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PROTOCOL FOR EVALUATING BALD EAGLE HABITAT AND POPULATIONS IN CALIFORNIA

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FIGURES:

1.0 Introduction

Purpose. This document provides background information and survey techniques to identify bald eagle (*Haliaeetus leucocephalus*) use of potential habitat in site assessments for proposed projects with possible effects on bald eagles. The protocol is designed to assist wildlife professionals in determining the level of effort and methods necessary to evaluate bald eagle use of suitable breeding and wintering habitat in California. The survey criteria used in this protocol is based on over 20 years of field experience by each of the authors and an extensive review of the literature.

Bald eagle populations have recovered in many regions of the lower 48 states during the post-DDT era, although they remain a federally threatened species in 2004. In July 1999, the U.S. Fish and Wildlife Service (USFWS) proposed to delist the bald eagle under the Endangered Species Act (ESA). Section 4(g)(1) of the ESA requires that a post-delisting monitoring plan of not fewer than five years be developed and implemented for the recovered eagle population. The species is still listed as endangered by the California Department of Fish and Game (CDFG). While the threat of DDT poisoning to bald eagles has mostly been eliminated[1], bald eagles and their habitats remain vulnerable to other factors, including human encroachment, disease (e.g., West Nile virus and avian vacuolar myelinopathy (AVM) in the southeast), and pollution of waterways and food resources, especially in coastal and estuarine habitats.

Justification. In 2003, the USFWS Sacramento Office, Endangered Species Division contacted Pacific Gas and Electric Company and Garcia and Associates biologists concerning the development of a standard survey protocol to assess bald eagle habitats in California. USFWS recognized that there was no standardized process for the USFWS and other agencies to evaluate habitat loss and disturbance levels associated with various types of development within bald eagle use areas. Several proposed developments in a six-month period at Lake Almanor, California (Lassen/Plumas counties) involved such potential habitat loss or disturbance. Breeding survey instructions for surveying *known* bald eagle nesting territories are available from CDFG (Section 3.3), and these will be useful in the federal post-delisting monitoring of California bald eagles. Also, numerous management plans and habitat management guidelines have been developed by agencies and working groups in California and other states, most of which address nest site protection. But there are no specific survey protocols that describe how to search for and document bald eagle nesting, foraging, and roosting habitats.

Life History Notes. The bald eagle is an opportunistic, generalized predator and scavenger adapted to aquatic habitats (Buehler 2000). They are a member of the sea eagle group (Genus Haliaeetus), with eight species distributed worldwide. Bald eagles typically produce one or two young each year and occasionally three; however, it is not uncommon for pairs to suspend breeding in some years. Breeding bald eagles require relatively large bodies of water containing resident populations of suitable-sized fish, generally larger than 200 mm total length (Jackman, et al. 1999).

The majority of bald eagles in California breed near reservoirs (Detrich 1986). Most prey taken by eagles on reservoirs in northern California is carrion fish; fish mortality is typically related to

[1] Contamination of sediments adjacent to California's Channel Islands still impact coastal bald eagle populations.

spawning and angling stress (Jackman, et al. 2001). Waterfowl supplement the diet of bald eagles, especially in the winter and early nesting season (Hunt, et al. 1992b). Nests are usually located within one mile of key foraging areas; California eagles characteristically choose large conifers in relatively secluded locations to build nests (Lehman 1979). Bald eagles are year-round residents in ice-free regions of California (Jenkins and Jackman 1993). In northern California, they lay eggs in late February and March, with young fledging by July (Hunt, et al. 1992a, Jenkins 1992). However, at higher altitudes (e.g., Snag Lake, Lassen County, 1,860 m/6,100 ft elevation) eaglets may not fledge until August (R. Jurek, CDFG, 2003, pers. comm.). The breeding population in California has been increasing by about six percent a year since the early 1980s (Jenkins, et al. 1994, Jenkins 1996). From a low of about eight known territories in the late 1950s (Detrich 1986), there were at least 192 recently occupied territories in California in 2003 (R. Jurek, CDFG, 2003, unpubl. data).

Overview. The following sections provide guidelines for assessing bald eagle occurrence and habitat use within particular project areas. Project areas (i.e., study or survey areas) are defined as any bald eagle habitats potentially affected by proposed activities associated with projects such as recreational or residential developments, timber harvesting, and operational changes to existing hydroelectric or irrigation storage facilities. Background information is provided for each component of the protocol to aid the reader and support the recommended methodologies. The protocol is divided into separate sections that include instructions on how to search for new nests, monitor existing nests, document breeding season foraging habitat and prey, assess disturbance factors, and survey wintering habitats.

2.0 Research Existing Information

Bald eagle nesting and wintering activities have been monitored in many parts of California beginning in 1968, and a thorough survey program was developed by the mid- to late 1970s. Therefore, some information may exist on bald eagle nesting or bald eagle sightings in the vicinity of many aquatic systems in the state. A thorough search for historical information in project areas is recommended prior to beginning protocol-level field work. These data may provide baseline information concerning bald eagle use in the area of concern and may aid in the survey design. Contact local CDFG, USFS, and U.S. Bureau of Land Management (BLM) offices and biologists as a starting point.

Sources. Potential sources of information include the California Natural Diversity Data Base, CDFG bald eagle records, USFS district files, the Raptor Information System maintained by the U.S. Geological Survey (USGS; see Section 7.3), previous studies related to hydroelectric project relicensing in the state (e.g., Pacific Gas and Electric Company, Southern California Edison, Sacramento Municipal Utility District, etc.), mid-winter bald eagle counts (see Section 5.0), the published literature, and unpublished reports. Such information might include incidental sightings; historical breeding records for known territories; nest site and habitat management plans; reports on wintering distribution and abundance; and, in the case of more detailed studies, food habits, foraging ecology, and home range. Section 7 is a list of materials that may be of use. For instance, Detrich (1986) provides numerous locations and other citations referencing historical bald eagle nesting and wintering habitats.

3.0 Bald Eagle Nesting

Projects may potentially impact bald eagle nest sites only during their implementation, for instance during timber harvest. Alternatively, the operation of projects may affect bald eagle productivity during the long term, such as when a flow regime is modified in regulated rivers during hydroelectric relicensing. Monitoring requirements of management and regulatory agencies, therefore, may differ depending on the anticipated impacts of various project activities. For these reasons, methods are provided in the following sections to search for previously unknown nests in new project areas and to monitor nesting activity and productivity at known nest sites during the long term. First, some background information is presented on what constitutes suitable bald eagle habitat in California.

3.1 Nesting habitat

3.1.1 Background

Bald eagles nest on a variety of natural structures, including projections or ledges on cliffs, trees protruding from cliffs, in deciduous trees lining river courses, and in a number of conifer species found along or near major water bodies (Call 1978). In areas where osprey (*Pandion haliaetus*) and bald eagles occur sympatrically, certain generalities can be assumed to help distinguish between the two species' nests. Bald eagles typically nest in live trees, some with dead tops, and build a large (~1.8 m/6 ft diameter), generally flat-topped and cone-shaped nest usually below the top with some cover above the nest. Osprey nests are usually more rounded and placed on the tops of dead trees. Osprey commonly use artificial structures (e.g., power poles), and their nests are typically smaller than eagle nests (Call 1978; Figure 1).

Figure 1. Comparison between typical bald eagle nesting structure located on Lake Britton, Shasta Co. (left) and typical osprey nest located at Bucks Lake, Plumas Co. (right).

An understanding of what represents suitable nesting habitat for bald eagles in California is necessary to make an initial habitat assessment. In general, bald eagles require a large tree (or cliff or rock outcrop, as on Catalina Island; see below) to accommodate a large nest in a relatively secluded location within the range of their tolerance of human disturbance. The species typically chooses a tree in the overstory, often the largest in the stand. Sensitivity to human activities varies by individual eagles and location (see Section 4.4). Bald eagles select nest sites on the basis of structure, prominence, and security (Anthony and Isaacs 1989).

Timber stand characteristics. Lehman (1979) evaluated physical and silvicultural features at 95 bald eagle nest sites at 54 nesting territories in California. To give the reader a general idea of bald eagle habitat preferences in California and to help formulate a search image, the following is a summary of Lehman's findings:

- The predominate nest tree species was ponderosa pine (*Pinus ponderosa*) with some sugar pine (*Pinus lambertiana*) – 91 percent pines overall.
- Most nests (95%) were in the upper forest canopy in live, dominant or co-dominant trees.
- Most nest trees (81%) were over 30 m (100 ft) tall.
- Nest trees surveyed had a mean DBH of 109 cm (43 in.).
- Eighty-nine percent of the nests surveyed were located in the top 9 m (30 feet) of the tree.
- Total canopy closure (% cover) of the adjacent forest stand, as estimated from aerial photography, was below 40 percent for most (75 %) sites, indicating that "dense forest is not a prime requirement for nesting bald eagles in California" (Lehman 1979, p. 22).
- Over 80 percent of nests had at least light overhead cover providing some shade.
- Most nests (87%) were located within 1.6 km (1 mi) of a waterfront. One third was within 0.2 km (0.1 mi) of water, and none was greater than 3.2 km (2 mi) from water.
- Most nests (85%) had an unobstructed view of a water body.
- There was no discernable trend related to slope or nest position on slopes (i.e., low to high).
- Elevation of most nest trees above water (78%) was < 91 m (300 ft), but ranged up to 305 m (1,000 ft).
- Elevation above sea level ranged from 335 – 2,256 m (1,100 to 7,400 ft).
- Almost one half of the territories contained alternate nests.

In a study of mixed-conifer habitats in western Oregon, Douglas-fir (*Pseudotsuga mensiesii*) was the preferred nest tree species for nesting bald eagles (Anthony, et al. 1982). As they continue their expansion in California from the core population center in the north, other tree species are being occupied by eagles. For instance, bald eagles are now nesting in foothill pines (*Pinus sabiniana*) in the central coast area of California (K. Sorenson, Ventana Wildlife Society, 2001, pers. comm.). However, the structure of some conifers, such as the true firs (*Abies* sp.) and lodgepole pine (*Pinus contorta*), make them less desirable for nest placement (Anthony and Isaacs 1989). Non-coniferous species are now used for nesting by California bald eagles, including cottonwoods (*Populus* sp.), oaks (*Quercus* sp.), and eucalyptus (*Eucalyptus* sp.), and rock outcrops and spires characterize bald eagle nesting substrate on Santa Catalina Island (R. Jurek, CDFG, date [references] pers. comm.).

Habitat suitability models. Steenhof (1988) compared the variables used in ten habitat suitability models that were developed to predict the likely presence of bald eagles in particular areas throughout their range. Peterson (1986) developed a habitat suitability index for breeding bald eagles that showed that optimal bald eagle nesting habitat was characterized by: (1) a large foraging area with high fish production, (2) the presence of mature trees for nest sites, and (3) minimal human disturbance. The variables used in each model fell into four broad categories: (1) topographic situation (e.g., elevation and terrain); (2) nesting substrate (e.g., forest type and tree size); (3) disturbance factors (types, levels, and proximity); and (4) foraging habitats (e.g., distance from water and size of water body). Of these, the latter is the most difficult to measure subjectively (i.e., without actually sampling prey populations; see Section 4.2). However, Detrich and Garcelon (1986) suggested that the presence of osprey or seabird colonies might predict adequate prey abundance for eagles. Detrich (1986) also used an index of nutrient availability (morphoedaphic index) to explain varying eagle densities at lakes and reservoirs in California. Livingston, et al. (1990) applied discriminant analysis of bald eagle habitat features in Maine to show that nests along rivers were generally located in reaches within large basins, with less forest edge, and close to shore. On lakes, their model indicated that nests were positively associated with dominant trees and negatively associated with distance to water, human-disturbed areas, and timber harvest.

3.1.2 Identifying potential bald eagle nesting habitat

After reviewing available aerial photos, topographic maps, photographs, and silvicultural descriptions, conduct an initial site visit to determine if bald eagle nesting habitat occurs in the project area and adjacent lands. In the case of small projects, consider habitats up to one-quarter to one-half mile (conservative) from proposed activity, distances typically used to buffer nesting eagles from disturbances (MBEWG 1986). If no suitable trees or cliffs are available in or around the project area, then nesting can probably be ruled out. However, eagles may still hunt in project areas and nest elsewhere, so an assessment of foraging activity may be necessary in foraging habitats potentially affected by project construction or operation (see Section 4.0).

Evaluate the condition of forest stands and land status in the project area, keeping in mind that an expanding bald eagle population is likely to colonize marginal habitats. Although a prominent nesting location, relative security from human disturbance, and access to permanent prey sources are important, the guidelines provided here can be relaxed in some cases. For example, telemetry studies have shown that bald eagles will travel many miles and carry prey hundreds of feet in elevation to provide food for their young. However, if a project area does not support a standing (non-migratory) population of prey-sized fish (i.e., more than a brief anadromous run) or breeding waterfowl that will sustain a pair of bald eagles, then nesting is unlikely (see Section 4.2). In rare instances, abundant terrestrial prey such as ground squirrels may support a breeding pair of bald eagles.

3.2 Search for new bald eagle nest sites

3.2.1 Background

Nesting chronology. Figure 2 shows the typical chronology and approximate dates for bald eagle breeding events in the Pit River area of northern California. In general, higher latitudes and elevations delay onset of breeding. Courtship activity includes nest building, nest maintenance, pair bonding (e.g., vocalizing), copulation, and territory defense, all of which may occur throughout the year as well. Bald eagles lay one to three eggs asynchronously, two to four days apart (Stalmaster 1987). Each egg requires about 35 days of incubation to hatch, and nestlings remain in the nest for about 12 weeks until they are fully fledged (obtain plumage necessary for flight) and take their first flight. The post-fledging period lasts about one month, but is highly variable. In northern California, this phase ends when the juvenile eagles suddenly depart on a solitary migration in late July and August toward the north, typically to the early salmon runs occurring in coastal British Columbia (Hunt, et al. 1992a, Jackman, et al. 2001).

