APPENDIX A

Proposed Monitoring Program for Bald Eagle Feasibility Study for Reintroduction to the Northern Channel Islands

Background

Bald eagles (*Haliaeetus leucocephalus*) were historic resident breeding species on all eight of the California Channel Islands, and were extirpated by the 1960's; the primary cause of the extirpation is believed to be DDT released into the environment (Kiff 1980, 2000). It is estimated that a minimum of 35 bald eagle nest sites existed on the Channel Islands earlier this century, making the Channel Islands a stronghold for this species in Southern California (Kiff 2000). On the Northern Channel Islands (Anacapa, Santa Cruz, Santa Rosa, and San Miguel Islands), Kiff (2000) estimated that there were a minimum of 24 different nest territories, with a maximum of 14 nesting pairs observed in any one year. Kiff (2000) documents the number of bald eagle territories on Anacapa Island as 3, San Miguel and Prince Island as 6, Santa Cruz Island as 7, and Santa Rosa Island as 8. Kiff notes that the actual number of bald eagle nesting territories on Santa Cruz and Santa Rosa Islands was undoubtedly greater since historical accounts are based largely from collectors who did not visit many portions of these large islands. To date, bald eagles have not naturally reestablished on the Channel Islands. Bald eagles were reintroduced to Catalina Island starting in the early 1980's. However, due to the continuing levels of DDT in the food web of the Southern California Bight, bald eagles on Catalina Island still are unable to reproduce successfully due to DDE effects on eggshell quality resulting in breakage of eggs and severe water loss, and require intensive management to maintain the population (Garcelon testimony 2000, Garcelon 1997).

The realization in the mid to late 1980's that bald eagle reproduction on Catalina Island was not successful due to effects associated with very high residues of DDE in the eggs was one indication among many that the massive releases of DDT into the Southern California Bight were still ecologically relevant. In 1990, the State of California and the Federal Government Natural Resource Trustees brought suit against Montrose Chemical Corporation (Montrose), among other dischargers, for releases of DDT and PCBs that injured natural resources including bald eagles, peregrine falcons and fishery resources. In December of 2000, the Natural Resource Trustees settled the final remaining legal claim brought against Montrose and the other dischargers. Approximately $30 million is now available for the restoration of the injured resources. Bald eagles were identified as one of the primary resources that continue to be impacted by DDT contamination. Federal law requires that restoration dollars be spent to “restore, rehabilitate, replace, or acquire the equivalent” resources that were injured.

As part of restoration planning efforts prior to the case settling, a predictive risk assessment for reintroducing bald eagles to the Northern Channel Islands (NCI), was conducted (Valoppi et al. 1999, Valoppi et al. 2000). The goal of the predictive risk assessment was not to determine the degree of likely breeding success of bald eagles reintroduced to the Northern Channel Islands. Instead, the Natural Resource Trustees wanted to know if a naturally reproducing, stable population of bald eagles could be established on the Northern Channel Islands (i.e., if at least a productivity of 0.7 young/nest would be likely). There was limited data for DDE and PCB residues in eagle prey for the immediate area around the Islands, so assumptions were made concerning the level of contaminants in prey available on the Northern Channel Islands. For example, very limited fish residue data was available, which suggested fish residues might be 2- fold higher on the Northern Channel Islands than on Catalina, so this assumption was used in the model. The predictive risk assessment concluded that it was unlikely that a naturally reproducing, stable population of bald eagles could be established due to DDT contamination predicted to occur in eagle eggs. However, there was a large degree of uncertainty concerning the availability of marine mammal carcasses on the Northern Channel Islands, as well as a large variability in prey concentrations of DDT, such that it was not possible to say with great confidence what level of bald eagle productivity would be expected.

