CALIFORNIA DEPARTMENT OF FISH AND GAME BIOLOGICAL RESOURCES INFORMATION SYSTEM

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ABSTRACT: We developed a relational database designed to store and retrieve existing information for biological resources (i.e., wildlife, plants, habitats, etc.) on properties owned by the California Department of Fish and Game (CDFG). Data sources included CDFG land management plans, land acquisition proposals, species lists, and various other sources collected from CDFG headquarters, regional offices, and individual properties. We created several forms allowing users to interact with the database by developing queries using either species-by-area or area-by-species criteria. Initial analysis of currently entered data shows that CDFG has conserved an equivalent proportion of habitats and unequivalent proportions of birds and vegetation communities based on regional availability. This database will assist in assessing conservation status of CDFG lands, monitor management effectiveness, and help direct land acquisition efforts.

Key words: biological resources, California, database, inventory, relational database, GIS, tables.

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A current and accurate biological inventory is important in the management and acquisition of public lands for biological resource evaluation (Cushwa and DuBrock 1982, Quinn and Van Ripper unpublished data, Sauvajot et al. unpublished data, Noss and Cooperrider 1994). To promote species presence and habitat diversity, land managers should accurately assess occurrence information (Quinn and Van Ripper unpublished data). Site-specific data on species occurrence and habitat composition is critical for species conservation and management (Garrison et al. 1999*a*).

California has a tremendous array of biological resources. There are 59 major habitat types within California (Mayer and Laudenslayer 1988) supporting 675 regular occurring vertebrate species (Garrison et al. 1999*b*). California also has 1,300 terrestrial natural communities (California Department of Fish and Game 1997) and 8,363 plant species (CalFlora 2000). Over 1,000 plant species and 550 natural communities are considered rare, threatened, or endangered by California Department of Fish and Game (CDFG).

CDFG owns and/or manages over 866,000 acres of land in California (Figure 1) including Wildlife Areas (WA's), Ecological Reserves (ER's), Undesignated Lands (UL's), public access lands, fish hatcheries, and other miscellaneous lands (Table 1). These lands support many of the plant and animal species found in the state, but an assessment of the occurrences of biological resources on these lands does not exist. Furthermore, until recently CDFG has not consolidated this biological resource information into a single information system such as a comprehensive database. The lack of accurate and comprehensive data on these resources on CDFG lands may hinder land management activities and affect land acquisition efforts because we cannot fully prioritize acquisition proposals.

California's rapidly expanding population, increased development of private lands, and loss of critical habitat has heightened our awareness about the need for information on biological resources. In March 2000 California voters passed Proposition 12 (Safe Neighborhood Parks, Clean Water, Clean Air, and Coastal Protection Bond Act of 2000) providing $2.1 billion in bond funds to protect open space and preserve habitat through land acquisition throughout the state. This new legislation will necessitate accurate wildlife and wildlife habitat inventories. This data must be centralized and assessable to land managers and policy makers alike.

In 1999, CDFG's Lands and Facilities Branch began developing a comprehensive biological resource information system for all properties owned by CDFG. Our objective was to create a database system compiling biological resource data from CDFG lands. Our goals in developing the database were to: (1) create a tool to assist in planning land acquisitions; (2) identify and fill in gaps in existing biological information on CDFG lands; (3) create a tool to assist administrators and managers make decisions; (4) increase the accessibility of CDFG employ-

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ees and the general public; (5) create a structure that is easily updated and accurate; and (6) integrate this system with other CDFG and state databases. This paper describes how this system was developed, what its capabilities are, and what efforts will be made to improve and expand the information system.

DESIGN CONSIDERATIONS AND INFORMATION SOURCES

The information system was designed after soliciting and receiving input from CDFG personnel throughout the state regarding the types of information available on biological resources from our lands and how this information could be used by CDFG. We used Microsoft ® Access 97 (Microsoft Corp 1996) to develop the system because it is CDFG's standard database software.

We initially gathered information from files for all CDFG properties housed in the Lands and Facilities Branch (LFB) in Sacramento. Biological resource information was extracted from management plans, acquisition proposals, species lists, and inventories. After all available information was gleaned from these files, we visited CDFG regional offices and individual properties to locate additional information not housed in LFB files. Additional information included published and unpublished reports, species lists, personal communications, California Natural Diversity Data Base (CNBBD) (CDFG 1997), and California Wildlife Habitat Relationships System (CWHR) (CDFG 1999) outputs. Paper copies were made for all new information collected and this information was archived in the main property files at LFB in Sacramento.