Bald eagles begin visiting nesting sites as early as November to make repairs to nesting structures, although nest maintenance may occur at any time of year. Most northern California bald eagles lay their eggs no later than the end of March. Reproductive failure may occur for various reasons, including egg breakage, egg death from exposure or chemical contamination, unfertilized eggs, nest predation (particularly from great horned owls and bears), nestling death from exposure or starvation, nest structure failure, human disturbance, and inclement weather conditions. Failures usually occur during incubation and early brood-rearing and prior to mid-May in northern California.

Nest search. In his comprehensive report, *Nesting habitats and survey techniques for common western raptors*, Call (1978) considered slow-flying light aircraft (fixed-wing or helicopter) to be the preferred method to survey for nesting bald eagles. He suggested flying on clear days during mid-day at about 150 m (500 ft) or closer to tree-top level while searching for perched or flushed eagles. When possible (i.e., on lakes, reservoirs, and large rivers), Call (1978) considered boat surveys to be an effective, and perhaps the cheapest, method to search for eagle territories and nests, with observers traveling about 30–60 m (100–200 ft) from shore and in a position to "skyline" nests. With both survey techniques, he suggested making more than one pass to maximize coverage of potential nesting habitat. Grubb, et al. (1975) effectively searched Washington's entire marine coastline for bald eagle nesting activity by fixed-wing aircraft flown at 100–130 km/h (60-80 mph) and 60–90 m (200–300 feet) above ground level.

The behavior of adult bald eagles may give clues to the presence of nests (Dzus and Gerrard 1989), and repeated sightings of adults in a particular area during the breeding season is an obvious indication of potential nesting activity. Other clues include flights with prey toward nesting substrate, perching in prominent locations away from foraging areas, and territorial vocalizations directed toward human and other raptor intruders. See Fuller and Mosher (1987) for more details concerning raptor nest searches, including the pros and cons of various survey modes and methods discussed in the following sections.

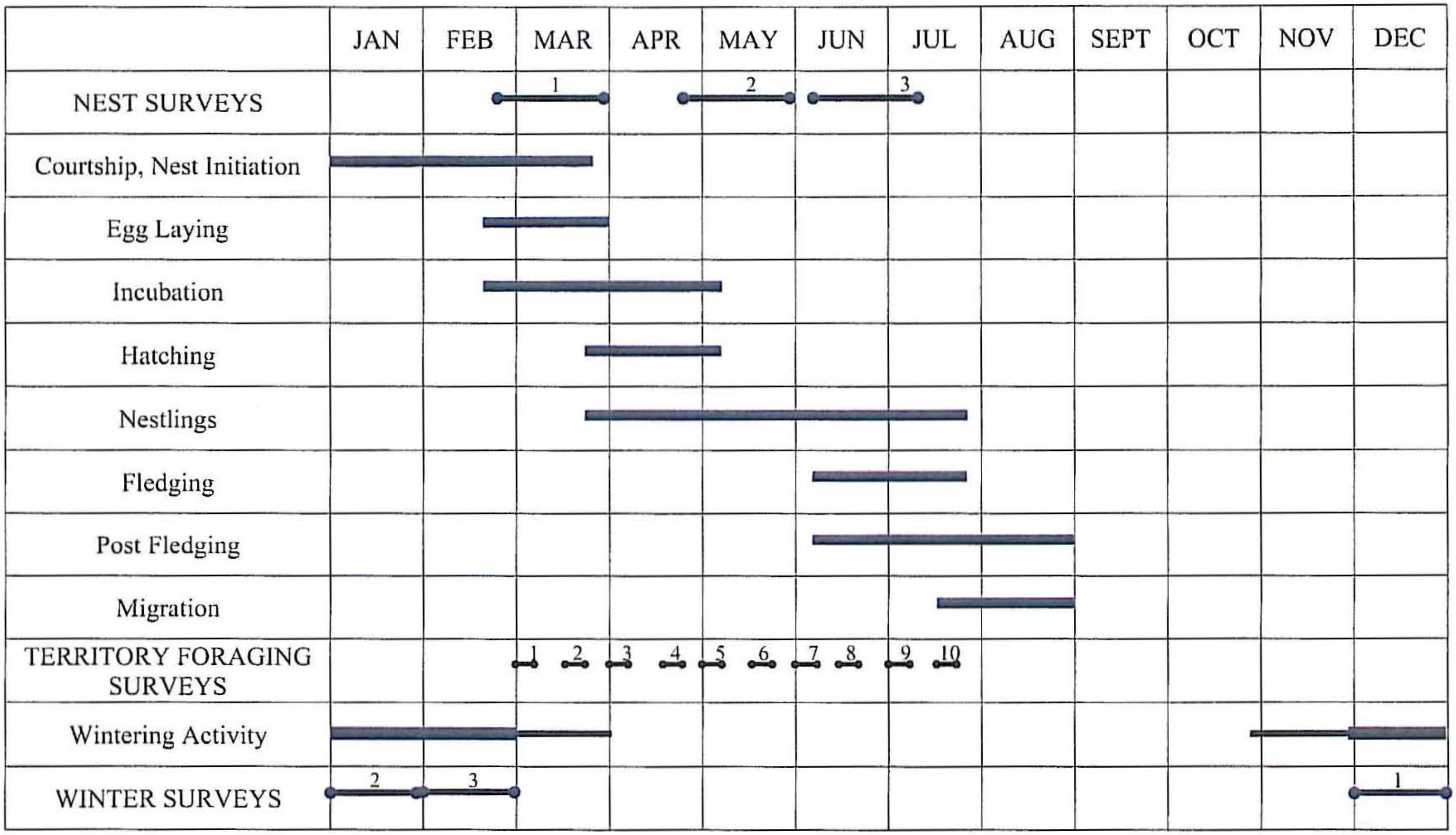

Figure 2. Chronology of bald eagle breeding and wintering activity in Northern California, along with recommended breeding and wintering survey effort and survey periods.

3.2.2 Searching for new bald eagle nests

Survey effort and chronology. Initial bald eagle nest searches should be conducted when eagles are most likely to be found at nest sites and as early in the breeding season as possible to avoid missing activity prior to any potential nesting failures. In northern California, this initial survey window extends from late February through March; however, adult eagles may be found in nest groves or even perched in nest trees at any time of the year. Because CDFG recommends three separate visits to *known* bald eagle nests in the state to document occupancy, successful hatching, and to count the number of young (see Section 3.3), three surveys during similar time periods are recommended to search for new nests in project areas (Figure 2).

After an initial survey (late February through March), additional surveys should be conducted in mid-nesting season (late April through May) and late in the season (early June to early July). Bald eagle behavior around nest sites changes during the course of the nesting season, and detectability may improve at some sites as the nesting season progresses. For instance, nestling caloric requirements are greatest around the mid-nesting season (i.e., greatest weight gain; see Bortolotti 1984a); as a result, adults make more foraging flights to and from nests in this period. In the late nesting season, large nestlings are often highly visible as they exercise their wings and branch out of the nest; and adults tend to perch less often in the nest and more often in conspicuous sentry or pilot perches. In addition, a season's coating of nestling whitewash is often very conspicuous at this time.

Surveys for new nests need only to be conducted during the year of proposed project activity (e.g., timber harvest). However, a complete series of three surveys should be conducted each year for the duration of the project, or until the impact period has passed (e.g., recreational site construction is finished and operating, or timber harvest prescription and clean up is complete). If all three surveys cannot be completed in one year, then all three surveys should be conducted the following year to account for any new nest sites colonized during the non-breeding season.

Survey modes. Depending on the local topography, road access, and aquatic conditions, searches for new bald eagle nests can be conducted on foot, or with terrestrial vehicles, boats, or aircraft Bald eagles and their nests are often very conspicuous, although nests can be hidden in dense foliage well below the crown. Search for bald eagles in adult plumages and large dark stick masses in dominant and co-dominant trees. When adults are frequenting a waterway to forage during the breeding season, observers should attempt to follow incubation exchange flights early in the nesting season, and later prey delivery flights that are directed to and from potential nesting areas. Use spotting scopes and binoculars when possible to observe eagles and search for nests. A good pair of binoculars are also useful in a helicopter and often save flight time by helping to rule out "stick" birds or "witches' broom" (thick growth of branches caused by fungal or other infestations), often mistaken for nests. A gunstock-mounted spotting scope is particularly useful when surveying from boats to help compensate for the rocking motion caused by waves.

Morning hours are typically best for surveying for nesting eagles since the adults are most active foraging and feeding during this period; however, because of their conspicuous plumage and large nests, eagle nests can be searched for throughout the day. Days of inclement weather (i.e., rain, snow, extreme cold, and high winds) should be avoided because of problems with visibility and to avoid failures associated with unintentional flushing or other disturbances to nesting adults.

Small project area parcels can often be surveyed on foot, and wilderness restrictions often leave no other option. During searches, take steps to avoid disturbing nesting eagles. Bald eagles are most susceptible to disturbance during incubation and the early nestling phase, when forced absence from their nest may expose vulnerable eggs or young to hypothermia or predation (Fyfe and Olendorff 1976, Grier and Fyfe 1987). Also, pedestrian traffic is often more distressing to bald eagles than vehicular traffic, especially if observers are close (generally <330 ft or 100 m) and within full view from nests. If surveying from a boat, travel slowly and vary distances from shore (approximately 50–100 m or 165–330 ft) depending on the gradient of shoreline banks.

Helicopters, though expensive, may be the most cost-effective and comprehensive survey mode for bald eagles, especially if project areas encompass an extensive length of shoreline or river. When surveying for bald eagle nests from a helicopter, travel at approximately 75 km/h (45 mph) and about 100–200 m (330–650 ft) above shoreline, depending on slope gradient. Because of the potential dangers of aircraft collision with birds, avoid close encounters with eagles and especially the more aggressive osprey at nest sites. Retreat some distance or depart the area immediately if eagles flush or take flight. Often eagles will fly immediately to their nest if flushed from nearby sentry perches, so keep track of flying eagles if the nest site has not yet been determined. Surveyors should concentrate on areas closest to water, but search up to one mile from the shoreline using a zigzag route between habitat patches. Make multiple passes in homogenous stands containing suitable habitat. Avoid engaging pilots in searching for eagles so they can concentrate on avoiding wires and other hazards. Slow-flying, fixed-wing aircraft are more economical than helicopters, but are less maneuverable and require a very experienced observer. While days of inclement weather must be avoided for safety reasons, overcast days provide the best lighting conditions by highlighting the white plumage of adult eagles and dark nests against a forest green background without glare.

3.3 Existing nest sites

3.3.1 Background

Besides the obvious concerns of finding previously unknown nests within project areas, managers should also be concerned with bald eagle productivity at known nest sites if project activities may affect reproductive rates over time. Therefore, it is important to know the methods used to monitor existing bald eagle nest sites. See Steenhof (1987) for a comprehensive presentation of the terminology used in describing raptor reproductive behaviors, the timing and various techniques of nest surveying, and the potential errors associated with reporting nesting success and productivity.

To accurately assess the status of *known* pairs of nesting bald eagles, it is important that surveys be scheduled to coincide with the regional chronology of egg laying and fledging of young. Since activity at a particular nest site may be missed if the pair fails before nest surveys are conducted, it is important to begin surveys as early in the nesting season as possible (Steenhof 1987). For example, Fraser, et al. (1983) found that scheduling occupancy survey flights outside the peak bald eagle egg-laying period resulted in erroneous interpretations of site occupancy in up to 50 percent or more of territories. Likewise, flights assessing juvenile (in this case, older nestling) recruitment conducted at times outside the principal fledging period when young were too small (too early) or some young had already departed the nest (too late) resulted in miscounts in up to 40 percent of territories surveyed. Steenhof and Kochert (1982) suggested that the minimum age for counting nestlings produced at diurnal raptor nest sites should be 80 percent of the average age of first flight (about 8 weeks for bald eagles), because they are large enough to count then, and mortality after this period is usually minimal.

As with new nest searches, various survey modes can be used depending on topography, weather conditions, and costs. When conducting ground-based counts, Fuller, et al. (1995) recommended spending up to one hour at each nest to get an accurate count of nestlings during their later development stages. When surveying by helicopter, Watson (1993) made the following recommendations: Use quieter, turbine-engine helicopters; stay at least 60 m (200 ft) from nests and use binoculars; spend <10 seconds at the nest; move away from the nest if adults appear agitated or flush; and avoid hovering (also a safety concern), since it may increase agitation responses.

3.3.2 Monitoring existing nest sites

CDFG Breeding Survey. For the considerations discussed above, and to avoid erroneous breeding status reports, CDFG recommends that each known bald eagle nest be checked at least three times during the breeding season: early in the season (early March) to determine occupancy; in mid-nesting season (late April/early May) to determine the presence of eggs or young (i.e., continued activity); and late in the season (mid-June) to determine success and the number of young near fledging (see Jurek 1990, and see http://www.dfg.ca.gov/hcpb/species/stds_gdl/bird_sg/baldenstsurv.pdf for complete CDFG instructions and survey forms). During site visits, record all nesting activities onto CDFG forms, including nest repair or construction, incubation posture, brooding posture, and number and age of young. Take care to avoid disturbing nesting eagles, and use sufficient optics to view the nest area from a safe distance. Use an aging key (Carpenter 1990) to help identify the stage of nestling development (see also Bortolotti 1984a). Note the condition of nests, especially if no adults are found. Recently used nests will have high margins of freshly laid sticks, well-defined nest cups and recent nest lining often including some fresh greenery (these characteristics are especially visible from the air), and whitewash in surrounding branches and below the nest along with recent prey remains. Old nests are matted down and often slumped in the tree.