With the settlement of the case, the Natural Resource Trustees have determined that an experimental release of bald eagles to Santa Cruz Island is warranted. This view acknowledges the uncertainties of the risk assessment, but balances these against the obligation to restore the injured resource if possible, the very low probability that the bald eagles will naturally repopulate the Channel Islands in the absence of active management (Garcelon 2000), the high importance of the Channel Islands as breeding territory in Southern California (Jurek 2000), and the goals of the Bald Eagle Recovery Plan (U.S. Fish and Wildlife Service 1986). The Feasibility Study involves the release of bald eagles onto Santa Cruz Island and monitoring the eagles to obtain information on contamination of the eagles and the eagle food web, and the potential for breeding success. This information will be used by the Natural Resource Trustees to determine whether full-scale restoration efforts on other Channel Islands should be initiated, or whether it is more prudent to try to focus restoration efforts elsewhere.

Input from Scientific Experts

In the summer of 2001, the U.S. Fish and Wildlife Service convened a meeting of a few experts to provide guidance on monitoring of bald eagles released to the Northern Channel Islands as part of a reintroduction feasibility study. The group of experts included John Elliott (Canadian Wildlife Service), Stan Wiemeyer (U.S. Fish and Wildlife Service), Chuck Henny (U.S. Geological Survey), and Keith Hobson (Canadian Wildlife Service). Each expert was chosen for his expertise in monitoring organochlorine contaminants in raptors, and his experience in evaluating techniques for assessing dietary foodwebs. At issue was how best to conduct a monitoring program for the Feasibility Study to determine if restoration to the Northern Channel Islands will be successful given the potential for elevated levels of DDE in the food web. The experts were requested to :

1. Advise on techniques for monitoring bald eagle DDE exposure.

2. Advise on techniques for evaluating the diets of bald eagles released to the Northern Channel Islands.

3. Advise on biases inherent in various monitoring techniques and how to address bias.

4. Advise on the level of reliability needed for the monitoring program, and the desired number of sample or data points needed to achieve that level of reliability.

5. Advise on decision criteria for further reintroduction..

The experts each wrote a report recommending specific aspects of a monitoring program that the Natural Resource Trustees have considered in developing this proposed monitoring plan (Elliott 2001; Wiemeyer 2001; Henny 2001; Hobson 2001).

Discussion of Monitoring Plan Elements

Based on the recommendations of the scientific experts, the following elements for a monitoring program of juvenile bald eagles to be released to Santa Cruz Island have been considered. It must be emphasized that this monitoring plan is viewed as adaptive – elements of the plan may be changed based upon usefulness and feasibility of the collected data. It is anticipated that some or all of the previously consulted experts, or others, will evaluate the monitoring data as it becomes available to advise on possible changes to the monitoring plan.

1. Stable Isotopes - Use stable isotope analysis of tissues of juvenile bald eagles and the bald eagle food web of the Channel Islands to determine sources and trophic levels which eagles may be feeding on, which would indicate higher or lower DDE residues in the diet. An initial study using the eagle tissues and prey collected from Catalina Island will be conducted to determine if this technique is feasible and useful for the Northern Channel Islands.

2. Blood Analysis - Conduct sampling and analysis of DDE residues in juvenile bald eagle blood, or other non-lethal tissue monitoring.

3. Radiotelemetry/Food Habits - Conduct radiotelemetry of juvenile bald eagles to monitor their dispersal and movement. These techniques will also provide information on locations where repeated juvenile bald eagle foraging activities are occurring (e.g. seabird breeding sites). In addition, it will allow evaluation of food habits of bald eagles that remain on the Northern Channel Islands to determine their inclination to ingest high DDE-containing prey items (e.g. marine mammal carcasses, certain seabirds, etc...).

4. Trend Analysis - Collect bald eagle prey items to evaluate whether contaminant levels are changing over time, and to refine the inputs to the predictive risk assessment.

5. Osprey (*Pandion haliaetus*) - Release osprey to the Northern Channel Islands and use osprey breeding success as an indicator of bald eagle breeding success (osprey are fish eating birds that are slightly less sensitive than bald eagles to the effects of DDE for reproductive effects).