Our first step was to consolidate information for WA's and ER's because: (1) these areas have proportionately more biological resource information than other types of CDFG lands such as fish hatcheries, undesignated lands, public access, and miscellaneous lands; (2) the amount of readily available information on these properties; and (3) they represent 85% of all owned properties and are managed primarily for their biological resources. As of February 2000, we had collected data from 92 of the 215 (43%) WA's and ER's owned by CDFG including all 70 WA's and ER's in three CDFG Regions - San Joaquin Valley and Southern Sierra, South Coast, and Eastern Sierra and Inland Deserts.

DATA ENTRY

Data entered for each property consisted of species lists (mammals, birds, reptiles, amphibians, fishes, plants, and special status invertebrates species) and habitat information (vegetation communities, wildlife habitats). For wildlife species we entered common and scientific name, seasonal distribution, and available abundance data. Data entered for plant communities and wildlife habitats included common name and acreage data if available.

Wildlife habitats were classified and standardized according to Mayer and Laudenslayer (1988) and plant communities were classified according to the system of Sawyer and Keeler-Wolf (1995). Taxonomy of plants was based on the CalFlora classification system (CalFlora 2000). Selected wildlife species (birds, mammals, reptiles, and amphibians) were classified according to CWHR species lists (California Department of Fish and Game

Table 1. Type and acreage of lands owned and/or managed by region by the California Department of Fish and Game as of February 2000.

Region	WA'S[a]	ER'S[b]	UL'S[c]	OTHER[d]	TOTAL'S
Northern California and North Coast	129,718	1,289	22,423	1,156	154,586
Sacramento Valley and Central Sierra	89,864	3,320	40,023	1,526	134,724
Central Coast	64,398	24,556	18,747	748	108,449
San Joaquin Valley and Southern Sierra	39,023	15,545	15,631	928	71,127
South Coast	1,627	5,589	14,354	284	21,854
Eastern Sierra and Inland Deserts	293,664	27,066	15,489	1,818	338,037
Marine	0	35,600	1,151	31	36,842
Total	618,294	113,025	127,827	6,491	865,618

[a] WA's = wildlife area
[b] ER's = ecological reserve
[c] UL'S = undesignated lands
[d] OTHER = fish hatcheries, public access, and miscellaneous lands

1999). Bird species taxonomy was based on the American Ornithologist's Union's *Checklist of North American Birds* (1998). These classification systems and taxonomies were selected because they represent standardized systems used in California and elsewhere.

Biological resources information for each property was entered using master data tables created from the various classification systems and species lists (Figure 2). These data tables ensured standardization in nomenclature, expedited data entry, and minimized typing errors. Occurrences of biological resources by property were entered into our database named "Department Lands Biological Resources Information System" (DLBRIS) by selecting occurrences from the master data tables (Figure 3). A binary field (i.e. yes - no) was used in each master table allowing us to select individual records and these records were appended to a parent table as a group. Occurrences for all properties accumulate in the various parent tables (Figure 3). The database has individual parent tables for vegetation communities, wildlife habitats, wildlife, fish, invertebrates, and plants.

In addition to taxonomy, information in the master tables included legal status, seasonal activity, migratory status, abundance, and harvest status (Figure 3). We created additional fields in each table that are utilized by other CDFG information systems such as CWHR, CNDDB, and the lands inventory system so that these information systems were integrated in a relational manner.

We created two additional tables. These included: (1) a table citing the sources of all biological resources information and; (2) a table to track the status of what