Terminology. Bald eagle nesting activity is generally classified and described using the following categories, after Jurek (1990) and Lehman (1983):

> **Occupied**: two adults present in a territory containing a nest during the breeding season; or one adult observed incubating, with young, or near a recently used nest.
> **Occupied, Not Successful**: an occupied territory where no young were produced (failed) because of egg breakage, egg death, nestling death, or no breeding attempt was made.
> **Not Occupied**: no nesting activity and no adults in a nesting territory.
> **Failure**: nesting attempt failed due to egg breakage, egg death, or nestling death (same as Occupied, Not Successful).
> **Successful**: one or more young fledged from the nest.
> **Status Unknown**: territory not checked or incompletely checked to determine occupancy.
> **Occupied, Success Unknown**: occupied territory not adequately monitored to determine success.

Territories are classified as occupied if two adults are present near a nest, when eggs are laid, or young are raised. Inferred evidence of occupancy includes observations of an adult in incubation posture or when there is evidence of recent nest repair or use (e.g., fresh droppings or prey remains). If only one or no eagles are observed at known territories with no nest or an unused nest, these are classified as unoccupied. Pairs may fail if all eggs or young die and if adults abandon the nest site for that season. Successful territories are those with at least one fledged juvenile that has acquired flight feathers, observed either flying near the nest or as a late stage nestling.

Mean annual bald eagle productivity is calculated by dividing the number of times a territory was occupied into the total young produced therein over a period of years. Young-per-occupied-territory should be used to account for any unsuccessful periods as recommended by Postupalsky (1974) and Steenhof (1987) and to be consistent with other researchers and bald eagle data bases. Nesting success is calculated as the number of successful years divided by the number of unoccupied years, expressed as a percentage.

4.0 Bald Eagle Breeding Season Foraging Habitat

Bald eagles use a variety of aquatic habitats for foraging during the breeding season, including regulated and unregulated rivers, reservoirs, lakes, estuaries, and coastal marine ecosystems. Both natural forces and human activities affect water levels and flows in these systems, thereby influencing prey populations and movements, and consequently bald eagle foraging. Researchers have documented bald eagles making sudden shifts in hunting areas to exploit spawning fish, carrion blooms, or even terrestrial prey when water clarity degrades from storms (Hunt, et al. 2002). This dynamic situation warrants multiple surveys spread evenly across the long (six-month) bald eagle breeding period to identify and describe all important foraging locations within project/study areas.

Bald eagle foraging ecology has been studied on many ecosystems. On Pit River reservoirs in California, eagles hunted mostly from perches, either foraging in deep, open water taking fish carrion or fish swimming near the surface, or foraging in shallows, particularly in coves near tributary streams where the clear inflow improved visibility into the water (Hunt, et al. 1992b). Sacramento suckers (*Catosotomus occidentalis*) were vulnerable to eagles in the shallows of both reservoirs and river pools while spawning or when feeding on algae in the photic zone (Hunt, et al. 1992b). Suckers were also available as carrion, probably related to spawning, and often floated in open water. In some areas, foraging bald eagles focus on the inflow, estuary-like habitats at the upstream portion of reservoirs. At Arizona reservoirs, eagles found fish carrion that accumulated at inflows from spawning activity upstream, and captured bottom-dwelling fish from extensive shallows produced from siltation (Hunt, et al. 2002). At deepwater lakes in Montana, bald eagle foraging perch sites were correlated with distance to the main inlet, tributaries, and shallow water (Caton 1992).

Several studies have demonstrated the importance of shallow habitats to bald eagles foraging in riverine habitats. Most water-oriented forage attempts in Arizona described by Grubb (1995) were in shallow areas close to shore. Bald eagles on the Pit River usually perched above pools and captured live Sacramento suckers from shallow areas with little or no surface turbulence (Hunt, et al. 1992b). Arizona eagles also captured suckers (*Catosotomus* spp.) from shallow riverine habitats, but they selected mostly turbulent riffle habitats (Hunt, et al. 2002). The difference in foraging strategy between the Pit River and Arizona rivers reflected the behavior of suckers adapting to the differing hydrography of two systems, and the eagles exploited these behaviors (see Hunt, et al. 2002, 1992b).

In marine ecosystems along coastal Maine, bald eagles nested near areas with extensive shallow water at low tide (Livingston, et al. 1990). In the Columbia River estuary, eagles foraged mostly in tidal flats, especially at low tide (Garrett, et al. 1993), and most foraging occurred in water <4 m deep (Watson, et al. 1991). Overall, tidal flats and shallow bays contributed to the availability of fish carrion, live fish, and waterfowl. Pelagic fish are also taken by bald eagles in marine and other open water habitats. For example, cisco *(Coregonus artedi)* are common in the bald eagle diet at Besnard Lake in Saskatchewan (Dzus and Gerrard 1993). This species exhibits diurnal and seasonal movements through the water column, and apparently swims near the surface, making it likely prey for eagles. Trout stocked from hatcheries in California reservoirs are often taken live as they swim or feed near the surface in open water (R. Jackman, pers. obs.).

4.1 Bald eagle distribution and abundance

4.1.1 Background

Fuller and Mosher (1987, p. 37) defined a raptor *survey* as "(1) the process of finding individuals in relation to geographic areas or habitat features; and (2) an enumeration or index of abundance of individuals in an area from which inferences about the population can be made." The use of index values (i.e., raw counts) has been criticized in recent years, and is sometimes considered unreliable, mostly because of highly variable detection probabilities, unless standard double sampling methods are used to calibrate values (Anderson 2001). However, for the purpose of this protocol, we believe the documentation of bald eagle presence, distribution, and relative abundance from standardized surveys at particular locations during the breeding season is sufficient to assess the relative importance of those habitats to eagles over the breeding period. Also, this species' reliance on aquatic habitats and its habit of perch-hunting and loafing along linear edges of these habitats (i.e., shorelines and riparian corridors) mostly eliminates the need for probabilistic sampling and the use of random transects to sub-sample geographic polygons. In other words, it makes no sense to survey foraging bald eagles at random locations that might fall in the middle of the forest or far out from shore in most breeding habitats in California. However, in the case of certain terrestrial basins or broad wetland areas (e.g., alluvial valleys) used primarily by wintering populations (see Section 5.1) or to monitor population trends along extensive shoreline areas (e.g., Alaska), a stratified sampling effort may be more appropriate (Hodges, et al. 1979, Brown and Nassar 1991).

Survey variability. A number of factors contribute to variability and underestimation of abundance, including visibility or detectability, time of day, season, weather, habitat conditions, prey base, and observer experience (see Fuller and Mosher 1987). The white head and tail of adult and near-adult bald eagles (Basic III and Basic IV plumages, Section 5.1.1) are striking field characteristics, unless observed against a backdrop of snow-covered forest. Because of their cryptic coloration, subadult and juvenile bald eagles are often difficult to see, especially when perched in heavy foliage. For this reason, researchers sometimes adjust counts of subadults by calculating age ratios of eagles when they are most visible (e.g., in flight) or by extrapolating population estimates for large areas based on sampling data (Swenson, et al. 1986, Hunt, et al. 1992c). In these cases, estimates of the population are based on subadult:adult ratios. Using radio-tagged eagles to test detection rates of bald eagles, Bowman and Schempf (1999) calculated that 79 and 51 percent of *observable* adults and subadults, respectively, were detected during aerial surveys in Alaska. Since bald eagles typically move into foraging areas around first light, eagles can best be located by conducting surveys of potential hunting grounds during the morning hours.

Selected studies. A wide range of survey methods have been used to document bald eagle distribution and abundance in particular habitats. Hunt, et al. (1992b) conducted weekly helicopter flights along 78 km (48 mi) of the Pit River in northern California and showed that eagles selected river pool habitats disproportionately to pool occurrence. Dzus and Gerrard (1989) used motor boats traveling at 8–16 km/h (5–10 mph) at a distance of about 100 m (330 ft) from shore to census bald eagles and search for nests along lakes in north-central Saskatchewan. Surveys were suspended during periods of low visibility arising from moderate to heavy rain showers, fog, and high winds. Anthony, et al. (1999) used the double survey method to estimate bald eagle sighting probabilities for different survey methods in Oregon on the Columbia River and Crooked River and found that the probability of finding eagles from aircraft was lower than that from boats and from the ground.

Using daily radio telemetry data analyzed by two-week periods over the entire bald eagle breeding season, Hunt, et al. (2002) demonstrated that nesting eagles exploited a variety of spawning fisheries affected by flows and water temperatures in a regulated river system in Arizona. They also confirmed previously unknown bald eagle use of reservoir habitats by eagles nesting in river canyons along the Salt and Verde River. Alternatively, Hunt, et al. (1992b) radio-tracked adult breeders from nests along reservoirs into the steep Pit River canyon in northern California, where they determined that the eagles were foraging on grazing suckers in the shallows of riverine pools. For a period of eight years, Chandler, et al. (1995) conducted twice-weekly to twice-monthly aerial surveys to document perching preference of radio-tagged eagles in relation to human development on Chesapeake Bay.

4.1.2 Defining bald eagle use areas during the breeding season

There are two basic approaches to survey bald eagle use within project areas. The most straightforward and economical—an eagle "census"—is a count made by moving through potential habitat under the most appropriate mode of travel (e.g., foot, vehicle, boat, or aircraft). These surveys provide data to map eagle distributions and identify use areas, calculate relative abundance, estimate densities, and define habitat use (Fuller and Mosher 1987). By conducting multiple censuses throughout the breeding season, a fairly accurate description can be made of within-season variation in eagle numbers and habitat use. Important habitat features that will be identified include hunting perches, loafing perches, foraging areas, and possibly night roosting sites.

The second approach to surveying breeding bald eagles involves continuous monitoring of individual eagles (i.e., focal animal sampling), that is, to construct a time and activity budget (i.e., chronological accounting) of eagle habitat use during a survey day, or series of survey days spanning the breeding season. Depending on the circumstances, these intensive surveys may be effective without telemetry; however, radio-telemetry may be necessary in more complex habitats or inaccessible terrain. The continuous monitoring approach will reveal more information on eagle foraging behavior, mechanisms of prey acquisition, diel patterns of potential prey, and eagle night roosting locations. Continuous monitoring of more than one eagle pair requires a sampling schedule; however, each key territory should be surveyed at least once during every two-week period.

The decision to use either the eagle census method or the continuous monitoring method should be based on the anticipated project effects on the bald eagle prey base and foraging habitat (e.g., flow changes in regulated river systems affecting fisheries), and so on whether information on foraging behavior and food habits is necessary, in addition to the eagle distribution and abundance data, to make an adequate assessment of these impacts (see sections 4.2, 4.3).

Eagle census. Decide on the most efficient and effective mode of travel to survey bald eagles in the project area. Whether using helicopter, fixed-wing aircraft, boat, vehicle, or pedestrian surveys, establish a replicable survey route to follow on subsequent surveys for continuity. The best time of day to conduct single surveys is in the morning during the first few hours after sunrise. Record all eagle locations by date, time, location (general or established river or shoreline kilometer locations), bird (i.e., adult, juvenile, or subadult by basic plumage type, see Section 5.1.1), activity, perch type, and adjacent aquatic habitat. Record locations onto USGS 7.5 min. quad maps, or program waypoints into a GPS unit in the field. See Appendix A for an example of a data form. To accurately access within-season changes in eagle numbers and habitat use associated with possible changing sources of prey, surveys should be conducted every two weeks, at a minimum, throughout one bald eagle breeding season extending from March through July (Figure 2). If all surveys cannot be completed in a given year, only those two-week periods missed during the first year need to be completed in the second year.

Continuous monitoring. Surveys should begin at first light and extend until eagle activity drops off in late morning (this typically occurs around 1100-1200 h). Continue past this period if foraging activity remains constant. If no eagles are seen in the morning, or if no foraging occurs, then surveys should include a portion of the mid- to late afternoon (approximately three hours before sunset to dusk). Often during the middle portion of the day, bald eagles will soar above their territories if conditions are right, or loaf in shady perches, especially on hot days. An afternoon/evening survey is usually necessary to find night roosting locations, unless eagles can be observed emerging from roost sites before sunrise. As with the eagle census survey described above, continuous monitoring time budget surveys should be conducted every two weeks, at a minimum, throughout one bald eagle breeding season from March through August (Figure 2), or two seasons to complete all survey periods (see above).

Observations. To document areas important to nesting adults, follow adult eagles as they depart the nesting area at first light (approximately one-half hour before sunrise) to foraging locations, and attempt to maintain visual contact with one or both adults while hunting. When this is not possible, conduct boat searches of the entire lake or reservoir to find eagles in hunting perches, and then observe behaviors and movements by maintaining visual contact. Often teams of two or more observers positioned at key observation points in boats or vehicles, and maintaining contact with hand-held communication radios, are required to adequately follow hunting eagles. Record the timing of eagle movements and activities, and plot all eagle perch locations onto 7.5-minute USGS topographic maps in the field. Locations can be facilitated by a hand-held GPS unit. Record eagle movements to include date, time (begin/end at each location), location (general or established river or shoreline kilometer locations), bird (i.e., adult male, female, juvenile, or subadult by basic plumage type), activity, perch type, and aquatic habitat utilized. See Appendix A for an example of a data form. Summarize chronologically habitat use data by the number of minutes eagles (both male and female adults when present) spent utilizing different habitat locations (i.e., reservoir, river, inflow, cove, etc.).

Plot the location of foraging strike points onto 7.5-minute USGS topographical maps for later conversion to latitude/longitude coordinates in a computer-based GIS program. Also for each foraging observation, record the attack mode, success, estimated distance from perch and shore, prey type, prey status (alive, moribund, or carrion), and aquatic habitat (i.e., open water, cove, or tributary). Use visual cues such as how the eagle obtained the prey, and movement and appearance of the prey item to determine its status. Carrion fish, lifeless and sometimes pale, are typically plucked easily from the water by the eagle at the terminus of a direct flight. Live fish, bright and usually animated, are obtained from a more active, maneuverable flight pattern, often after a period of obvious visual assessment from a nearby perch. Moribund fish share characteristics of both (i.e., bright, semi-mobile, yet impaired), and can be mistaken as either depending on the degree of mobility.