Stable Isotope Analysis of Bald Eagle Tissues

Staff at the San Francisco Zoo, where the Catalina bald eagle eggs are artificially incubated, have indicated that the eagles from the Twin Rocks territory on Catalina lay eggs which are slower to lose water, and die later in embryo development compared to the other nest sites on Catalina (pers comm. Kathy Hobson). Limited residue data from the Twin Rocks territory indicates that these eggs have among the lowest concentrations of DDE. In the last few years, all of the eggs that hatched were from the Twin Rocks territory. This information suggests that there may be feeding differences between the Twin Rocks territory and the other territories on Catalina that result in lower DDE exposure for Twin Rocks bald eagles. The Twin Rocks nest is on the north side of the island, on a steep cliff with limited access to beaches where marine mammal carcasses may wash up.

Stable isotope analysis could be a viable technique to determine if there are differences in diet between Catalina Island territories that result in eggs with lower DDE residues. Initially, this will be accomplished by analyzing a variety of eagle tissues (mostly egg residues and eggshells, some blood samples) from Catalina Island, along with some tissue from eagle prey (e.g. seabird, marine mammal). Later, it may be feasible to add some additional components of stable isotope sampling of Catalina birds in subsequent years (e.g. blood or feather samples). The basic approach is to investigate whether stable isotope analysis can be used to differentiate diets between bald eagle nesting territories on Catalina Island, and then evaluate whether stable isotope techniques would be helpful for evaluating diets of bald eagles released to the Northern Channel Islands.

Elements occur in nature in both stable and radioactive forms (radioactive forms are nonstable). Elements in nature usually occur in more than one stable form, referred to as stable isotopes of that element (isotopes differ in the number of neutrons in the nucleus, but have the same number of protons and electrons). The different number of neutrons give each isotope of an element slightly different chemical and physical properties. These differences mean that the isotopes of an element behave differently in natural systems from the physical and chemical process that react with the isotopes over time. The differences in the proportion of one isotope over another isotope of the same element provides the key to discriminating differences in dietary exposure. The stable isotope analysis measures naturally occurring stable isotopes of specific elements (e.g., carbon, nitrogen) that are present in the food web. Stable-nitrogen isotope abundance in bald eagle tissues from Catalina Island could help determine trophic positions and changes in diet over time. Stable-carbon isotopes could provide information on inshore versus offshore sources of prey in the marine environment, and possibly the contribution from terrestrial sources. Hobson (2001) recommended measuring nitrogen and carbon isotopes in archived egg yolk or homogenates for which we have contaminant information. A biplot of stable nitrogen versus stable carbon would help to determine if individual birds laying more contaminated eggs tend to cluster according to trophic level and location of prey (Hobson 2001).

In the first phase, Hobson (2001) recommended conducting stable isotope analysis on already collected eggshells and membranes of Catalina eggshells. Relationships between DDE concentrations, stable isotopes, and breeding history of the nest from where the egg came from would help in examining short-term dietary exposures, i.e. immediately prior to laying of individual eggs.

In the second phase, Hobson (2001) recommended opportunistically collecting blood and feather samples for analysis of isotopic signature of carbon and nitrogen from captured individuals on Catalina Island. This would identify a non-lethal tissue to sample from captured eagles to analyze for stable isotopes. This may not be feasible during the breeding season, as the capturing would potentially disrupt breeding activity. However, it may be possible to collect these samples during the non-breeding season. Related to analysis of feather samples on live birds, is the analysis of feather, or other tissues (muscle, bone) from carcasses of dead birds. One adult female has died in all likelihood of DDE poisoning (Garcelon and Thomas 1997), and DDE values from this hen's eggs have been among the highest concentrations of DDE recorded at Catalina Island (Seal Rocks territory, 1990 and 1992).

In the final phase, Hobson (2001) recommended collecting a suite of foodweb samples for the creation of a foodweb isotope model. Development of such an isotope model could be done once it has been determined from the examination of the egg homogenate, eggshell and egg membrane isotope analysis that differences in trophic level feeding are discernible among bald eagle territories on Catalina Island. Construction of an isotope food web model would necessitate taking marine food items that span several trophic levels and represent inshore/benthic and off shore/pelagic organisms (Hobson 2001).

<u>DDE Residues in Bald Eagle Blood</u>

Elliott (2001) summarized the value of measuring contaminant residues in blood to evaluate body burden and exposure to raptors, and concluded that this is a valid method of monitoring, provided the influence of food intake and fasting on plasma lipid concentrations is taken into account. Elliott (2001) provided a simple visual method of screening blood samples which are highly lipemic, and also recommended analyzing the blood samples for plasma lipid content, in addition to contaminant residues.

