0				
				MFD	0		0				
1	145	Monitor population at Maliko gulch	C	ES*	2		0.5	0.5	0.5	0.5	
				DLNR	2		0.5	0.5	0.5	0.5	
1	15	Establish propagule bank	1	DLNR*	0.5				0.5		
				ES	0.5				0.5		
				NTBG	1				1		
		Need 1 (Protect existing populations)			146	3.5	81.5	11	26	24	
Need 2 (Conduct studies to better manage taxa)											
2	211	Determining threatening alien plant species	2	DLNR	2		1	1			
				ES	2		1	1			
				NBS*	6		3	3			
2	212	Develop alien plant control methods	3	DLNR	3			1	1	1	
				ES	3			1	1	1	
				NBS*	12			4	4	4	
2	221	Study life history	4	DLNR	4		1	1	1	1	
				ES	4		1	1	1	1	
				NBS*	20		5	5	5	5	
2	222	Determine propagation techniques	3	DLNR	1.5			0.5	0.5	0.5	
				ES	1.5			0.5	0.5	0.5	
				NBS*	6			2	2	2	
				NTBG	6			2	2	2	
2	223	Determine introduction techniques	2	DLNR	1					1	
				ES	1					1	
				NBS*	3					3	
2	23	Conduct genetic research if necessary	2	DLNR	0						
				ES	0						
				NBS*	0						
		Need 2 (Conduct studies to better manage taxa)			76	0	12	23	18	23	

Recovery Plan Implementation Schedule for Carter's Panicgrass (Panicum fauriei var. carteri)

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY	TOTAL COST	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	Comments
Need 3 (Identify or establish additional populations)											
2	31	Survey for additional populations	1	DLNR ES*	7.5 7.5					7.5 7.5	
2	321	Identify additional site for Oahu, if necessary	1	DLNR ES*	0 0					TBD TBD	
2	3221	Protect habitat on Oahu	1	DLNR ES*	0 0						
2	3222	Control threats to new population on Oahu	C	DLNR ES*	0 0						
2	3223	Establish new population on Oahu	2	DLNR ES*	0 0						
2	331	Identify additional site for Molokai, if necessary	1	DLNR ES*	0 0						
2	3321	Protect habitat on Molokai	1	DLNR ES*	0 0						
2	3322	Control threats to new Molokai population	C	DLNR ES*	0 0						
2	3323	Establish new population on Molokai	2	DLNR ES*	0 0						
2	34	Monitor new populations.	C	DLNR ES*	0 0						
		Need 3 (Identify or establish additional popul			15	0	0	0	0	15	
Need 4 (Augment populations, if necessary)											
2	4	Augment populations, if necessary	3	DLNR ES*	0 0						
		Need 4 (Augment populations, if necessary)			0	0	0	0	0	0	

Recovery Plan Implementation Schedule for Carter's Panicgrass (Panicum fauriei var. carteri)

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY	TOTAL COST	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	Comments
Need 5 (Validate recovery objectives)											
3	51	Determine minimal viable population size.	2	ES*	0						
				DLNR	0						
3	52	Determine number of sites needed.	2	ES*	0						
				DLNR	0						
		Need 5 (Validate recovery objectives)			0	0	0	0	0	0	
		TOTAL COST			237	3.5	93.5	34	44	62	

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