Radio tracking (telemetry). Many bald eagle pairs are relatively easy to follow visually if nesting in open water territories, and radio tracking is often not required to delineate use areas. However, if eagles are nesting near riverine, timbered canyons (Figure 3), visual contact may not be possible without the aid of telemetry. For typical small-scale project assessments, telemetry may be too time-consuming and not cost-effective; however, for long-term and large-scale management studies in difficult terrain (see Hunt, et al. 2002), the use of radio tracking may be most appropriate.

Figure 3. Contrasting bald eagle habitats found in the Pit River canyon located below Lake Britton, Shasta Co. (left) and in open water of Shasta Lake, Shasta Co. (right).

To facilitate the pursuit of foraging eagles in riverine habitats, attempt to radio-tag the adult males at territories where conditions do not enable easy visual monitoring of eagle movements. The capture and marking of bald eagles requires several special permits, including a federal endangered species permit and a state memorandum of understanding. Target adult males for telemetry, since they typically do most of the foraging, especially early in the nesting cycle. Various capture methods are effective on bald eagles, including floating noosed fish techniques described in Cain and Hodges (1989) and Jackman, et al. (1993) and a radio-controlled bow net or power snare (Jackman, et al. 1994). Once captured, hood and constrain eagles, make standard measurements to determine sex (Bortolotti 1984b), and attach a radio transmitter. To monitor local movements, use a 3- to 5-year, 60-gram VHF transmitter attached backpack-style using teflon-coated nylon straps connected at the sternum with two or three stitches of cotton embroidery thread (Garcelon 1985). This technique allows the possibility that the transmitter will fall off after a period approximating the life of the batteries. Since bald eagles typically replace their tail feathers during the summer, tail-mounting transmitters is not an option for breeding studies. To track eagles, use standard telemetry receivers and three-element yagi-style antennas.

Night roosting habitats. Most breeding adult bald eagles night roost in their nesting stands, which are typically one of the more secure locations in eagle territories, and night use may occur there throughout the year by the territory holders. Communal night roosting is common during the winter or non-breeding season by migrants; however, communal roosting during the summer breeding season by non-breeders is less common (Buehler 2000). Individuals may night roost around daytime foraging perches, or seek more protected stands during inclement weather (Buehler 2000). Night roosting locations can be determined by observing eagles as they emerge from roosts, typically one-half hour before sunrise at active nesting territories and from dawn to mid-morning on wintering grounds. Roosts can also be located when eagles depart foraging grounds during the several hours prior to sunset; the onset of departure is probably influenced by foraging success and weather conditions. Once a roost stand is identified, visit the area during the day to search for bald eagle sign (feathers, castings, mute) and GPS or map the exact location onto 7.5-minute topographic maps (see also Section 5.2).

4.2 Bald eagle prey base

4.2.1 Background

Along with surveys for bald eagle distribution and abundance within a project area, it may also be important to determine the kinds of prey available to bald eagles and the mechanism of prey acquisition (Section 4.3). These inquiries are necessary if project-related activities may present an obstacle to foraging success (e.g., on-going disturbance preventing access to preferred hunting locations), or if project construction may negatively affect prey populations or key habitats (e.g., water diversions or altered flow releases affecting fish populations or spawning habitats).

An immediate need for prey base surveys is to determine whether and when there may be sufficient abundance of potential prey to support bald eagles within a project area. If bald eagles are nesting or wintering in a particular area, an assumption can be made that they are sustained by a reliable source of food, and perhaps have reached a carrying capacity as a result (Hunt, et al. 1992c). Also, particular habitats may provide resources for only seasonal use, such as a migration stop-over location for late fall kokanee runs (McClelland, et al. 19982). Or, in the case of breeding habitats, prey resources may be limited and provide only marginal conditions for breeding, and this may be reflected in poor eagle productivity, such as at many high-altitude, relatively oligotrophic lakes and reservoirs in California. For instance, fish abundance (catch per unit effort) and primary productivity (standing crops of plankton and benthic organisms) were positively correlated with bald eagle nesting densities on two lakes in Saskatchewan, one relatively productive and the other less productive (Dzus and Gerrard 1989).

A series of focused surveys are necessary to accurately describe the bald eagle prey base at inland water locations. These include fisheries sampling, carrion surveys, and waterfowl surveys. While fisheries sampling often involves methodologies beyond the logistical means of most terrestrial biologists, information on resident (standing) and anadromous fish populations may already exist for many streams, lakes, and reservoirs in California. Local CDFG fisheries biologists often know the species composition and relative abundance of prey-sized fish in a particular area, and an initial assessment of this prey resource can usually be formulated. Carrion and waterfowl surveys can be conducted simultaneously with bald eagle surveys, and can easily provide data on the availability of these important food sources, including beach-cast seabirds and marine mammals within coastal environments.

4.2.2 Conducting prey base surveys

Carrion. To obtain an index of available carrion prey, conduct carrion surveys as early as possible in the day. Often, when available in only limited numbers, carrion fish are quickly removed by eagles, osprey, and other piscivorous birds and scavengers. While it is logistically impossible to intercept all carrion items prior to their recovery by these scavengers, carrion surveys do provide data on carrion surplus. Most surplus items recovered during surveys are either unpalatable (highly decomposed) or inaccessible (i.e., in deep water or brush piles). Carrion surveys should be conducted preferably by boat or by hiking along shorelines. Set up and search replicable transects in coves, shallow shorelines, gravel bars, and anywhere prevailing currents, winds, or tides are likely to concentrate floating debris. Surveys conducted by boat require moving slowly near shore with an observer scanning for floating objects, those submerged in shallow water, or items washed ashore or caught up in floating or submerged vegetation. Record species, size, number, and condition (degree of decomposition; signs of spawning—eggs, milt; wounds, or infections—see Figure 4) and map locations of all carrion items observed during carrion surveys and other incidental observations onto 7.5-minute topographic quads.

Waterfowl. Conduct surveys for waterfowl and other waterbirds that may be potential bald eagle prey (see Jackman, et al. 1999) concurrent with bald eagle surveys. Record species, numbers, and general locations of all waterbirds encountered during the eagle surveys.

Figure 4. Carrion post-spawn spotted bass with signs of disease.

Fisheries. If no information exists on fisheries for waters within the project area, some standard fisheries survey techniques can be implemented. These include electroshocking, gillnetting, and snorkeling (Murphy and Willis 1996). Of course, state scientific collecting permits are required for the former two techniques, and keen fish identification skills are necessary to accurately sample fish by snorkeling. Boat and backpack electroshocking and gillnetting within various eagle foraging habitats yield direct quantitative data on the relative abundance of fish species; however, some fish mortality is possible. Snorkeling is less intrusive and more easily implemented than electroshocking or gillnetting; however, good results depend on water clarity and visibility (Flosi, et al. 1998).

4.3 Bald eagle food habits

4.3.1 Background

Several studies have positively correlated the *abundance* of fish (measured by gillnetting) in open water habitats (i.e., estuary, reservoir, and natural lake) with the diets of bald eagles (Gerrard and Bortolotti 1988, Mersmann 1989, Vondracek, et al. 1989, Hunt, et al. 1992b). While an abundant prey base may be evident in potential bald eagle habitats, the availability of certain prey species may depend on habitat conditions (e.g., shallows available) or the timing of certain events (e.g., spawning fish, molting waterfowl, etc.). Much of the literature concerning bald eagle foraging ecology examines their inclination to target bottom-feeding fish, and how the downward visual orientation of these fish makes them more vulnerable to eagle predation than top-feeding fish (Todd, et al. 1982, Haywood and Ohmart 1986, Hunt, et al. 1992b). Therefore, it is not only important to document the relative abundance of prey for bald eagles (see Section 4.2), but to also study the *availability* of those prey. Since eagles usually feed daily and forage many more times per day when feeding young, an analysis of their food habits gives immediate results to these questions concerning access to prey.

Bald eagles are extremely opportunistic when acquiring prey during the nesting season, and this has been demonstrated extensively in the literature (see Stalmaster 1987 and Buehler 2000 for reviews). Some of their well-known foraging techniques include: recovering fish stranded by fluctuating river flows (Brown, et al. 1998); exploiting spawning runs of salmonids and other fish species as they move from lakes and reservoirs into tributary streams (Swenson, et al. 1986); retrieving carrion or moribund fish post-spawn from inland reservoirs (Hunt, et al. 1992b, 2002—see Figure 5); capturing waterfowl during flightless molting periods (Swenson, et al. 1986); collecting road-killed mammals (Retfalvi 1970); and raiding nesting waterbird colonies (Norman, et al. 1989). Simply by observing their foraging behavior, bald eagles will readily show the observer how prey becomes available to them within project area habitats.

To avoid biases associated with using just one technique to assess bald eagle food habits, Mersmann, et al. (1992) concluded that multiple sampling techniques are necessary to make an accurate assessment of prey utilization. The various techniques useful in determining bald eagle food habits include direct observations of prey deliveries to nests (Hunt, et al. 2002) including videos or time-lapse photography (Hunt, et al. 1992b), direct observations of eagles with prey on foraging grounds (Watson, et al. 1991), and the collection of prey remains at foraging grounds and from nests (Jackman, et al. 1999).

Figure 5. Moribund carp on the surface of Shasta Lake, Shasta Co.

The timing of surveys targeting foraging observations is important since most bald eagle hunting occurs during the morning hours. However, in areas affected by tides for example, eagles may forage when prey are most available, in this case at low tide when fish may be stranded in tide pools (Watson, et al. 1991). A second peak of foraging activity is typical in late afternoon or early evening. Other factors may affect temporal bald eagle foraging activity, such as flow releases from dams for hydroelectric power generation or irrigation affecting river temperatures, fish stranding, fish stocking, and reservoir levels (Detrich 1977, Brown, et al. 1998, Jackman, et al. 2000, Hunt, et al. 2002).

From a study of prey remains collected at inland bald eagle nests in northern California, commonly used bald eagle prey species varied by river drainages (Jackman, et al. 1999). For example, Sacramento sucker were most common in eagle diets at reservoirs along the Pit and American Rivers; catfish (Ictaluridae) predominated at reservoirs on the Trinity and Feather Rivers; and tui chub (*Gila bicolor*) were the principal prey of eagles nesting in the Lahontan System (i.e., Eagle Lake). In general, eagles ate mainly fish at breeding sites in northern California as is typical for the species; however, waterbirds (mostly American coots, *Fulica americana*, and mallards, *Anas platyrhynchos*) were more important than fish at sites isolated from the larger river drainages.

4.3.2 Quantifying bald eagle food habits

When possible, multiple approaches should be used to quantify the diet of bald eagles in project areas, including an analysis of prey remains found in and below active nest sites or below feeding perches; direct observations of prey deliveries to the nest; and/or observations of foraging eagles with prey. A state scientific collecting permit is necessary to collect prey remains (i.e., bones, feathers, and fur); however, pictures (for later analysis) or field identification may be used in lieu of collecting. State and federal permits are also required to enter bald eagle nests. At a minimum, observe foraging eagles and attempt to retrieve some information on prey species from observation or prey remains.

Prey remains. The type of prey remains available following a bald eagle feeding event range from none at all or tiny scales, in the case of small fish, up to huge, partially consumed ungulate carcasses. Collections at nests vary greatly depending on the sanitary habits of individual eagles. Field identification of fish remains, feathers, and fur is sometimes difficult; however, reference bone materials and study skins are available at university museum collections, some keys are available, and a local reference collection can be constructed from resident fish with the proper permits, if feasible. A comparison of prey species' biomass is often more accurate than prey numbers when assessing the relative importance of prey species, since the former approach accounts for actual caloric contributions, not just frequency. Both are important to report, as the acquisition of frequent smaller items by eagles is also significant, especially when sustaining small young.

Use reference bones, bone keys (Casteel 1976), and scale keys (Lagler 1940, Casteel 1972), or consult with experts to identify the species and size of fish represented by each prey item found in prey collections (Hunt, et al. 1992b). For each fish species in a reference collection, develop bone-length to total-body-length regression equations for opercula, cleithra, crania, dentary, and other species-diagnostic bones (McConnell 1952, Hansel, et al. 1988). Using these equations, calculate total fish lengths for each prey item and eliminate duplicate prey items by matching parts representing like-sized individuals falling within 95 percent confidence intervals. The ages of fish scales can be determined by standard methods (i.e., counting annuli; Bagenal and Tesch 1978), and use length/annulus tables (Carlander 1969, 1977) to estimate size of fish represented only by scales. Calculate total weights for the selected (non-duplicate) prey items using length-to-weight equations from reference fish and from Carlander (1969, 1977).

Identify non-fish remains by comparison with museum study skin collections, field guides, and hair keys (Moore, et al. 1974). Calculate biomass for non-fish prey from standard mean weights (Burt and Grossenheider 1964, Steenhof 1983, Dunning 1992).

Direct observations. Although prey remains collected at nests tend to show all taxa eaten by eagles, they often under-estimate small, soft-boned fish (e.g., salmonids) while over-representing large, bony fish (e.g., carp, *Cyprinus carpio*, and catfish—Ictaluridae) and birds (Todd, et al. 1982, Knight, et al. 1990, Grubb 1995). For this reason, prey collections should be balanced with some direct observation of foraging eagles and/or observations of prey deliveries to nests. The key prerequisite to making nest delivery observations is the establishment of observation points with clear views into nests from distances within the range of available optics that will be tolerated by the nesting eagles. These distances can range from approximately 100 to 500 m depending on the degree of concealment near nests, individual eagle tolerances to disturbance, and quality of optics. For each prey delivery, record the time of delivery, prey species to nearest taxa, estimated size (based on comparison to the known size of adult or $\geq$ 7-week-old nestling eagles' culmen—about 5 cm), and status (e.g., alive or carrion) of each prey item brought to the nest.

While observing foraging eagles with binoculars and spotting scopes (Section 4.1.2), it is sometimes possible to identify key characteristics of prey items during or just after foraging events. Often during the non-nesting season or prior to nest delivery, eagles will fly to shore or other perches to feed partially or completely on prey. Direct observation of prey at that time, and prey remains or scales collected at these feeding sites, can also be used to identify prey items.