Elliott (2001) recommended attempting to trap bald eagles released to the Northern Channel Islands at older than one year of age to allow for body burdens of organochlorines to equilibrate with dietary exposures. Use of both solar powered satellite transmitters and conventional transmitters with long battery life on all released birds will help facilitate tracking. Waiting to trap bald eagles until at least 1 year after release would also allow for juvenile dispersal away from the Channel Islands to occur, and therefore limit the number of birds that would need to be trapped. Elliott (2001) recommended trapping released birds at 2 years post release, and attempting to trap again at 3 years post-release. The difficulty in trapping bald eagles should not be underestimated; the feasibility of trapping an eagle the second time is not certain. While blood residues of DDE will provide very useful information, blood DDE cannot be relied upon solely for decision making given the uncertainties of being able to successfully trap bald eagles.

The next issue becomes how to interpret the DDE blood residue data from the juvenile bald eagles released to the Northern Channel Islands once it is available. Elliott and Norstrom (1998) and Elliott and Harris (2002) have developed relationships between DDE in nestling plasma and DDE concentrations in eagle eggs. Limited data from Catalina Island is available for DDE residues in blood of juvenile, sub-adults and adults, for comparison. There are very few published results of DDE residues in juvenile and sub-adult bald eagles; the available data has been summarized by Elliott (2001, Table 1). Elliott recommended analyzing any existing, unanalyzed Catalina Island bald eagle blood samples for residue analysis, and conducting a statistical analysis of the existing plasma samples from Catalina Island bald eagles. Collection of additional samples from juvenile and sub adults at Catalina to establish a reference area for known DDE contamination and productivity may also be needed.

A "clean" reference area should be established as well. Two options have been identified for the clean reference area: 1) eagles nesting on reservoirs in Southern California, or 2) eagles feeding in marine and estuarine environments from Oregon, Washington, Alaska, and British Columbia. The latter locations may already have archived blood samples which could be sampled for DDE analysis. We believe using a clean reference area from Oregon, Washington, Alaska, or British Columbia is preferable (compared to eagles nesting on reservoirs) because these locations may already have substantial contaminant history and productivity data. In addition, coastal environments would more closely match the feeding habits of Channel Islands bald eagles.

In addition to DDE residue analysis of the eagle plasma, other assays are recommended (in order of suggested priority): total PCBs in plasma, total mercury in whole blood, total lead in whole blood, haematocrit and blood smears for cell counts and parasites, standard veterinary blood screening, rodenticide residues in plasma, cholinesterase activity in plasma, and Vitamin A and thyroid hormones in plasma. As noted previously, stable isotope analysis of bald eagle blood may also prove valuable in interpreting feeding trophic level.

<u>Food Habits and Availability</u>

Elliott (2001) recommended that all bald eagles released to the Channel Islands be color banded and tagged with both satellite and conventional radio telemetry transmitters. Wiemeyer (2001) also recommended both types of telemetry be utilized for bald eagles released to the Northern Channel Islands. Wiemeyer indicated that data from satellite telemetry is needed to obtain data on overall movements, and would provide information on the overall range of the bird during a 24 hour period. Satellite transmitters can be expected to last 5 years. Once the general location of a bird is tracked using the satellite data, conventional telemetry can be used to track birds during specific times or locations for defining feeding locations and habits. Blinds could be set up near feeding areas to allow direct observations of specific feeding activity, frequency, and amount ingested (biomass) (Wiemeyer 2001; Henny 2001). The use of both satellite and conventional telemetry would also be useful for collection of blood and feather samples for contaminant residues or stable isotope analysis (Wiemeyer 2001).