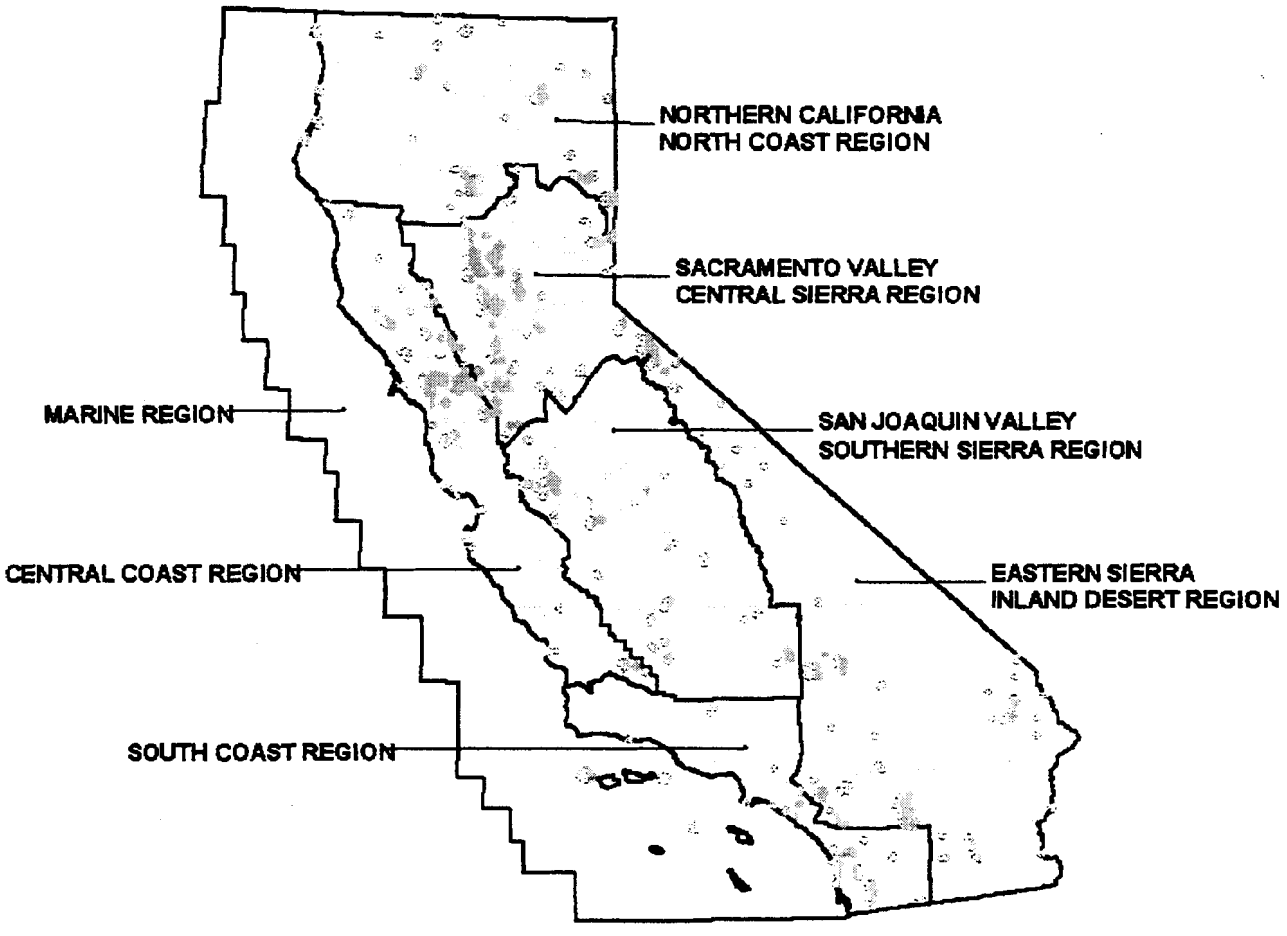

Figure 1. Lands owned and/or managed by the California Department of Fish and Game (CDFG) and boundaries of the seven CDFG Regions as of February 2000.

properties were entered into DLBRIS and the completeness of the data. We subjectively looked at individual groups of taxa (i.e. birds, mammals, plants, habitats, etc.) to determine completeness for finished properties. In addition, a memo field was added to the end of each record for any additional notes.

OUTPUT AND ANALYSIS

The database contains forms, queries, and reports allowing users to interact with the database. Forms were created for data entry and to access information for individual taxa (i.e. amphibians, mammals, plants) or lists (i.e. wildlife and habitats). The database can be queried