4.4 Assessing disturbance factors

4.4.1 Background

Individual bald eagles exhibit various degrees of sensitivity and/or habituation to disturbance; however, certain levels of human activity can exceed a threshold level that make areas unsuitable to any eagles (i.e., on a population level). Many studies have determined the thresholds at which human activities elicit individual response from eagles (Stalmaster and Newman 1978, Knight and Knight 1984, Grubb, et al. 1992, Steidl and Anthony 1996), which is useful in determining buffer zones to protect eagles from energy expenditures related to these interactions. One critical component of suitable bald eagle habitat is its protection from human disturbances that might disrupt or prevent nesting or adversely affect foraging activities.

Several authors have demonstrated that nesting and foraging eagles avoid areas of human use or development (Buehler, et al. 1991, McGarigal, et al. 1991, Brown and Stevens 1997). Stalmaster and Kaiser (1998) found wintering eagle numbers and feeding activity to be negatively correlated with recreational events along a northwestern river. Wood

(1999) reported evidence that boating reduced eagle use of a lake in Florida, but saw little measurable effect on the eagles, suggesting they were habituated to boating activity while perched on the lake (i.e., those that showed up tolerated the level of activity). Anthony and Isaacs (1989) reported that bald eagle productivity was lower at sites in Oregon altered by logging or other human disturbances, and that recently used nests had fewer roads and recreational facilities nearby than older nests in the same territory, suggesting a shift away from human activities.

Despite anecdotal accounts of disturbance-caused nesting failures at individual sites, most published data show little *direct* effect of human activities on bald eagle nesting attempts (Mathisen 1968, Fraser, et al. 1985, Anthony, et al. 1994). Human-induced failures are likely one-time catastrophic events (e.g., camping, woodcutting, or firearm target practice too close to nests) occurring near nests early in the nesting season, which often escape detection by managers.

While humans are responsible for negatively affecting bald eagles by altering habitats, interrupting eagle foraging and loafing activities (which deplete energy reserves, especially in winter), or excluding eagles from preferred habitats, many recreational activities, especially hunting and fishing, contribute to eagle prey acquisition (Ewins and Andress 1995, Jackman, et al. 2000). Examples include turbine-killed fish below powerhouse tailraces, crippled waterfowl from duck hunting, and unintentional mortalities associated with catch-and-release fishing or deliberate discarding of undesirable fish species.

4.4.2 Documenting human activities in bald eagle habitats

Document and map existing developments (recreational, industrial, and residential) within project areas in order to assess correlation between these facilities and bald eagle use in the area. Conduct public use counts at facilities where human use fluctuates (e.g., boat launches) or waterways (e.g., number of boats on a lake) concurrent with bald eagle surveys (see Section 4.1) to establish a baseline of human use patterns in the project area. Ongoing creel surveys by CDFG or daily records kept by campground or boat launch concessionaires may substitute when available. Conduct these public use counts at approximately the same time each survey day so the data will be comparable. Record any human/eagle interactions by noting the mode of human travel and the eagle's response and map locations.

5.0 Bald Eagle Wintering Habitat

5.1 Wintering foraging habitats

5.1.1 Background

Wintering concentrations of bald eagles, often associated with populations retreating from frozen breeding or natal grounds in Canada and Alaska, are found throughout much of California where food is available. Prey sources during this period vary considerably.

Common food resources include crippled or diseased waterfowl (Griffin and Baskett 1985), runs of anadromous fishes (Hunt, et al. 1992c), winter rainbow trout spawning runs (Brown and Stevens 1992), inland fish available at lower elevations, fish in ice-free waterways maintained by hydroelectric power operations (Stalmaster and Plettner 1992), winter-killed fish (Steenhof 1978), road-killed or winter-killed mammals (Todd, et al. 1982), domestic livestock still- and afterbirths (DellaSala, et al. 1989), kleptoparasitism (Jorde and Lingle 1988), ground squirrels in open ranchlands (M. Smith, 2003, pers. comm.), and voles in flooded farmlands. Wintering eagles are often nomadic (in contrast to territory holders that are yearlong residents in ice-free areas of California) and will search for and congregate where food is plentiful (Steenhof, et al. 1980). Although traveling from extreme northern latitudes, many wintering eagles return to the same wintering grounds during succeeding winters (Harmata and Stahlecker 1993).

Peak counts. Numbers of eagles at wintering areas typically peak between mid-December and early February (Hunt, et al. 1992c), with adults usually arriving and departing sooner than immature birds (Bowerman, et al. 1993), though there is much variation throughout the range. In the Klamath Basin in northeastern California, wintering eagles begin arriving in late October, peak during late January, and decline from February through March (Keister, et al. 1987). In contrast, Isaacs and Anthony (1987) found peak numbers of eagles during late February through mid-March in the Harney Basin of eastern Oregon, coinciding with large numbers of migrating waterfowl using the area. Regional weather patterns often affect numbers of wintering bald eagles from year to year. During a particularly harsh winter along the Platte River in Nebraska, Lingle and Krapu (1986) saw peak counts of eagles in March (1979) when most eagles likely wintered further south, compared to peak counts made in January (1980) during a relatively mild winter.

Published survey methods. As with breeding surveys (Section 4.1), published winter surveys used various modes of travel. Lingle and Krapu (1986) counted eagles along the Platte River in Nebraska in monthly and bimonthly intervals from December through March. They conducted midmorning aerial surveys from a fixed-wing aircraft flown at 30-150m (~100–500 ft) above the river at 130–190 km/h (~80–120 mph). Using this level of effort, these researchers were able to document changes to relative abundance of eagles within habitat segments, mostly influenced by waterfowl concentrations, fishery accessibility, and the availability of open water. In a Michigan study, Bowerman, et al. (1993) sampled wintering eagle concentrations along rivers using fixed-wing aircraft flown at 60–150 m (~200–500 ft) above the ground, also at speeds of 130-190 km/h (~80–120 mph). Fielder and Starkey (1986) surveyed a total of 1,775 km (1,103 mi) of shoreline along eastern Washington rivers and reservoirs by flying fixed-wing aircraft at speeds of 130–145 km/hr (~80–90 mph), 30-60 m (~100–200 ft) above ground level during monthly surveys from November through March. Reservoir shorelines were flown separately, unless the width between both shores was less than 0.8 km (0.5 mi), which allowed for simultaneous observation of both shores. Brown and Stevens (1997) conducted weekly helicopter surveys (90 km/h, 100 m above and directly over rivers) from November to March to correlate eagle numbers with areas of low human activity along 120 km (75 mi) of the Colorado River in Arizona.

Isaacs and Anthony (1987) used weekly and bi-weekly vehicle surveys along roads to census bald eagle feeding grounds in relatively open, flooded meadow and shrub-steppe habitats in eastern Oregon. Eagles switched between hunting waterfowl when wetlands were ice-free, to mammal carrion during colder periods. Hunt, et al. (1992c) counted eagles by slow-moving road vehicle and from a number of fixed vantage points twice a week from late November through mid-March along the Skagit River in Washington. These data were averaged for two-week periods to make comparisons between eagle numbers and available food resources (i.e., spawned-out salmon carcasses). Knight, et al. (1979) used weekly boat surveys (16–24 km/h; 10–15 mph) from October to April to census the complete rise and fall of wintering bald eagle numbers along a 72 km (45 mi) impounded stretch of the Columbia River in eastern Washington. Brown, et al. (1989) documented bald eagle winter-time use of the Colorado River in Arizona by conducting multiple-day boat surveys during the months of October 1987, and January, February, and April 1988 (no eagles were seen during the first and last surveys; peak numbers occurred in February). In a large regional survey for wintering bald eagle in Arizona and New Mexico, Grubb and Kennedy (1982) relied on National Forest biologists and historical information to prioritize known and suspected wintering areas. Small fixed-wing aircraft and helicopters were used to census remote areas and to prioritize ground team survey locations. By comparison, Brown and Stevens (1992) conducted daily eagle counts from January through March on a much smaller study area along the Colorado River in Arizona to contrast eagle abundance with prey (trout) abundance.

Weather and perching. Inclement weather often influences bald eagle distribution and perching locations on wintering grounds. Bald eagles typically perch in the highest available perches. During winter, many eagles choose leafless deciduous trees over conifers when available, probably to maximize flight clearance, visibility of foraging grounds, and thermal warming from solar radiation (Bowerman, et al. 1993, Chester, et al. 1990). Most eagles wintering along the Missouri River in South Dakota perched within 5 m (16 ft) of the river bank, usually on stout branches in cottonwoods adjacent to openings (Steenhof, et al. 1980). Steenhof, et al. (1980) also found that wintering bald eagles sought sheltered portions of their wintering range during inclement (cold, windy) weather. Chester, et al. (1990) observed that bald eagles utilized lower portions of perch trees more often during the summer than during the winter when they were more likely to be found near the top of the crown. Bald eagles typically ignore artificial perches or man-made structures for perching when natural perching opportunities are available (Steenhof, et al. 1980).

Aging eagles. The younger age classes of bald eagles are nomadic and can be expected in eagle habitats year-round. Bald eagles characteristically molt through five plumages (Juvenal and Basic I-IV) during the four years prior to achieving the adult or definitive plumage (McCollough 1989). In brief, the Juvenal (first year) plumage is mostly dark including the head and beak. The Basic I (second year) plumage is mottled, often with a white belly and inverted triangle on the back, and the head crown is tan. The Basic II (third year) plumage is also mottled and extremely variable, the head is osprey-like with a light crown and throat and dark eye stripe. The Basic III (fourth year) plumage is adult-like with brown flecking on the head and a fading eye stripe, a mostly yellow beak, some white flecking on belly and chest, and a brown terminal band on an otherwise white tail. And the Basic IV (fifth year) is often indistinguishable from the adult plumage, especially at a distance, with some brown flecking on the head and tail.

5.1.2 Surveying bald eagles in winter

Winter surveys for bald eagles should cover ice-free aquatic habitats where breeding eagles might be found, but also might include open valleys and basins where eagles may have access to winter-kill livestock or wild ungulates, rabbits, and rodent populations, some exposed by flooded farm fields during the winter, such as voles (*Microtus* sp.) in the Klamath Basin. Survey modes should duplicate those used during breeding surveys (Section 4.1), with the appropriate logistical and safety considerations for winter weather. Often dense fog and other inclement weather preclude survey travel and may hamper eagle activity as well. While most project areas should be surveyed completely, consideration can be given to a stratified random sampling design in broad wetland or basin areas (see Brown and Nassar 1991).

Single-day surveys should be conducted monthly along established survey census routes, from December through February (three surveys, at least two weeks apart) to encompass peak wintering activity in California. The January survey should occur during the two-week nationwide, mid-winter bald eagle survey (see Section 7.3) typically scheduled during the first part of January every year (coordinated in California by the CDFG and the University of California Santa Cruz Predatory Bird Research Group [PBRG]). While this survey is not as regionally comprehensive as in past years (see Detrich 1981, 1982), project data will be more comparable to state-wide trends when conducted in concert with this event. A two-year survey protocol for the three-month survey is recommended to include possible between-year variation caused by cyclic weather patterns (e.g., El Niño ocean warming events) or other factors affecting prey and winter eagle populations.

Often, it is important to identify prey species utilization by wintering bald eagles to predict the importance and longevity of food sources (e.g., kokanee spawning runs peak in late fall/early winter and decline in late winter). Prey of wintering eagles can be identified by direct observation of eagles feeding or hunting; by collecting prey remains from feeding locations or below perches; and by collecting castings below winter night roost trees (Ewins and Andress 1995; see Section 4.3). Spotting scopes and binoculars are often sufficient to identify species pursued or fed upon by eagles, particularly the larger taxa.

5.2 Night roosting habitats

5.2.1 Background

While secure night-roosting locations are a component of all bald eagle habitats, bald eagles may gather in communal night roosting locations near wintering foraging grounds in protected locations to minimize energy expenditures. Roosting concentrations can be quite large, numbering in the hundreds of eagles, especially where these habitats are relatively scarce in the vicinity of open-terrain foraging areas such as in the Klamath Basin of northeastern California (Keister, et al. 1987). Obviously, larger "traditional" roosts used regularly on multiple days or consecutive years by numerous eagles in winter are the most important in terms of habitat preservation. However, smaller more transitory roost sites used by single or few eagles near temporary or less-visited foraging areas also provide valuable habitat, though these are harder to locate than traditional roosts (Lingle and Krapu 1986, Martell 1992). Many wintering areas in California are used by only a few individuals, and their roosting locations highlight preferred habitats that may experience increased use as bald eagle populations continue to grow.

Roosting habitats. In general, species composition of forest stands in bald eagle roosting habitats is similar to nesting stands (i.e., mostly ponderosa pine in northern California and mixed conifer/Douglas-fir in Oregon); however, roosting trees may be smaller in size since they do not have to accommodate a nest structure (Anthony, et al. 1982). For example, Anthony, et al. (1982) reported that mean DBH of actual ponderosa pine roost trees at four key bald eagle roosts in the Klamath Basin ranged from 56–79 cm (22 to 31 in.) and most were under 30 m (100 ft) in height. Even so, roost trees were usually larger than the surrounding forest stand, suggesting a preference for open branch structure and greater visibility at the roost site, and snags and dead-top trees were selected more than expected based on availability. Chester, et al. (1990) found that bald eagles in North Carolina used night roosting areas that contained larger trees, were less dense, had less crown cover, and were closer to the forest edges than randomly selected sites.