The monitoring plan will include placing both conventional VHF transmitters and GPS/ARGOS satellite transmitters on each of the eagles released on the Northern Channel Islands. The conventional VHF transmitters will assist in locating bald eagles while they are in the general release area, while the satellite transmitters will allow for long-range tracking of the eagle's movements. Use of both types of transmitters will help in determining whether bald eagles are repeatedly visiting known seabird nesting colonies or marine mammal rookeries, as well as providing general tracking information. A solar powered GPS transmitter can operate for about 3 years. Attempts will be made to capture and take samples of blood from eagles aged 2 years or older that have remained on, or returned to, the Northern Channel Islands. Once captured, the transmitters can be replaced, thereby extending the effective time of tracking for at least some of the bald eagles released.

The predictive risk assessment (Valoppi, et al. 2000) indicated that the marine mammal component of the bald eagle diet contributes the most uncertainty to the model results (both the frequency of marine mammal ingestion as well as concentration of contaminants in the tissue). Beach surveys for dead or stranded animals are periodically conducted on San Miguel and Santa Rosa Islands as part of another program for the Channel Islands National Park. Ideally, these beach watch surveys could be expanded to include islands where bald eagles are released and surveys conducted monthly, or at least quarterly (i.e., monthly monitoring on each of the 4 Northern Channel Islands). However, discussions with National Park Service staff have indicated that logistical considerations of conducting beach watch surveys on Santa Rosa Island and San Miguel Island are extremely difficult due to the limited accessibility, no available housing, and no available transportation. The beach watch surveys could be redirected to other Northern Channel Islands if telemetry data indicate eagles are feeding near known marine mammal haul out or rookery sites (e.g. Point Bennett on San Miguel Island).

Therefore, the monitoring plan will include the beach watch surveys only on Santa Cruz Island, where the eagles will be released. Data on the location, species, and number of beached marine mammals will also be recorded (Wiemeyer 2001). Remote video cameras should be set up to monitor beached marine mammals located near bald eagle feeding areas to record and estimate the frequency of use and quantity of marine mammal carcass consumed. Samples of tissue for contaminant residues and stable isotope analysis should be conducted to refine the inputs into the predictive model (Wiemeyer 2001).

Samples of marine mammal tissues previously collected for contaminant residues were heterogeneous, being a mix of blubber plug samples from live adults, and composite samples of blubber, skin, and muscle taken from carcasses found on Santa Catalina Island. These data have high variability in contaminant residues due at least in part to the different types of samples taken. Sampling of marine mammal tissue for the feasibility study will be opportunistic, and sample protocols will be developed in order to obtain as homogeneous a sample set as possible with respect to tissue type sampled. Separate samples of blubber and muscle from marine mammal carcasses will be opportunistically collected and analyzed for DDE and PCB residues during the first year. Data from the first year's sampling will be used in a statistical power analysis to determine the number of sample needed in subsequent years of the feasibility study.

<u>Contaminant Trend Analysis</u>

Contaminant residue data collected in the early 1990s were used to estimate concentrations of DDT and PCBs in bald eagle prey (as summarized in Valoppi et al. 2000; HydroQual, Inc. 1997). These data are now almost 10 years old. Limited contaminant residue data are available on prey species around the northern Channel Islands (Valoppi et al. 2000). Henny (2001) emphasized the need to determine if DDE residues in bald eagle prey have decreased over the last decade, or if contaminant residues are lower around the Northern Channel Islands compared to that assumed in the predictive model. Henny (2001) indicated that collecting and analyzing prey items for DDE and PCB residues would provide the following information:

a) present-day DDE and PCB concentrations of prey around the Northern Channel Islands,

b) long-term trends in DDE concentrations in prey collected around Santa Catalina Island,

c) improved validation of the predictive model through refinement of the egg-carcass residue relationship.

Henny recommended collecting at least 10 eggs each from 5 species of seabirds: ashy storm-petrel (*Oceanodroma homochroa*), pigeon guillemot (*Cepphus columba*; Santa Cruz Island), brown pelican (*Pelecanus occidentalis*) and double-crested cormorant *(Phalacrocorax auritus*) from Anacapa Island, and western gull (*Larus occidentalis*) either Santa Cruz or Anacapa Islands). In addition, Henny recommended collecting 5 adult birds of each of the 5 species at the same colony where eggs were collected in order to evaluate the egg to whole-body conversion factors used in the predictive model. In addition to the recommendations made by Henny, it would be worthwhile to collect egg and whole-body pelagic cormorants tissues for analysis, since the predictive risk assessment found considerable difference between DDE and PCB residues in double-crested and pelagic cormorants (based on egg to whole-body conversion). The modelers assumed that all cormorants had the same body burden as did double-crested cormorants, which may have skewed the model results. The Fry data from the early 1990s indicated that there is a difference in double-crested cormorant egg residues of DDE between Anacapa Island (mean of 5.96 ppm) versus Santa Barbara Island (mean of 1.11 ppm) (Fry 1994).