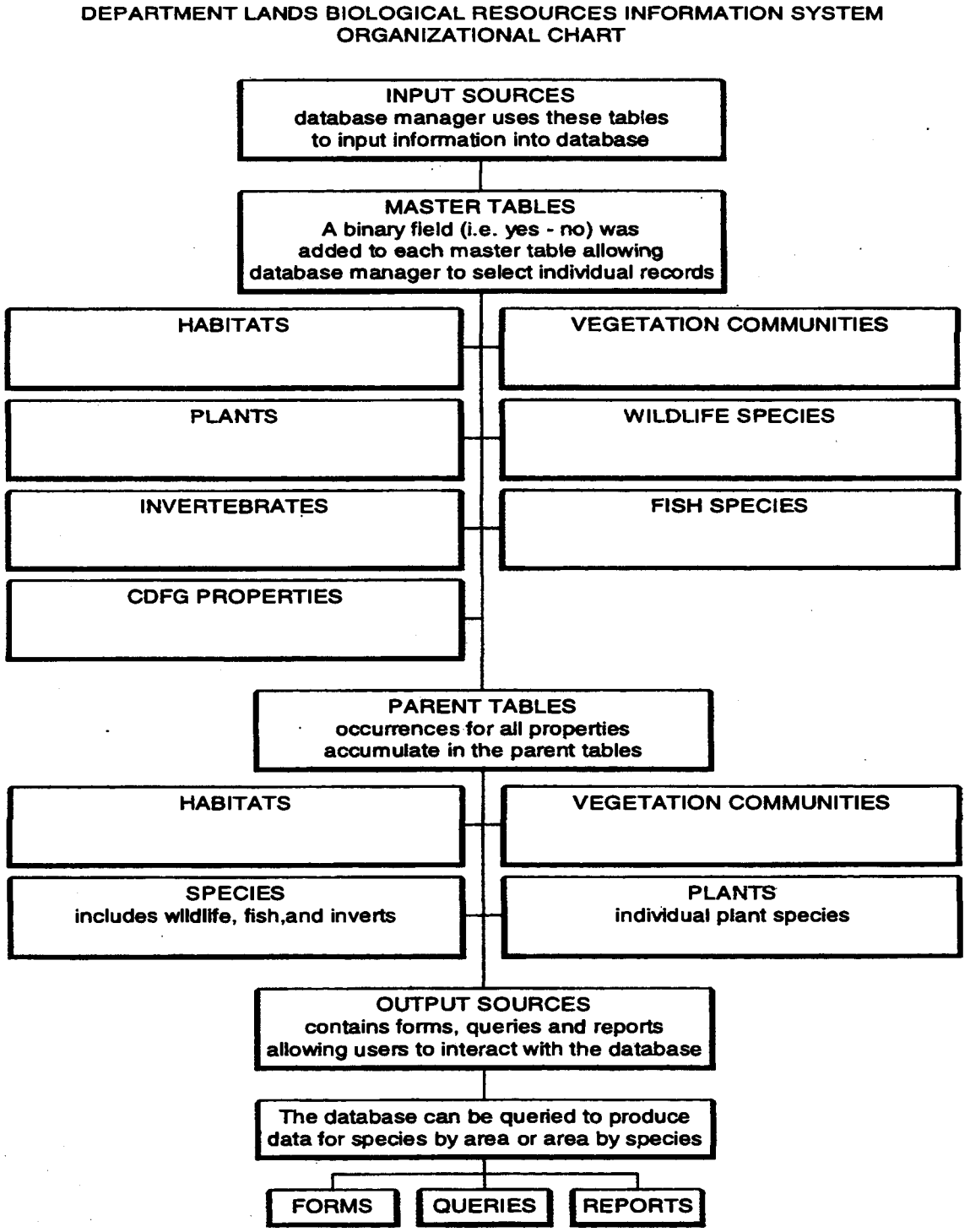

Figure 2. Department Lands Biological Resource Information System organizational chart.

to produce data for species by area or area by species. A species by area query will generate a list of all species for individual properties, while area by species queries generate lists of all properties where individual species occur. DLBRIS has reporting functions that report all habitat types and acreage for a property, or individual wildlife habitat types and the total acreage of these habitats for properties where the habitat is found.

DLBRIS can be used for analyses of the biological representativeness of CDFG lands relative to biological resources found in an area. For example, data from DLBRIS can be compared to lists of regional biological resources. Comparing DLBRIS lists from three completed CDFG Regions to available regional lands using a Pearson Chi-square (SPSS Incorporated 1998) showed that CDFG lands support equivalent proportions of habitats (X^2 = 4.484, df = 2, P = 0.089) and bird species (X^2 = 4.123, df = 2, P = 0.127) that are equivalent among regions based on availability within each region (Table 2). Proportions of vegetation communities differed among the three regions relative to the frequency of vegetation communities available within each region (X^2 = 13.687, df = 2, P = 0.001).