Roosting behavior. Around winter foraging areas where roosting opportunities are abundant (i.e., waterways or feeding grounds surrounded by forest), where small numbers of eagles are found in a particular area (Grubb, et al. 1989), or where prey availability is varied temporally or spatially, bald eagles may select multiple roosting locations, either roosting singly or in small groups. In these cases, the roosts may still be traditional and are likely not random. Rather, these sites are important habitats that satisfy the microclimatic requirements of eagles and offer protection from human disturbance. Keister, et al. (1987) determined that use of particular night roosts was affected by proximity to food resources which, in turn, was affected by weather, season, and human activities (e.g., waterfowl hunting). Grubb, et al. (1989) used radio-tagged eagles to help categorize these smaller roost sites as either 1) repeat—used more than once by the same eagle; 2) common—used by more than one eagle, not necessarily on the same night; and 3) simultaneous—used by more than one eagle on the same night. The greatest distance Grubb, et al. (1989) recorded a radio-tagged eagle flying between foraging grounds and night roost location was 35.4 km (22.0 mi), and eagles in their study typically moved to different roost locations between consecutive nights (mean distance = 5.9 km/3.7 mi, range = 0-22.4 km/0–13.9 mi).

Published survey methodologies. Keister, et al. (1987) recorded bald eagle numbers at large roost sites in the Klamath Basin weekly from November through March. Bald eagles were counted as they flew out of the roosting area from about one-half hour before sunrise until flight ceased, when they subsequently counted eagles remaining in the roost area. Isaacs, et al. (1996) used visual methods to find previously unknown night roost locations. This team followed eagles leaving feeding areas in late afternoon by vehicle when possible, and when this was not possible, they searched areas suspected of night roosting activity identified by consistent flight patterns mapped to the area. Grubb, et al. (1989) used telemetry to relocate four bald eagles in a 2,800 km^2 (1,081 square mile) study area in Arizona by driving or walking during 40 nights between February and April to triangulate night roosting positions with hand-held telemetry equipment. To follow up, exact roosting locations were found during the daylight hours by searching telemetry locations for eagle sign (i.e., casting, defecation [mute, whitewash], and feathers).

5.2.2 Finding night roost locations

Finding the location of bald eagle night roosts can be facilitated with radio tracking; however, since eagle capture and use of radio transmitters on bald eagles is often outside the resources of many project assessments, the use of a visual survey is more pragmatic. Therefore, conduct at least one afternoon/early evening survey monthly during the wintering survey (Section 5.1.2) from December through February each year to find eagles on foraging grounds and follow them to night roosting locations. Count the number of eagles observed entering the roost area at night, and revisit the location one-half hour before sunrise the following morning for at least two hours to make an additional count of eagles leaving the roost. Once a stand is identified, visit the area during the day to search for bald eagle signs (feathers, castings, mute) and GPS or map the exact location onto 7.5-minute topographic maps.

6.0 Summary and Decision Flow Chart

The following is a summary of recommended actions for key elements described in this protocol (refer also to Figure 2 for timing of events):

- Research Existing Information—contact local CDFG, USFS, and BLM offices.
- Identify Potential Bald Eagle Nesting Habitat
  - Review available aerial photos, topographic maps, photographs, and silvicultural descriptions.
  - Conduct a site visit to determine if bald eagle nesting habitat occurs in the project area.
  - Determine if project waterways adjacent to, or within flight distance of, potential nesting habitat likely support a sufficient prey base for eagles.
- Search for *New Nests* in Potential Habitat
  - Conduct three surveys, one each during late February/March, late April through May, and early June to early July to search for new nests in project areas.
  - Conduct a complete series of three surveys each year for the duration of project activity, or until project conditions stabilize.
- Monitor *Existing Nests*—refer annually to http://www.dfg.ca.gov/hcpb/species/stds_gdl/bird_sg/baldenstsurv.pdf
- Define Bald Eagle Use Areas During the Breeding Season

- Conduct *eagle census* surveys at least every two weeks throughout one bald eagle breeding season extending from March through July to document bald eagle numbers, distribution, and habitat use, <u>or</u>,
- Conduct *continuous monitoring* surveys at least one day every two weeks throughout one bald eagle breeding season extending from March through July if eagle prey base or foraging habitat might be affected by project activities.
  Use telemetry in riverine, timbered canyons, <u>or</u>
  Follow eagles visually in open water territories.

- Conduct Prey Base Survey Concurrent with *Continuous Monitoring* of Eagles.
  - Conduct carrion surveys along shore transects in eagle use areas.
  - Survey potential waterfowl prey in eagle use areas.
  - Conduct fisheries sampling or consult with CDFG fisheries biologist.
- Identify Bald Eagle Food Habits Concurrent with *Continuous Monitoring*.
  - Collect and analyze prey remains after feeding or at nests, <u>and/or</u>
  - Observe and identify prey following foraging or at nests.
- Document Human Activities in Bald Eagle Habitats
  - Map existing developments in project areas.
  - Conduct public use counts concurrent with bald eagle surveys at facilities where human use fluctuates.
  - Record any human/eagle interactions.
- Survey Wintering Bald Eagles
  - Conduct single-day surveys monthly along established survey census routes, from December through February (three surveys).
  - Conduct a two-year survey protocol for the three-month survey to include possible between-year variation caused by cyclic weather patterns.
  - Conduct afternoon/early evening surveys to follow eagles to night roosting locations.

Recommended data forms are located in Appendix A. These forms were modified by Jackman, et al. (2001) from forms developed by Zack, et al. (1997), and present a concise, relatively simple format for recording multiple resource occurrences that cross-reference easily to field maps by using record numbers. Consistent use of these forms will facilitate data comparisons among studies and ensure the collection of complete data sets.

The flow diagram in Figure 6 provides guidance in decision making associated with conducting protocol-level bald eagle surveys for projects with the potential to impact bald eagle habitats in California. Once bald eagle habitat and use areas are identified, further steps beyond the scope of this protocol should be considered to protect these habitats, including a silvicultural evaluation of timber stand health; fuel loading; and potential to maintain desirable stand characteristics and structure over time in nesting, foraging, and roosting locations (Figure 6). In addition, these data should be compiled into a mitigation or conservation plan and, in the case of bald eagle breeding territories, a bald eagle nest site management plan. The requirements of regulatory and management agencies will vary, and their implementation are beyond the scope of this protocol.

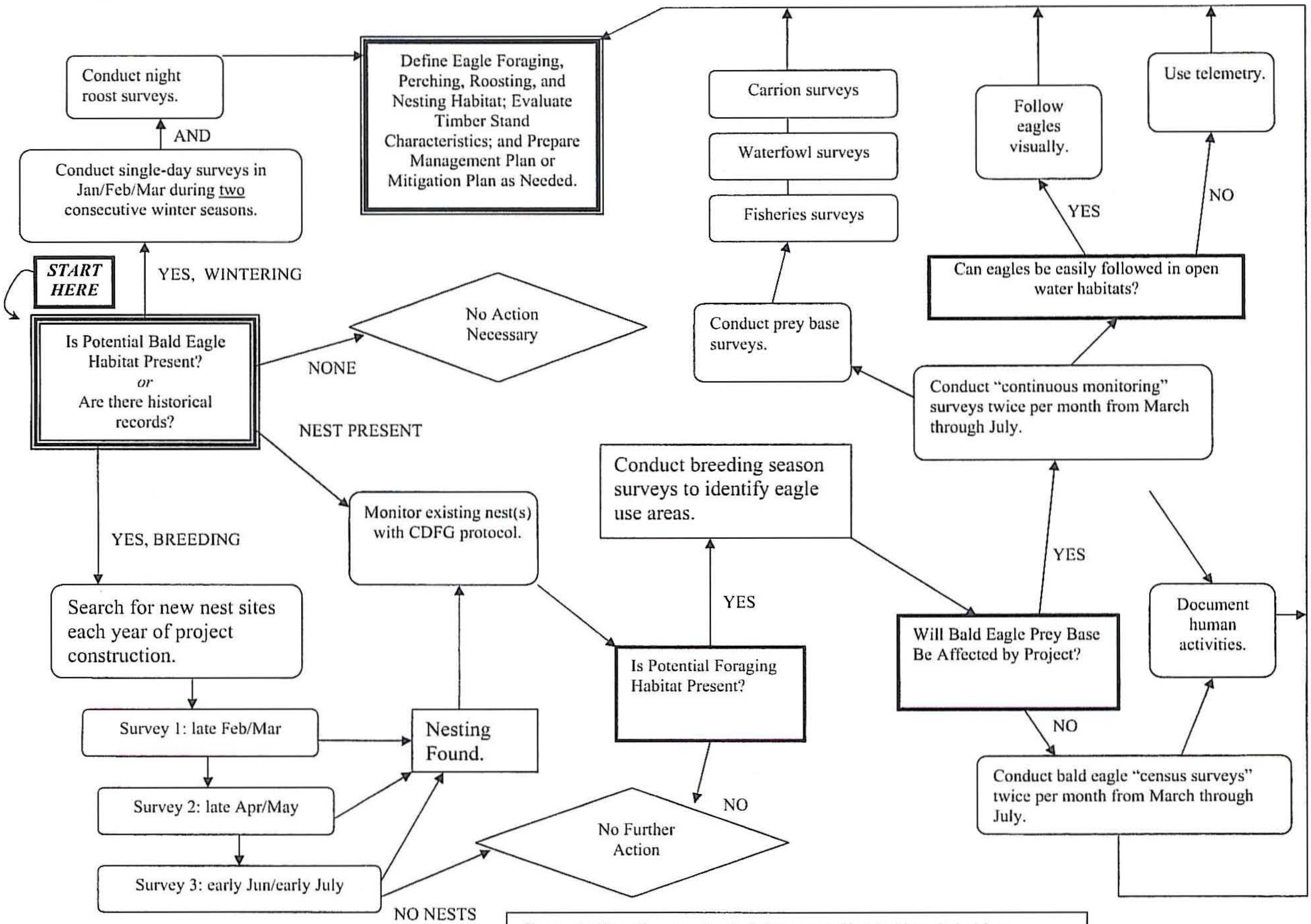

Figure 6. Flow diagram for decisions regarding bald eagle habitat assessments in California.

7.0 References

7.1 Literature cited

Anderson, D.R. 2001. The need to get the basics right in wildlife field studies. Wildl. Soc. Bull. 29(4):1294-1297.

Anthony, R.G., R.W. Frenzel, F.B. Isaacs and M.G. Garrett. 1994. Probable causes of nesting failures in Oregon's bald eagle population. Wildl. Soc. Bull. 22(4):576-582.

Anthony, R.G., M.G. Garrett, and F.B. Isaacs. 1999. Double-survey estimates of bald eagle populations in Oregon. J. Wildl. Manage. 63(3): 794-802.

Anthony, R.G. and F.B Isaacs. 1989. Characteristics of bald eagle nest sites in Oregon. J. Wildl. Manage. 53(1): 148-159.

Anthony, R.G., R.L. Knight, G.T. Allen, B.R. McClelland, and J.I. Hodges. 1982. Habitat use by nesting and roosting bald eagles in the Pacific Northwest. Trans. North Am. Wildl. and Nat. Resour. Conf. 47:332-342.

Bagenal, T.B. and F.W. Tesch. 1978. Age and growth. Pages 101-136 *in* T.B. Bagenal, ed. Methods for Assessment of Fish Production in Fresh Waters. IBP Handbook, No. 3, 3/e. Blackwell Scientific Publ., Oxford.

Bowerman, W.W., T.G. Grubb, A.J Bath, J.P. Giesy, Jr., G.A. Dawson, and R.K. Ennis. 1993. Population composition and perching habitat of wintering bald eagles, *Haliaeetus leucocephalus*, in northcentral Michigan. Can. Field Naturalist 107:273-278.

Bortolotti, G.R. 1984a. Physical development of nestling bald eagles with emphasis on the timing of growth events. Wilson Bull. 96(4):524-542.

Bortolotti, G.R. 1984b. Sexual size dimorphism and age-related size variation in bald eagles. J. Wildl. Manage. 48:72-81.

Bowman, T. D. and P. F. Schempf. 1999. Detection of bald eagles during aerial surveys in Prince William Sound, Alaska J. Raptor Res. 33(4): 299 - 304.

Brown, B.T., R. Mesta, L.E. Stevens, and J. Weisheit. 1989. Changes in winter distribution of bald eagles along the Colorado River in Grand Canyon, Arizona. J. Raptor Res. 23:110-113.

Brown, B.T. and L.E. Stevens. 1992. Winter abundance, age structure, and distribution of bald eagles along the Colorado River, Arizona. Southwestern Naturalist 37(4):404-435.

Brown, B.T. and L.E. Stevens. 1997. Winter bald eagle distribution is inversely correlated with human activity along the Colorado River, Arizona. J. Raptor Res. 31(1):7-10.

Brown, B.T., L.E. Stevens, and T.A. Yates. 1998. Influences of fluctuating river flows on bald eagle foraging behavior. Condor 100:745-748.

Brown, M. and J.R. Nassar. 1991. Estimating bald eagle densities in the Mississippi alluvial valley. J. Raptor Res. 25(2):40-42.

Buehler, D.A. 2000. Bald Eagle (Haliaeetus leucocephalus). *In*: The Birds of North America, No. 506 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Buehler, D.A., T.J. Mersmann, J.D. Fraser and J.K.D.Seegar. 1991. Effects of human activity on bald eagle distribution on the northern Chesapeake Bay. J. Wildl. Manage. 55(2):282-290.

Burt, W.H. and R.P. Grossenheider. 1964. A Field Guide to the Mammals, 2/e. Houghton Mifflin Co., Boston. 284pp.

Call, M.W. 1978. Nesting habitats and surveys techniques for common western raptors. U.S.E.I., Bureau of Land Management, Technical Note TN-316. 115pp.

Cain, S.L. and J.I. Hodges. 1989. A floating-fish snare for capturing bald eagles. J. Raptor Res. 23(1):10-13.

Carlander, K.D. 1969. Handbook of Freshwater Fishery Biology. Vol. I. Iowa State Univ. Press, Ames, Iowa.

Carlander, K.D. 1977. Handbook of Freshwater Fishery Biology. Vol. II. Iowa State Univ. Press, Ames, Iowa.

Carpenter, G.P. 1990. An illustrated guide for identifying developmental stages of bald eagles nestlings in the field. San Francisco Zoological Society, San Francisco, CA. 31 pp.