Specific species and island combinations (bird eggs and whole body) for contaminant trend analysis will be determined based on a statistical power analysis of the data from the 1990s to determine which species/island combination will provide a realistic chance of detecting changes in contaminant concentrations. The number of samples to collect in order to detect temporal changes in DDE and PCB residues in seabirds will also be evaluated. No more than 50 eggs of any seabird species will be collected, and it is likely that the power analysis will indicate far fewer eggs will need to be collected. No adult brown pelican, Xantus' murrelet (*Synthliboramphus hypoleuscus*), or ashy storm-petrel (*Oceanodroma homochroa*) will be sacrificed, and no more than 10 adults of other seabird species will be collected. Collections should occur during the 2nd and 3rd year of the feasibility study to coincide with the collection of bald eagle blood for contaminant analysis and stable isotope analysis so interpretation of the results are integrated.

There are limited contaminant residue data from fish and invertebrate prey species for the Northern Channel Islands. No whole body residue data for fish are available. Samples of kelp bass liver and muscle (15 samples total), and bivalve (mussel, 6 samples total)) samples were collected from Anacapa Island in the early 1990s. In contrast, food habit observations recorded 35 different fish and invertebrate species from observations of bald eagles feeding studies on Santa Catalina Island (Valoppi, et al. 2000). Therefore, fish and invertebrate prey of the bald eagle should be collected around the Northern Channel Islands. Samples should be analyzed for both contaminant residues and stable isotopes. Fish and invertebrate samples from the Northern Channel Islands will be collected at the same time as the bird tissues are collected to help with the interpretation of the bald eagle blood data that are collected during those years. A specific sampling plan detailing the number, species and methods for collecting fish and invertebrate samples will be developed at a later date.

Osprey

Kiff (1980) documented the presence of osprey on the Channel Islands. He indicated that shooting of osprey was likely the most significant cause of their decline, but did not rule out that an environmental change also affected the species. Nonetheless, the latest record of osprey breeding on the Channel Islands is 1927, and it appears that the species declined in the 1920s and 1930s, prior to the releases of DDT into the Southern California Bight.

Henny (2001) noted that osprey historically nested on the Channel Islands (Kiff 1980), and suggested that the fish component of the diets of bald eagle and osprey may be similar because they both catch fish at the surface (as opposed to diving for fish below the surface as cormorants and pelicans do). Henny (2001) noted that since osprey reach sexual maturity 1 or 2 years before the bald eagle and the two species are somewhat equal in their sensitivity to DDE, that reintroduction of osprey to the Northern Channel Islands could provide an early warning system for whether bald eagle breeding would be successful. Henny (2001) suggested that osprey from San Ignacio Lagoon, Baja, Mexico would be a good source of young osprey to release onto the Northern Channel Islands since the nests are easily accessible, and the timing and nesting cycle of these birds is well studied. The Mexican osprey are resident and coastal, and would be preferred over migratory northern osprey. Locating nesting platforms for the osprey would facilitate nesting potential for osprey on the Channel Islands (Henny 2001).

The Institute for Wildlife Studies (IWS) has already initiated hacking of osprey on Santa Catalina Island in 2000 and 2001 (total of 8 birds) from a hack tower on the island. To date, two of the released osprey have died. All released birds have radio transmitters, with expected battery life of about 1 year. IWS hacked northern osprey (which are more migratory than the Mexico birds) onto Catalina Island, and these birds may or may not return to Catalina to breed. IWS plans to monitor the return of the osprey and evaluate their breeding success.

