Science Foundation Chapter 5
Appendix 5.1 – Case Study
Northern Harrier (*Circus cyaneus*)

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DESCRIPTION OF THE SPECIES

This fairly common bird of prey is a medium sized, slender bodied raptor with long wings and tail. Highly sexually dimorphic, females are larger than males, brown above and heavily streaked below. The smaller male is cadet gray above and mostly white below with spare cinnamon flecking on the breast. Young birds are similar to the adult female, a rich brown above and broadly washed russet below but with less streaking. All ages and both sexes have a conspicuous white saddle across the rump in all plumages, a reliable field mark. The pale-plumaged adult male harrier may be confused with the White-tailed Kite, as their habitat preferences overlap, but the kite is smaller and more slender, shorter-tailed, tends to hover, and has black chevrons on its "shoulders."

Northern Harriers are food and habitat generalists, although open habitats are selected. They are usually seen coursing low and buoyantly over marshland or grassland, ready to quarter and capture anything that moves—especially small mammals and birds. The dihedral and rocking-flight is similar to that of Turkey Vulture. The former common name, "Marsh Hawk," well-describes the habitat preference. They are the most owl-like of our raptors, with facial disks that aid their acute hearing. Primarily "vole specialists," but harriers frequently take other small mammals, birds (meadowlarks, quail), and snakes.

Northern Harriers nest at favored places around the San Francisco Bay but are much more common and widespread in winter. The nest is placed on the ground, often in tidal, brackish, or freshwater marshes or sometimes in a swale or moist pasture densely vegetated with sedges or rushes, limiting intrusion by mammalian predators. In spring, the males perform a dramatic courtship flight display, wheeling in an undulating roller-coaster flight in the vicinity of the nest site. Once the pair bond is established and the female is attending the nest, the male delivers prey and the pair exchanges the offering in the air, displaying the aerobatic skills of this unique predator.

Harriers are highly migratory, and it seems that in the non-breeding season, most adult females vacate the Bay Area whereas adult males remain throughout winter.

CRITERIA FOR SELECTION OF THE SPECIES

The Northern Harrier is perhaps the most representative raptor that commonly forages in bay wetlands. It is a California Bird Species of Special Concern, priority 3, because of historic population declines due to loss or modification of wetlands and native grasslands (Davis and Niemela 2008). Because tidal marshes are an important nesting habitat, land management practices that are likely to disturb nest sites during the

breeding season (March-August)—e.g. mosquito abatement, marsh restoration projects, intrusion by researchers, hunters, and recreationists—should consider impacts to nesting harriers. "Ground nesting harriers are highly vulnerable to trampling by livestock, haying, plowing, flooding, and fire associated with some agricultural operations and management activities" (Davis and Niemala 2008).

OTHER INFORMATION ABOUT THE SPECIES

This raptor has a northern Holarctic distribution with only two subspecies. The New World subspecies (*C.c. hudsonius*) is the larger of the two. The diet is broad with distinct seasonal and geographical variation, dependent of cyclical prey abundance (Smith *et al.* 2011).

Nest sites in wet substrate are significantly more successful than those on dry substrate because of reduced predation on the former (Simons and Smith 1985).

Harriers are highly vocal, especially around the nest site and during flight display, uttering a high-pitched and repetitive "kekking." Aerial displays over and around nest site are elaborate, including food exchange, talon gripping, and roller-coaster flight. Harriers are more prone to polygyny than other raptors (Smith *et al.* 2011). In the non-breeding season, harriers may gather in communal roosts where prey densities are abundant, sometimes in the company of Short-eared Owls. Foraging behavior and diet overlap between the two raptors, but the owl hunts more in twilight and night conditions. Terrestrial mammals are likely the most important predators of eggs and nestlings.

Mammalian predators include coyotes, foxes, skunks, weasels (river otter?), raccoons, squirrels, as well as deer and livestock by trampling. Avian predators include crows, ravens, and owls. Reptilian predators may include snakes.

Although the population suffered historic declines and habitat loss continues statewide (Davis and Niemela 2008), currently the Bay Area population appears to be relatively stable.