Casteel, R.W. 1972. A key based on the scales to the families of native California freshwater fishes. Proc. Calif. Acad. Sci. 39(7):75-86.

Casteel, R.W. 1976. Identification of the native Cyprinids (Pisces: Cyprinidae) of California based upon their basioccipital. PaleoBios No. 22, Museum of Paleontology, Univ. of Calif., Berkeley.

Caton, E.L., B.R. McClelland, D.A. Patterson, and R.E. Yates. 1992. Characteristics of foraging perches used by breeding bald eagles in Montana. Wilson Bull. 104:136-142.

Chandler, S.K., J.D. Fraser, D.A. Buehler, and J.K.D. Seegar. 1995. Perch trees and shoreline development as predictors of bald eagle distribution on Chesapeake Bay. J. Wildl. Manage. 59(2):325-332.

Chester, D.N., D.F. Stauffer, T.J Smith, D.R. Luukkonen, and J.D. Fraser. 1990. Habitat use by nonbreeding bald eagles in North Carolina. J. Wildl. Manage. 54(2):223-234.

DellaSala, D.A., C.L. Thomas, and R.G. Anthony. 1989. Use of domestic sheep carrion by bald eagles wintering in the Willamette Valley, Oregon. Northwest Sci., 63(3):104-108.

Detrich, P.J. 1977. Bald eagle management study, Shasta-Trinity National Forest, Shasta and Trinity counties, California. California Dept. of Fish and Game, Sacramento, CA. 35 pp.

Detrich, P.J. 1981. Results of the California winter bald eagle survey, 1979-81. U.S. Fish and Wildlife Service, Endangered Species Office, Sacramento, CA.

Detrich, P.J. 1982 Results of the California winter bald eagle survey, 1982. National Wildlife Federation, Raptor Information Center, Washington D.C.

Detrich, P.J. 1986. The status and distribution of the Bald Eagle in California. M.S. Thesis, California State University, Chico.

Detrich, P.J. and D.K. Garcelon. 1986. Criteria and habitat evaluation for bald eagle reintroduction in coastal California. California Dept. of Fish and Game, Wildlife Management Branch, Contract C-1307, unpublished report. 32pp.

Dunning, J.B., Jr. (editor). 1992. Handbook of Avian Body Masses. CRC Press.

Dzus, E.H. and J.M Gerrard. 1989. Interlake variations of bald eagle, *Haliaeetus leucocephalus*, populations in north-central Saskatchewan. Can. Field Naturalist 103: 29-33.

Dzus, E.H. and J.M. Gerrard. 1993. Factors influencing bald eagle densities in northcentral Saskatchewan. J. Wildl. Manage. 57:771-778.

Ewins, P.J. and R.A. Andress. 1995. The diet of bald eagles, *Haliaeetus leucocephalus*, wintering in the lower Great Lakes Basin, 1987-1995. Can. Field-Naturalist 109(4):418-425.

Fielder, P.C. and R.G. Starkey. 1986. Bald eagle perch-sites in eastern Washington. Northwest Sci. 60(3):186-190.

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins. 1998. California Salmonid Stream Habitat Restoration Manual, Third Edition. Inland Fisheries Division, California Dept. of Fish and Game

Fraser, J.D., L.D. Frenzel and J.E. Mathisen. 1985. The impact of human activities on breeding bald eagles in north-central Minnesota. J. Wildl. Manage. 49(3):585-592.

Fraser, J.D., L.D. Frenzel, J.E. Mathisen, F. Martin, and M.E. Shough. 1983. Scheduling bald eagle reproduction surveys. Wildl. Soc. Bull. 11910:13-16.

Fuller, M.R. and J.A. Mosher. 1987. Raptor survey techniques. Pages 37-65 *in* B.A. Giron Pendleton, B.A. Millsap, K.W. Cline, and D.M. Bird, eds. Raptor management techniques manual. Natl. Wildl. Fed., Washington, D.C.

Fuller, M.R., J.S. Hatfield, E.L Lindquist. 1995. Assessing ground-based counts of nestling bald eagles in northeastern Minnesota. Wildl. Soc. Bull. 23(2):169-174.

Fyfe, R.W. and R.R. Olendorff. 1976. Minimizing the dangers of nesting studies to raptors and other sensitive species. Can. Wildl. Serv. Occas. Pap. 23. 17pp.

Garcelon, D.K. 1985. Mounting backpack telemetry packages on bald eagles. Institute for Wildlife Studies, Arcata, CA. 2 pp.

Garrett, M.G., J.W. Watson, and R.G. Anthony. 1993. Bald eagle home range and habitat use in the Columbia River estuary. J. Wildl. Manage. 57:19—27.

Gerrard, J.M. and G.R. Bortolotti. 1988. The Bald Eagle, Haunts and Habits of a Wilderness Monarch. Smithsonian Institute Press, Washington D.C. 178 pp.

Grier, J.W. and R.W. Fyfe. 1987. Preventing research and management disturbance. Pages 173-182 *in* B.A. Giron Pendleton, B.A. Millsap, K.W. Cline, and D.M. Bird, eds. Raptor management techniques manual. Natl. Wildl. Fed., Washington, D.C.

Griffin, C.R. and T.S. Baskett. 1985. Food availability and winter range sizes of immature and adult bald eagles. J. Wildl. Manage. 49(3):592-594.

Grubb, T.G. 1977. Nest distribution and productivity of bald eagles in western Washington. Murrelet 56(3):2-6.

Grubb, T.G. 1995. Food habits of Bald Eagles breeding in the Arizona desert. Wilson Bull. 107:258-274.

Grubb, T.G., W.W. Bowerman, J.P. Giesy and G.A. Dawson. 1992. Responses of breeding bald eagles, *Haliaeetus leucocephalus*, to human activities in northcentral Michigan. Can. Field Nat. 106:443-453.

Grubb, T.G. and C.E. Kennedy. 1982. Bald eagle winter habitat on southwestern National Forests. USDA Forest Service Res. Paper RM-237.

Grubb, T.G., S.J. Nagiller, W.L. Eakle, and G.A. Goodwin. 1989. Winter roosting patterns of bald eagles (*Haliaeetus leucocephalus*) in north-central Arizona. Southwestern Naturalist 34(4):453-459.

Hansel, H.C., S.D. Duke, P.T. Lofy and G.A. Gray. 1988. Use of diagnostic bones to identify and estimate original length of ingested prey fishes. Trans. Amer. Fisheries Soc. 117:55-62.

Harmata, A.R. and D.W. Stahlecker. 1993. Fidelity of migrant bald eagles to wintering grounds in southern Colorado and northern New Mexico. J. Field Ornithol. 64(2):129-154.

Haywood, D.D. and R.D. Ohmart. 1986. Utilization of benthic-feeding fish by inland breeding bald eagles. Condor 88:35-42.

Hodges, J.I., J.G. King, and F.C. Robards. 1979. Resurvey of the bald eagle population in southeast Alaska. J. Wildl. Manage. 43(1):219-221.

Hunt, W.G., R.E. Jackman, J.M. Jenkins, C.G. Thelander and R.N. Lehman. 1992a. Northward post-fledging migration of California bald eagles. J. Raptor Res. 26:19-23.

Hunt, W.G., J.M. Jenkins, R.E. Jackman, C.G. Thelander and A.T. Gerstell. 1992b. Foraging ecology of bald eagles on a regulated river. J. Raptor Res. 26:243-256.

Hunt, W.G., B.S. Johnson, and R.E. Jackman. 1992c. Carrying capacity for bald eagles wintering along a northwestern river. J. Raptor Res. 26:49-60.

Hunt, W.G., R.E. Jackman, D.E. Driscoll, and E.W. Bianchi. 2002. Foraging ecology of nesting bald eagles in Arizona. J. Raptor Res. 36(4): 245-255.

Isaacs, F.B., and R.G. Anthony. 1987. Abundance, foraging, and roosting of bald eagles wintering in the Harney Basin, Oregon. Northwest Science 61:114-121.

Isaacs, F.B., R.G. Anthony, M. Vander Heyden, and C.D. Miller. 1996. Habits of bald eagles wintering along the upper John Day River, Oregon. Northwest Sci. 70(1):1-9.

Jackman, R.E., W.G. Hunt, D.E. Driscoll, and J.M. Jenkins. 1993. A modified floating-fish snare for capture of inland bald eagles. N. Amer. Bird Bander 18:98-101.

Jackman, R.E., W.G. Hunt, D.E. Driscoll, and F.J. Lapsansky. 1994. Refinements to selective trapping techniques: a radio-controlled bow net and power snare for bald and golden eagles. J. Raptor Res. 28(4):268-273.

Jackman, R.E., W.G. Hunt, and N. Hutchins. 2001. Foraging ecology of bald eagles on Shasta Lake. Report by U.C. Santa Cruz, Predatory Bird Research Group for USDA Forest Service, Shasta Lake Ranger District.

Jackman, R.E., W.G. Hunt, J.M. Jenkins, and P.J. Detrich. 1999. Prey of nesting bald eagles in northern California. J. Raptor Res. 33(2):87-96.

Jenkins, J.M. 1992. Ecology and behavior of a resident bald eagle population. Ph.D. dissertation, University of California, Davis.

Jenkins, J.M. 1996. Modeling of a resident bald eagle population using emphrical life table parameters, pp. 189-198, *in*: B.U. Meyburg and R.D. Chancellor (eds.), Eagle Studies. World Working Group on Birds of Prey: Berlin, London, and Paris.

Jenkins, J.M. and R.E. Jackman. 1993. Mate and nest site fidelity in a resident population of bald eagles. Condor 95:1053-1056.

Jenkins, J.M., R.E. Jackman, and W.G. Hunt. 1999. Survival and movements of immature bald eagles fledged in northern California. J. Raptor Res. 33(2):81-86.

Jenkins, J.M., R.M. Jurek, D.K. Garcelon, R. Mesta, W.G. Hunt, R.E. Jackman, D.E. Driscoll, and R.W. Risebrough. 1994. DDE contamination and population parameters of bald eagles in California and Arizona, U.S.A. Pages 751-756 *in*: B.U. Meyburg and R.D. Chancellor (eds.), Raptor Conservation Today, Proceedings of the IV World Conference on Birds of Prey and Owls. Berlin, Germany.

Jorde, D.G. and G.R. Lingle. 1988. Kleptoparasitism by bald eagles wintering in south-central Nebraska. J. Field Ornithol. 59(2):183-188.

Jurek, R.M. 1990. California bald eagle breeding population survey and trend, 1970-1990. Unpublished Admin. Report, Calif. Dept. of Fish and Game, Nongame Bird and Mammal Section. Sacramento, CA. 16 pp.

Jurek, R.M. 2003. Personal communication. California Department of Fish and Game. Sacramento, CA.

Keister, G.P., R.G. Anthony, and E.J. O'Neill. 1987. Use of communal roosts and foraging areas by bald eagles wintering in the Klamath Basin. J. Wildl. Manage. 51(2):425-420.

Knight, R.L., J.B. Athearn, J.J. Brueggeman, and A.W. Erickson. 1979. Observation on wintering bald and golden eagles on the Columbia River, Washington. Murrelet 60:99-105.

Knight, R.L. and S.K. Knight. 1984. Responses of wintering bald eagles to boating activity. J. Wildl. Manage. 48(3):999-1004.

Knight, R.L., P.J. Randolf, G.T. Allen, L.S. Young and R.G. Wigen. 1990. Diets of nesting Bald Eagles, *Haliaeetus leucocephalus*, in western Washington. Canadian Field-Naturalist 104:545-551.

Lagler, C.F. 1940. Lepidological studies: scale characteristics of the families of Great Lakes fishes. Trans. Amer. Micros. Soc. 66(2):149-162.

Lehman, R. N. 1979. A survey of selected habitat features of 95 bald eagle nest sites in California. California Dept. of Fish and Game, Wildlife Management Branch, Admin. Report. 79-1.

Lingle, G.R. and G.L. Krapu. 1986. Winter ecology of bald eagles in southcentral Nebraska. Prairie Nat. 18(2):65-78.

Livingston, S.A., C.S. Todd, W.B. Krohn, and R.B. Owen, Jr. 1990. Habitat models for nesting bald eagles in Maine. J. Wildl. Manage. 54(4):644-653.

Martell, M. 1992. Bald eagle winter management guidelines. U.S. Fish and Wildlife Service Region 3 and Wisconsin Adopt an Eagle Nest Program.

Mathisen, J.E. 1968. Effects of human disturbance on nesting bald eagles. J. Wildl. Manage. 32(1):1-6.

McClelland, B.R., L.S. Young, D.S. Shea, P.T. McClelland, H.L. Allen, and E.B. Spettigue. 1982. The bald eagle concentration in Glacier National Park, Montana: origin, growth, and variation in numbers. Living Bird 19:133-155.

McCollough, M.A. 1989. Molting sequence and aging of bald eagles. Wilson Bull. 101:1-10.

McConnell, W.J. 1952. The opercular bone as an indicator of age and growth of the carp (*Cyprinus carpio*). Trans. Amer. Fisheries Soc. 81:138-149.

McGarigal, K., R.G. Anthony and F.B. Isaacs. 1991. Interactions of humans and bald eagles on the Columbia River estuary. Wildl. Monograph No. 115.

Mersmann, T.J. 1989. Foraging ecology of Bald Eagles on the north Chesapeake Bay with an evaluation of techniques used in the study of Bald Eagle food habits. M.S. Thesis. Virginia Polytechnic Institute, Blacksburg. 145pp.

Mersmann, T.J., D.A. Buehler, J.D. Fraser, and J.K.D. Seegar. 1992. Assessing bias in studies of bald eagle food habits. J. Wildl. Manage. 65(1):73-78.

Montana Bald Eagle Working Group (MBEWG). 1986. Montana bald eagle management plan. U.S. Dept. of Interior, Bureau of Land Management, Montana State Office. Report BLM-MT-GI-86-001-4352.

