

of the fish sampling sites. Sampling will decrease to one neap tide per month October through December. To examine diel variation in juvenile and larval fish use among the flooded islands, seasonal 24-hour sampling series are scheduled at select sites. Our first 24-hour sampling event was completed in early June 1998.

Early Results

To date we have captured 27 fish species (8 native, 19 introduced). Our native fish catch includes fall-run and spring-run chinook salmon, delta smelt (larvae and adult), splittail (larvae and juvenile), tule perch, prickly sculpin, Sacramento sucker, Sacramento blackfish, and squawfish. High numbers of centrarchids (e.g., bluegill and redear sunfish) are captured at all sites each month. Young of the year (YOY) splittail and tule perch were

abundant in May 1998. Currently, YOY yellowfin gobies and inland silversides are being collected in high numbers.

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Table 1. Overview of Targeted Life Stages, Sample Frequency and Habitat Types Sampled for Each Gear Type

Gear Type	Targeted Lifestage	Sites/Locations	Frequency and Season	Water Depth (in meters)	Tidal Cycle	Habitat Types (not inclusive)
Block-net Enclosure	Small and juvenile fishes	All sites/inshore and small channels	Each site is sampled twice a month March-Sept., once a month Oct.-Dec.	< 1.5	Majority of sampling conducted around low slack	Submergent, emergent and floating aquatic vegetation and open water. Sand, mud, and woody debris substrates
Purse Seine	Small and juvenile fishes	All sites/inshore —offshore and wide channels	Each site is sampled twice a month March-Sept., once a month Oct.-Dec.	0-3	All tide cycles	Submergent, emergent and floating aquatic vegetation and open water
Plankton Net	Egg and larval fishes	All sites/inshore —offshore and channels	Each site is sampled twice a month Jan.-June	0-3	All tide cycles	Submergent, emergent and floating aquatic vegetation and open water
Light Traps	Larval fishes	All sites/inshore —offshore and channels	Designated site is sampled seasonally during 24-hour series	0.5-3	All tide cycles	Submergent, emergent and floating aquatic vegetation and open water

Migration and Wintering Areas of the Central Valley Swainson's Hawk

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Introduction

Subsequent to the 1994-95 Swainson's hawk (*Buteo swainsoni*) migration work and the discovery of mass poisonings of Swainson's hawks on La Pampas of Argentina (Woodbridge et al. 1995; Schmutz et al. 1996; Goldstein et al. 1996), the California-based Swainson's Hawk Technical Advisory Committee (TAC) initiated a migration study of the Central Valley population. Based on incidental observations and few band returns, the TAC surmised that the Central Valley hawks may be using alternative wintering grounds to those used by the main nesting population, and thus may be unprotected by efforts to reduce pesticide-induced mortalities in Argentina. The main nesting population (MNP) refers to Swainson's hawks in the geographically contiguous area that encompasses the Great Basin and Great Plains, and includes most nesting Swainson's hawks. The Central Valley population is currently estimated at 550-1,000 nesting pairs (CDFG 1988; Estep pers. comm.); the greatest concentration is in Yolo, Sacramento, Solano, and San Joaquin counties. The California Swainson's hawk population is approximately 10% of its 1800s population size (Bloom 1980); the species is listed as Threatened under the California Endangered Species Act.

Methods

In June and July 1997, TAC members attached 30-gram Platform Transmitter Terminals (satellite-tracked units) to six California Central Valley Swainson's hawks trapped at nest sites using a Dho-Gaza trap; four were trapped in Yolo County, one in Solano County, and one in San Joaquin County. Funding was provided by DWR. Due to weight constraints, no males were tagged. Tagged birds were tracked by NOAA satellites, and locational data were processed by Service Argos. Movements were plotted through the last week in December to determine migration routes and winter range.

From January 5 to 16, 1998, lead investigators traveled to Mexico to locate and confirm the wintering grounds of the Central Valley hawks. Three of the five delineated areas were visited. Observations were noted relative to numbers of Swainson's hawks using each area, land use practices, potential attractants to each area, potential prey items and foraging techniques, and potential threats to the species. Local experts were consulted relative to pesticide use, prey items likely to be found in

the forage areas, and cropping patterns and other land use practices.

Results

On November 21, the southward progression of tagged birds from the Central Valley was lagging significantly behind the time line defined by the MNP Swainson's hawks that were tagged in 1994, 1995, 1996, as well as three MNP birds tagged and migrating concurrently with California birds in 1997. Data on tagged MNP birds indicate that Argentina-bound Swainson's hawks are across the equator by November 25, and in Argentina by December 25 (Woodbridge et al. 1995; Schmutz et al. 1996; Fuller pers. comm.). By December 25, southward migration of the Central Valley tagged birds had ceased, with all six birds displaying only local movements for a minimum of 30 days.