The greatest differences occurred in the South Coast and Eastern Sierra and Inland Deserts Regions. In the South Coast Region 47% (7 of 15) of CDFG lands have coastal locations and 78% (14 of 18) of habitat types are dominated by shrub, herbaceous, or aquatic habitats. Lack of tree-dominated habitats accounts for the lower than expected frequencies of bird species and vegetation communities.

Developed wildlife habitats such as urban, irrigated row crop, vineyard, etc. account for 19% (7 of 37) of habitat types on CDFG lands in the Eastern Sierra and Inland Deserts Region. These habitats were over-represented on CDFG lands in this region as compared to other regions. This region has many wildlife habitats including desert, conifer forests, wetlands, and riparian habitats, and CDFG lands have fewer than expected frequencies of all habitats in the Region.

APPLICATIONS AND FUTURE DEVELOPMENT

Our primary short-term goal is to complete data entry for all seven CDFG Regions. When completed, DLBRIS will have all existing information on the known occurrences of all biological resources on CDFG WA's and ER's. DLBRIS will have data that can be used to: (1) identify gaps in our knowledge of biological resources on these lands; (2) quantify what biological resources occur on CDFG lands; (3) assist efforts to monitor the

Table 2. Observed and expected frequencies of birds, wildlife, and vegetation communities for comparison of data in Department Lands Biological Resource Information System and know occurences for three CDFG Regions.

		CDFG REGIONS		
		San Joaquin Valley and Southern Sierra	South Coast	Eastern Sierra and Inland Deserts
BIRDS	DLBRIS	316	369	409
	EXPECTED	316	390	388
	REGIONAL[a]	412	530	484
	EXPECTED	412	509	505
HABITATS	DLBRIS	29	18	37
	EXPECTED	28	25	31
	REGIONAL[b]	50	52	50
	EXPECTED	51	45	56
VEG. COMM.	DLBRIS	79	66	123
	EXPECTED	80	87	102
	REGIONAL[c]	176	212	203
	EXPECTED	176	191	224

[a] Regional County Bird List Source: Western Field Ornithologists and Smithsonian Migratory Bird Center
[b] Regional Habitat List Source: CDFA and California Gap Analysis Program
[c] Regional Vegetation Community Source: CDFG Natural Diversity Data Base

effectiveness of CDFG management; and (4) provide information that can be used in future land acquisition efforts.

DLBRIS can identify gaps in biological resource information for particular wildlife area and ecological resources. Resource assessment efforts could then be directed to gather that information. Information from DLBRIS data can be compared to biological resource data from larger land areas to assess the relative contribution of CDFG lands to conserving resources for these areas. Acquisition and conservation priorities could be developed based on these comparisons.

Land managers may monitor the effectiveness of various management actions on CDFG properties. For example, CDFG could use DLBRIS to produce a list of wildlife species for wetland habitat at a given wildlife area. Species could be selected from this list for monitoring of the effects of wetland management actions.

Policies and proposals to acquire lands are developed by CDFG regions and LFB. The land acquisition pro-