Moore, T.D., L.E. Spence, and C.E. Dugnolle. 1974. Identification of the dorsal guard hairs of some mammals of Wyoming. Wyoming Game and Fish Dept. Bull. No. 14, Cheyenne, WY.

Murphy, B. R., and D. W. Willis, eds. 1996. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, MD.

Norman, D.M., A.M. Breault, and I.E. Moul. 1989. Bald eagle incursions and predation at great blue heron colonies. Colonial Waterbirds 12(2):215-217.

Peterson, A. 1986. Habitat suitability index models: bald eagle (breeding season). U.S. Fish and Wildlife Service. Biological Report 82(10.126). 25pp.

Postupalsky, S. 1974. Raptor reproductive success: Some problems with methods, criteria, and terminology. Pages 21-31 *in*: F.N. Hamerstrom, Jr. B.E. Harrell, and R.R. Olendorff (eds.), Management of Raptors, Raptor Res. Found., Vermillion, S.D.

Retfalvi, L. 1970. Food on nesting bald eagles on San Juan Island, Washington. Condor 72:358-361.

Stalmaster, M.V. 1987. The Bald Eagle. Universe Books, New York. 227 pp.

Stalmaster, M.V. and J.R. Newman. 1978. Behavioral responses of wintering bald eagles to human activity. J. Wildl. Manage. 42(3):506-513.

Stalmaster, M.V. and J.L. Kaiser. 1998. Effects of recreational activity on wintering bald eagles. Wildl. Monogr. 137, 1-46.

Stalmaster, M.V. and R.G. Plettner. 1992. Diets and foraging effectiveness of bald eagles during extreme winter weather in Nebraska. J. Wildl. Manage. 56(2):355-367.

Steenhof, K. 1978. Management of wintering bald eagles. U.S. Fish and Wildlife Service, Biological Services Program Report FWS/OBS-78/79. 59 pp.

Steenhof, K. 1983. Prey weights for computing percent biomass in raptor diets. Raptor Res. 17(1):15-27.

Steenhof, K. 1988. Identifying potential bald eagle nesting habitat: a review of the state of the art. Pages 31-59 *in* D.K. Garcelon and G.W. Roemer, eds. Proc. of the International Symposium on Raptor Reintroduction, 1985. Institute for Wildlife studies, Arcata, California.

Steenhof, K., S.S. Berlinger, L.H. Fredrickson. 1980. Habitat use by wintering bald eagles in South Dakota. J. Wildl. Manage. 44(4):798-805.

Steenhof, K. and M.N. Kochert. 1982. An evaluation of methods used to estimate raptor nesting success. J. Wildl. Manage. 46:885-893.

Steidl, R.J., and R.G. Anthony. 1996. Responses of bald eagles to human activity during the summer in interior Alaska. Ecological Applications 6(2):482-491.

Swenson, J.E., K.L. Alt, and R.L. Eng. 1986. Ecology of bald eagles in the greater Yellowstone ecosystem. Wild. Monogr. 95:1-46.

Todd, C.S., L.S. Young, R.B. Owen, JR. and F.W. Gramlich. 1982. Food habits of Bald Eagles in Maine. J. Wildl. Manage. 46(3):636-645.

Vondracek, B., D.M. Baltz, L.R. Brown and P.B. Moyle. 1989. Spatial, seasonal, and diel distribution of fishes in a California reservoir dominated by native fishes. Fisheries Res. 7:31-53.

Watson, J.W. 1993. Responses of nesting bald eagles to helicopter surveys. Wildl. Soc. Bull. 21:171-178.

Watson, J.W., M.G. Garrett, and R.G. Anthony. 1991. Foraging ecology of bald eagles in the Columbia River estuary. J. Wildl. Manage. 55(3): 492-499.

Wood, P.B. 1999. Bald eagle response to boating activity in northcentral Florida. J. Raptor Res. 33(2):97-101.

Zack, S., H. Cooke, N. Nichol, K. Mehl, and J. Wood. 1997. Bald eagles at Shasta Lake: ecological and behavioral issues relating to lake management and eagle productivity. 1997 Summary Report of Field Activities.

7.2 Other Relevant Regional Literature

Butler, R., D. Rodriguez, S. Lhota, and A. Mann. 1995. 1991-1995 bald eagle telemetry results, Big Bear Ranger District, San Bernardino Nation Forest. Unpublished report, 46 pp.

California Department of Fish and Game. 1979. Raptor reporting program: bald eagle sightings 1966-1972. Nongame Wildlife Investigations, Project W-54-R. 19pp.

California Department of Fish and Game. 1981. Raptor reporting program: bald eagle sightings 1973-1980. Nongame Wildlife Investigations, unpublished report, 4pp.

Conrad, E.T. and J.E. Stilwell. 1984. Wintering bald eagles at Millerton Lake. Millerton Lake State Recreation Area, San Joaquin Valley District, California Department of Parks and Recreation. Unpublished report. 76 pp.

Detrich, P.J. 1978. Bald eagle winter habitat study – Shasta, Trinity, and Tehama counties, California. U.S. Forest Service, Shasta-Trinity National Forest, unpublished report. 36 pp.

Detrich, P.J. 1980. Pit 3, 4, 5 bald eagle study. Unpublished report, U.S. Forest Service, Shasta-Trinity National Forest. 20 pp. plus appendices.

Detrich. P.J. and R.N. Lehman. 1985. Habitat management review for ten selected bald eagle nest territories in northern California. California Department of Fish and Game, Wildlife Management Branch, Contract C-1110. Unpublished report, 23pp.

Hawks, S.J. 1982. Cleghorn habitat management plan (bald eagle nesting territory protection plan) C2-WHA-T6-S1. U.S.D.I, Bureau of Land Management, Susanville District, Eagle Lake Resource Area, unpublished report. 22 pp. plus appendices.

Hunt, W.G., D.E. Driscoll, E.W. Bianchi, and R.E. Jackman. 1992. Ecology of bald eagles in Arizona. Report to U.S. Bureau of Reclamation, Contract 6-CS-30-04470. BioSystems Analysis, Inc., Santa Cruz, CA.

Jackman, R.E., C.G. Thelander, and W.G. Hunt. 1988. Compatibility of bald eagles with PG&E facilities and operations. Report by BioSystems Anal., Inc. for Pacific Gas and Electric Company.

Jenkins, J.M. 1989. Effects of a proposed modification of the southwest cove of Macumber Reservoir on a resident pair of bald eagles. Pacific Gas and Electric Company, Technical and Ecological Services, San Ramon, CA. Unpublished report. 24pp.

Lehman, R.N. 1983. Breeding status and management of bald eagles in California – 1981. California Department of Fish and Game, Wildlife Management Branch, Administrative Report 83-1. 24 pp.

Lehman, R.N. 1988. Mount Dome Habitat Management Plan. U.S. Bureau of Land Management, Susanville District, Alturas Resource Area. Unpublished report. 81 pp.

Lehman, R. N., D. E. Craigie, P. L. Colins, and R. S. Griffen. 1980. An analysis of habitat requirements and site selection criteria for nesting bald eagles in California. Prepared for U.S. Forest Service, Region 5, San Francisco, CA. Arcata, CA: Wilderness Research Institute.

Mangan, G. 1985. Bald eagle seasonal use of the Cache Creek drainage – results of the winter 1984-1985 surveys. U.S. Bureau of Land Management, Ukaih District, Clear Lake Resource Area. Unpublished report.

Nahstoll, N. 1990. California midwinter bald eagle survey results, 1990. Draft report by the U.C. Predatory Bird Research Group, Santa Cruz, CA.

Naslund, N.L. 1985. Bald eagle nesting habitat assessment for northern and central coastal California. Unpublished report prepared by the U.C. Santa Cruz Predatory Bird Research Group for the Ventana Wilderness Sanctuary, 240 pp.

Olendorff, R.R., R.N. Lehman, and P.J. Detrich. 1986. Biological Assessment: anticipated impacts of the Geothermal Public Power Line on federally listed threatened or endangered species, with emphasis on the bald eagle. U.S. Bureau of Land Management, Sacramento, CA. Unpublished report. 72 pp.

Pacific Gas and Electric Company. 1985. Pit 3, 4, and 5 Project bald eagle and fish study. Report to the Pacific Gas and Electric Company, San Ramon, CA, by BioSystems Analysis, Inc. and U.C. Davis, Department of Wildlife and Fisheries Biology

Spiegel, L. and R. Anderson. 1986. Bald eagle study: Lake Berryessa study area interim report for the Geothermal Public Power Line. Staff Report, California Energy Commission. 67 pp.

Thelander, C.G. 1973. Bald eagle reproductions in California during 1972-1973. California Department of Fish and Game Admin. Report 73-5. 17pp.

U.S. Fish and Wildlife Service. 1986. Pacific bald eagle recovery plan. Portland, OR. 160pp.

U.S. Fish and Wildlife Service. 1986. Pit River interagency bald eagle management plan. Unpublished report by the Bald Eagle Planning Group. 58 pp.

U.S. Fish and Wildlife Service. 1977. Bald eagle management guidelines, Oregon-Washington. Pamphlet, 8 pp.

U.S. Forest Service. 1977. Bald eagle habitat management guidelines, U.S. Forest Service, California Region. U.S. Forest Service, Region 5 unpublished report. 60 pp.

Woodbridge, B., R. Hohnstone, and D.C. Sasse. 1985. Status, biology, and productivity of raptors and sandhill cranes on the Goosenest Ranger District, Klamath National Forest 1979 to 1985. U.S. Forest Service, Goosenest Ranger District. Unpublished report.

7.3 Web Sites of Interest

http://www.dfg.ca.gov/hcpb/species/stds_gdl/bird_sg/baldenstsurv.pdf : CDFG breeding survey instructions and data forms.

http://srfs.wr.usgs.gov/research/indivproj.asp?SRFSProj_ID=2 : Mid-winter bald eagle survey information and nationwide results.

http://ris.wr.usgs.gov : Raptor Information System, USGS, Richard R. Olendorff Memorial Library in Boise, Idaho.

http://www2.ucsc.edu/scpbrg/migration.htm : Bald eagle migration in California.

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APPENDIX A
Recommended Data Form

BALD EAGLE OBSERVATION DATA SHEET

Pg ___ of ____ **Data Entered:________________** **Reservoir surface elevation__________**

Date:__________Time Start:______End:______ Territory:__________________Nest Stage:________________

Observer Location:______________ Observers:_______________ Temperature (x10°):_________

Weather: (Clear / Partly Cloudy / Overcast / Rain/ Snow) **Wind:** (Calm / Slight Breeze / Breezy / Windy)

Eagle/Osprey	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Time start								
Species/Age/Sex								
Number								
General Location								
UTM northing								
UTM easting								
Activity								
Perch type								
Dist from H2O(m)								
Habitat								
Time End								

Forage	**1F**	**2F**	**3F**	**4F**	**5F**	**6F**	**7F**	**8F**
General Location								
UTM northing								
UTM easting								
Time								
# Attempts								
Attack mode								
Dist. from perch								
Dist. from shore								
Success?								
Prey species								
Prey remains?								
Prey size (mm)								
Prey status								
Aquatic Habitat								

Public user #	**1P**	**2P**	**3P**	**4P**	**5P**	**6P**	**7P**	**8P**
Time								
Type								
Number								
Location								
Shore dist. (m)								
Eagle response								
Dist. to eagle (m)								

Comments on back; plot map points by observation, forage, or public user # (e.g., 1, 1F, 1P).

BALD EAGLE OBSERVATION DATA SHEET

Pg _1_ **of** _1_ **Data Entered:**__EXAMPLES____ **Reservoir surface elevation**________

Date:__06/01/03_**Time Start:**_0530_**End:**_1200_ **Territory:**__River Dam___**Nest Stage:**_inc., brood., fledged

Observer Location:___Dam______ **Observers:**______________ **Temperature (x10°):**__70s____

Weather: (Clear / Partly Cloudy / Overcast / Rain/ Snow) **Wind:** (Calm / Slight Breeze / Breezy / Windy)

Eagle/Osprey	1	2	3	4	5	6	7	8
Time start	0550	0610						
Species/Age/Sex	baea/adult	ad male	am01	sub1,2,3	near-adult	osprey		
Number	1					2		
General Location	dam area	upper res.	river					
UTM northing	from GPS	or from maps						
UTM easting	use NAD 83							
Activity	perched	flying	soaring	watching water	hunting on wing	incubating	on nest	etc.
Perch type	p. pine	d. fir	s. pine	snag	snagtop	rock	shore	
Dist from H2O(m)	estimated							
Habitat	reservoir	river	cove	tailrace	run	riffle	pool	pocket water
Time End	0610	etc.						

Forage	1F	2F	3F	4F	5F	6F	7F	8F
General Location	below dam	river						
UTM northing	from GPS	or from maps						
UTM easting	use NAD 83							
Time								
# Attempts								
Attack mode	active forage	scavenge pluck	wade scavenge	shore scavenge	piracy osprey	piracy eagle	submerge dive	tandem
Dist. from perch	m					↓ →	live pluck	unseen
Dist. from shore	m							
Success?	yes	no	unknown					
Prey species	sucker	fish	coot	waterfowl	unknown			
Prey remains?	yes	no						
Prey size (mm)	head to tail	total length	1ft=300mm					
Prey status	live	carrion	moribund	piracy	unk.			
Aquatic Habitat	reservoir	river	cove	tailrace	run	riffle	pool	pocket water

Public user #	1P	2P	3P	4P	5P	6P	7P	8P
Time	event time					count time	count time	
Type	boat angler	boat	pedestrian	shore angler	waterskiier	vehicle	vehicle w/ boat trailer	
Number	1	15				12	8	
Location	UVR	UVR entire				Boat Launch	Boat Launch	
Shore dist. (m)	estimate							
Eagle response	none	watched	flushed	flinched	vocal	left prey	dropped prey	avoided area
Dist. to eagle (m)	estimate							

Comments on back; plot map points by observation, forage, or public user # (e.g., 1, 1F, 1P)