

recommendations to designate critical habitat. When determining which areas are critical habitat, a primary source of information should be the listing package for the species. Additional information may be obtained from recovery plans, articles in peer-reviewed journals, conservation plans developed by States and counties, scientific status surveys and studies, and biological assessments or other unpublished materials.

It is important to clearly understand that critical habitat designations do not signal that habitat outside the designation is unimportant or may not be required for conservation. Areas outside the critical habitat designation will continue to be subject to conservation actions that may be implemented under section 7(a)(1) and to the regulatory protections afforded by the Act's 7(a)(2) jeopardy standard and section 9 prohibitions, as determined on the basis of the best available information at the time of the action. We specifically anticipate that federally funded or assisted projects affecting listed species outside their designated critical habitat areas may still result in jeopardy findings in some cases. Similarly, critical habitat designations made on the basis of the best available information at the time of designation will not control the direction and substance of future recovery plans, habitat conservation plans, or other species conservation planning efforts if new information available to these planning efforts calls for a different outcome. Furthermore, we recognize that designation of critical habitat may not include all of the habitat areas that may eventually be determined to be necessary for the conservation of the species.

Methods

As required by section 4(b)(2) of the Act and regulations 50 CFR 424.12, we used the best scientific information available to determine areas containing the physical and biological features that are essential for the conservation of Blackburn's sphinx moth. We evaluated areas containing dry and mesic habitats as well as data on known moth occurrence. The best scientific information we analyzed included peer-reviewed scientific publications; unpublished reports by researchers; the final rule listing the species (65 FR 4770); the Blackburn's sphinx moth Recovery Outline (Service 2000); the HHP database; island-wide GIS coverages (e.g., vegetation, soils, annual rainfall, elevation contours, landownership); information received during the public comment periods and

public hearings; recent biological surveys and reports; and information received in response to outreach materials and from landowners, land managers, and interested parties.

The critical habitat unit approach in this rule addresses the numerous risks to the long-term survival and conservation of Blackburn's sphinx moth by employing two widely recognized and scientifically accepted methods for promoting viable populations of imperiled species—(1) creation or maintenance of multiple populations to reduce the possibility that a single or series of catastrophic events could threaten to extirpate the species; and (2) increasing the size of each population in the respective critical habitat units to a level where the threats of genetic, demographic, and normal environmental uncertainties are diminished (Tear *et al.* 1995; Meffe and Carroll 1996; Service 1997a).

In general, the larger the number of populations and the larger the size of each population, the lower the probability of extinction (Raup 1991; Meffe and Carroll 1996). This basic conservation principle of redundancy applies to Blackburn's sphinx moth. By maintaining viable populations in the designated critical habitat units, the threats represented by a fluctuating environment are reduced and the species has a greater likelihood of achieving conservation. Conversely, loss of a Blackburn's sphinx moth critical habitat unit will result in an appreciable increase in the risk that the species may not recover and survive.

The Blackburn's sphinx moth is short-lived, extremely mobile, and rare; hence population densities are not easily determined (A. Medeiros, pers comm., 1998; Janzen 1984; Roderick and Gillespie 1997; Van Gelder and Conant 1998). Even if the threats responsible for the decline of the moth were controlled, the persistence of existing populations is hampered by the small number of extant populations and the small number of individuals in known populations. These circumstances make the species more vulnerable to extinction resulting from a variety of natural processes. Small populations are particularly vulnerable to reduced reproductive vigor caused by inbreeding depression, and they may suffer a loss of genetic variability over time due to random genetic drift, resulting in decreased evolutionary potential and decreased ability to cope with environmental change (Lande 1988; International Union for Conservation of Nature and Natural Resources 1994).

Populations small in size are also demographically vulnerable to

extinction caused by random fluctuations in population size and sex ratio, and to catastrophes such as hurricanes (Lande 1988). We believe the existing Blackburn's sphinx moth populations on Kahoolawe, Hawaii, and Maui are insufficient in size and too limited in range to ensure the conservation of the species. While Blackburn's sphinx moth population sizes may be naturally small, establishing the species to a diverse set of habitats and climates within its former range is necessary to remove the long-term risk of rangewide extinction due to catastrophic events and the numerous direct threats to the species and its habitat (Service 1997a).

Janzen (1984) described the characteristics of tropical sphingid moths found in a Costa Rican National Park. In general, adult sphingids are nocturnal or crepuscular (dusk-flying) and regularly drink with a long proboscis from many kinds of sphingophilous flowers while hovering in front of them. Sphingophilus flowers are characterized by lightly colored tubular corollas, evening anthesis (opening), and nocturnal nectar and scent production (Haber and Frankie 1989). Fecundity was unknown, but estimated in the hundreds if the female can feed freely.

Particularly helpful in understanding the conservation needs of sphingids is Janzen's (1984) description of the adult moth biological characteristics, including that they have large latitudinal ranges, feed heavily over a long period of time and extensively at spatially particulate resources relatively fixed in location, *i.e.*, they feed on specific resources spread throughout the landscape, live for weeks to months, lay few eggs per night, probably oviposit (deposit eggs) on many host plant individuals and repeatedly visit many of them, have less synchronous eclosion (emergence from the pupa) during the rainy season than other moths, migrate, and are highly mobile, repeatedly returning to the same food plants. In another study of sphingids, adults were reported to travel greater distances to pollinate and visit flowers than those distances traveled by other insect pollinators or even hummingbirds (Linhart and Mendenhall 1977).

Sphingid caterpillars are known to feed heavily over a long time period and eat limited types of foliage, typically plants rich in toxic small molecules (e.g., in the family Solanaceae). They also have less synchronous eclosion than other moths. Since sphingids search widely for good local conditions, Janzen (1984) concluded that isolated habitats may have difficulty supporting