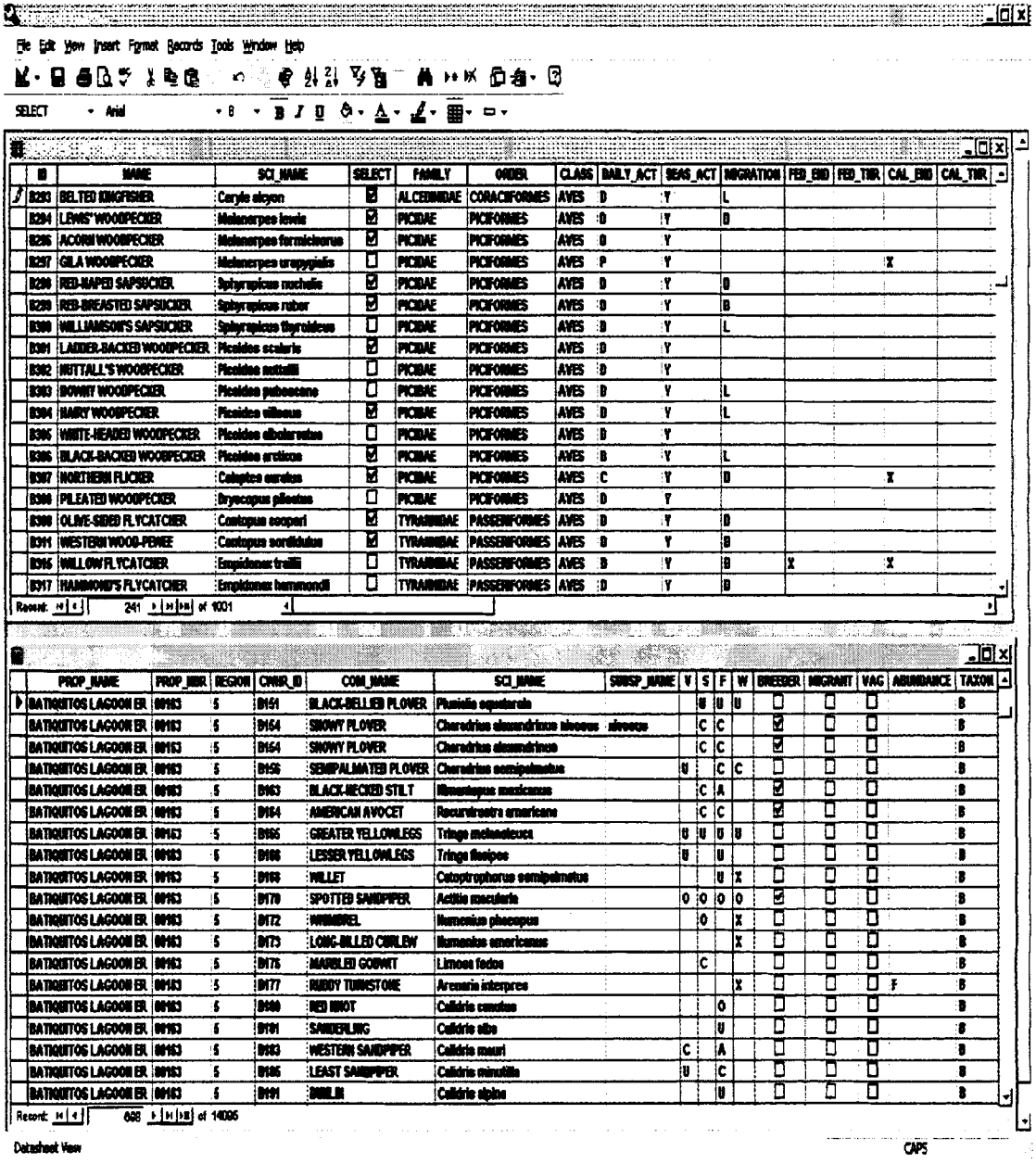

Figure 3. Examples of a master table (top) and parent table (bottom) from the Department Lands Biological Resources Information System.

cess typically begins when a Land Acquisition Proposal (LAP) is presented to CDFG Lands Committee by the Region's lands coordinator. DLBRIS could be queried to identify other wildlife areas or ecological reserves where species, habitats, or vegetation communities specifically identified as benefiting by the acquisition occur. After examining the query, the Lands Committee could then determine if conservation deficiencies exist and evaluate the proposal accordingly.

There are potential research applications with the data in DLBRIS. Agencies such as CDFG, U.S. Fish and Wildlife Service, and academic institutions such as The University of California, and California State University systems could use DLBRIS to guide research projects by identifying CDFG lands where species, habitats, or vegetation communities of interest occur. Data sets from other information systems such as GAP (Davis et al. 1998) could be used conjunctively with DLBRIS for future analysis and conservation work. Also, DLBRIS might have future applications for environmental review as point occurrence, site specific, or habitat relationship data.

Spatial data was collected for use in a future project GIS. These data were collected during site visits to individual properties and include, but are not limited to, wildlife habitats, vegetation communities, nest sites, buildings and facilities, and crop rotation data. Currently, we have not integrated this data into the database or a GIS application but the design features of DLBRIS allow for this information to be incorporated in the future.

Comprehensive biological resource information systems such as DLBRIS could be developed by agencies to assist in land management decisions and monitor changes in species habitats, distribution, and diversity. Data gaps and land use impacts could be identified and management activities addressed. Coordination between federal and state agencies could standardize databases, reduce costs, and assist in site-specific management activities. Integrating a GIS application into the database could assist in generating various maps including diversity indices, land use, vegetation, and species distribution maps. Land management agencies need information systems like DLBRIS to more efficiently manage their lands as well as have readily available biological information for monitoring and inventory purposes.

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