Five of the six tagged birds terminated their migration in Mexico; and one migrated to Columbia. The five birds that remained in Mexico traveled along the west coast of mainland Mexico to just south of Mazatlan. From that point, two birds went inland and southeast; one continued south through western Mexico until it settled at the border of Mexico and Guatemala. The sixth bird traveled laterally across northern Mexico, passing near Chihuahua, to the gulf coast, then directly south to Central America. It crossed the Panama Canal within the same period that the MNP Swainson's hawks crossed, but stopped its migration at 1.5± degrees north of the equator in Columbia.

Of the five wintering areas identified through satellite tracking, three areas were surveyed for wintering Swainson's hawks, and described relative to habitat types and land uses. The three areas included the Santiago area, adjacent to Santiago Ixcuintla, just northwest of Tepic, in the State of Nayarit; La Barca, east of Guadalajara, in the States of Jalisco and Michoacan; and the Cuautla area, south of Mexico City, in the States of Morelos and Puebla. Investigators were able to identify and observe a significant number of Swainson's hawks in each of the areas.

The Santiago area is on the coastal plain and includes extensive agricultural development, with hills and associated thorn forest adjacent to its eastern edge, and coastal wetlands bordering its western edge. Through observation and information provided by the State's agricultural authorities, investigators were able to determine that

tobacco and beans are the primary crops produced in the area. A wintering population was located, and a roost site and foraging areas identified. Numerous groups of Swainson's hawks were observed foraging in the recently cultivated fields, often in kettles and feeding on the ground, with 100+ birds grouped together. Mechanized cultivation (tractors) is wide-spread in the area, and an obvious attractant to Swainson's hawks.

La Barca includes an extensive valley of intense agricultural development enclosed by foothills. The primary crop grown in the area is corn, although a large amount of wheat had recently been planted. Mechanized cultivation predominates. Investigators located numerous roost sites, but observed few Swainson's hawks using the roosts. The minimal survey time available allowed investigators to determine that Swainson's hawks are using the area, but indications are that the species does not occur in this area in numbers equivalent to the Santiago area.

The Cuautla area also includes a very large agricultural valley surrounded by foothills. Corn and sugar cane are dominate crops. The roost in the area (as indicated by night location data) was located in the hills on the southeast edge of the valley, but was not observed due to its remote location. The most recent day location data indicate that the tagged bird was in rolling hill habitat adjacent to the main agricultural valley, which was dominated by dry land farming (corn) and grasslands.

One Swainson's hawk was observed in the area, but no kettles of Swainson's hawks were positively identified. A mixed kettle of hawks, vultures, and crested caracaras, which included as many as 40 Swainson's hawks, was observed in the valley. The raptors were actively foraging a harvested corn field that as being burned. There appears to be much less mechanized cultivation in this valley, so burning may be the greater attractant to Swainson's hawks. Indications are that the Cuautla area does not attract as many Swainson's hawks as the Santiago area.

Discussion

Although only a small portion of the area was surveyed, indications are that it is the wintering grounds for a significant number of Swainson's hawks, and potentially a significant percentage of the California birds. It is not yet known if these areas are being used by Swainson's hawks from nesting populations outside the Central Valley, but to date there are no data to support this. In addition, we observed the high ratios of darker morph hawks that are consistent with the Central Valley population. The Santiago area was converted from thorn forest to agriculture within the last 100 years, so the use of this

specific area of Mexico by Swainson's hawks is likely a recent adaptation.

The specific crops grown in the wintering areas are not likely as important as the cropping patterns. During the winter, from November through February, a large percentage of the crops is harvested, fields are burned and/or disced, and the following year's crop is planted (Ag personnel pers. comm.). The continuous cultivation of a large percentage of each area's fields is the probable attractant for wintering Swainson's hawks; this hypothesis was supported by numerous observations of Swainson's hawks foraging fields that were in transition.

Initial information gathered from knowledgeable sources has resulted in great optimism for the welfare of wintering Swainson's hawks in Mexico. Because Mexico is in its winter (unlike Argentina which is in the midst of summer), and night temperatures are low, crop pests, especially insects, occur in minimal numbers. In addition, winter months are defined by harvest, cultivation, and planting, a period in which pest control is of minimal concern to farmers.

The conclusion, which was supported by agricultural consultants in Mexico, is that there is little use of pesticides in these areas during the overwintering period. It is probable that Mexico is a relatively safe location for wintering Swainson's hawks compared to Argentina, given the differences in cropping patterns, and thus pesticide use, in the two areas. Additionally, Mexico's cropping patterns and resulting cultivation practices tend to expose what insects and small mammals there are in the fields, likely resulting in excellent foraging opportunities for raptors such as Swainson's hawks.

Given that the six tagged birds used at least five different areas (and probably others throughout the winter), it is likely that Central Valley Swainson's hawks use many different areas over a large portion of Mexico, Central America, and northern South America. As the migration study progresses, investigators hope to better define the quantity and quality of land area used, and to identify potential threats to the species in those areas, if any exist.

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Delta Outflow Index