Home ranges vary or are adjusted with prey abundance (Temeles 1987). Reported home range sizes range from 170-15,000 ha; median 260 ha (i*n* Smith *et al.* 2011). A nesting season study in Suisun Marsh (1987-1992) found harrier nest densities of 3.3 to 24.8 nests/km^2 (mean 8.4); the highest value was noted in 1987, a year of high vole abundance (Loughman & McLandress 1994). In another study at Grizzley Island Wildlife Area in 1987, 74 nests were found with 12.5 nests/100 acres in managed fields as opposed to 8.2 nests/100 acres in unmanaged uplands (Larsen 1987).

REVIEW OF CLIMATE CHANGE EFFECTS ON THE SPECIES

The loss of tidal marsh habitat associated with sea level rise is expected to reduce the extent of available nesting habitat around the bayshore (Stralberg *et al.* 2011, Thorne 2012, Thorne *et al.* 2012). Increased frequency of tidal marsh inundation associated with increasing strength of storm surges (Thorne *et al.* 2012) may increase flooding of nests resulting in reduced reproductive success (Stralberg 2010).

OTHER STRESSORS

- Predation of nest sites and nestlings by non-native Red Foxes (*Vulpes vulpes*) has been identified as a threat, as well as depredation by feral cats in more urban areas (Davis and Niemela 2008).

- Contamination of the food chain has unknown impacts, although organochlorine based pesticides resulted in reproductive failure and population declines in the mid-20th C. (Smith *et al.* 2011).
- Because birds make up a significant portion of the harrier diet, lead toxicity from upland game birds is a potential stressor (Martin & Barrett 2001, Pain *et al.* 2009), particularly in the Suisun region with the proximity of hunting clubs.

- Collisions with wind turbines is a potential stressor (e.g. Montezuma Hills), although flight patterns of harriers may put them at lower risk than other raptors.

- Even marsh nesting harriers use upland fields and open spaces for foraging. Conversion of uplands from agricultural production to urbanization is likely to have reduce habitat viability.

ENTIRE LIFE CYCLE AND INFLUENCES FROM OUTSIDE THE ESTUARY

Because at least a portion of the local population is migratory, and because the winter range extends into the southern U.S. and Mexico, land-use practices outside the San Francisco Bay watershed may affect locally nesting harriers. Transportation of contaminants from more southerly agricultural regions is a possibility.

FACTORS THAT MAY AFFECT SPECIES RESILIENCE

Northern Harriers are food and habitat generalists, therefore inherently resilient to some degree of environmental change, however the breadth of this resilience is not well understood. Harriers tend to avoid areas with intense human use, preferring wide-open spaces, a tendency resulting from generally large foraging territories.

LIKELY CLIMATE CHANGE IMPACTS AND RISKS

If predicted climate change impacts to tidal marshlands and adjacent bottomlands are realized (Stahlberg et al. 2010, 2011, Thorne 2012), availability of viable nesting habitat and prey species (e.g. voles in tidal marshes) are likely to be reduced.

MANAGEMENT ACTIONS TO BE CONSIDERED

- Minimize human disturbance near nesting areas and restrict public access and land management practices as necessary. (No buffer zone information available; 100-meter suggested depending on activity level).

- Reduce livestock impacts to nesting success by limiting access to nesting areas, especially during the nesting season.

- Maintain a mosaic of large undisturbed habitats for nesting and high value foraging areas—abandoned fields, wet grasslands, etcetera.

- Practice rotational grassland management (Suisun Bay, north shore) leaving some sections fallow each year.

- Delay haying and plowing until after fledging (mid-July) where feasible.
- Avoid raising water levels unnaturally in seasonal wetlands to prevent flooding nests.

- Investigate effects of environmental contaminants on harriers and prey populations.

UNCERTAINTY AND KNOWLEDGE GAPS

The uncertainty inherent in climate change modeling, land-use practices, etc. introduces a level of uncertainty to any prediction about future population viability of harrier population.

Knowledge Gaps

- Long-term studies on survival, reproductive success, dispersal.

- Comparison of reproductive success of harriers nesting in natural habitats(wetlands, grasslands) versus anthropogenic habitats (croplands, pastures, etc.)

- Effects of environmental contaminants on reproductive success.

- The effects of repeated exposure to agrochemical in wintering areas outside the United States needs to be investigated (Martin 1987).

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