If osprey introduced to the Northern Channel Islands could not breed successfully due to high DDE levels, then it would indicate that it is unlikely that bald eagles would successfully breed. However, if osprey did successfully breed, no conclusion could be drawn as to whether bald eagles would be successful because osprey are slightly less sensitive than bald eagles, and bald eagles ingest more contaminated prey that the osprey do not (i.e. seabirds and marine mammal carcasses). Release of osprey at this time would add additional costs to the feasibility study, and would potentially delay the release of bald eagles. Since the osprey would breed only 1 or 2 years earlier than the bald eagle, and there would still be uncertainty regarding the breeding success for bald eagles, use of osprey as an early indicator does not seem to be the best predictor for success of the bald eagle reintroduction.

Priorities

Although all the elements of the monitoring plan provide information which will be useful for predicting the breeding success of bald eagles, some elements of the plan are more critical than others. The following is a prioritization of the elements, with the most important element listed first:

1. <u>Radiotelemetry</u> (both radio and satellite) are essential elements for tracking the dispersal of the bald eagles after release. For the bald eagles that remain around the Channel Islands, or for those that return to the islands, telemetry will provide essential information on feeding locations and movements. In particular, telemetry will help identify whether bald eagles are consistently visiting seabird nesting colonies, and identify the need to conduct direct observations of bald eagle predation on seabirds.

2. <u>Beach Watch Surveys on Santa Cruz Island</u> would identify the location of marine mammal carcasses that may be available to bald eagles, and allow quantitative data to be gathered on the occurrence, type, frequency, and contaminant concentrations of marine mammal carcasses ingested by bald eagles. This will provide more precise and accurate information to be put into the predictive model to give better estimates of reproductive success. As a secondary benefit, beach watch surveys may provide the opportunity to evaluate techniques to reduce or eliminate bald eagle feeding on marine mammal carcasses (e.g. hazing techniques, removal of carcass from beach, covering of carcass to limit visual attraction by eagles, etc.).

3. Blood monitoring provides the most direct measurement of DDE exposure to eagles, though feasibility of collecting multiple measurements on a given bird is uncertain. The inclusion of other general health parameters also provides data to evaluate indirectly whether there are sufficient food resources to support the bald eagles. Although this is not expected to be an issue, the general health parameters provides assurance that the only limiting factor is contaminants.

4. Trend Analysis provides more current monitoring data as inputs to the predictive model, provides a way to evaluate whether contaminant residues have declined, and provides a current baseline from which to evaluate any future remedial actions that the U.S. Environmental Protection Agency may undertake.

5. Stable Isotope Analysis, is potentially very useful as a tool to understand the origins and mechanisms of contaminant exposure to individual bald eagles. First, stable isotope analysis will be done on samples from Catalina eagles and foodweb to understand the potential utility and ability of stable isotopes to predict contaminant levels and their relationship to the food web. Second, a non-lethal tissue for stable isotope analysis from released eagles will have to be determined. Finally, the stable isotope data would be collected on the Northern Channel Islands, and used in conjunction with other information (telemetry, contaminant residues, etc.) to understand the degree to which more or less contaminated prey items are used by the released eagles.

Elements and Timing of a Monitoring Plan

Table 1 indicates the timing of the elements of a monitoring plan. The elements marked by an "X" are the highest priority. Some elements are also high priority, but the exact timing of the activity is uncertain (noted by an "X ?" in Table 1). Some elements may or may not be conducted, depending upon the outcome of earlier analysis and the recommendations of the scientific experts (noted by an "?" in Table 1).

Releases of bald eagles would occur during the first 3 - 5 years. Monitoring the movement of eagles would occur for the full 5 years of the feasibility study, as would conducting beach watch surveys to record the presence and location of marine mammals. Video monitoring of marine mammal carcasses to detect bald eagle feeding would potentially occur during the entire 5 years of the feasibility study, as would collecting marine mammal carcass tissue for DDE and PCB residues. No collection of tissue samples from live marine mammals are proposed. Sampling of marine mammal tissues for residue analysis will be opportunistic, it is proposed to collect samples of carcasses during every year of the feasibility study (since it cannot be assured of collecting sufficient samples in any one year). Multiple years of collecting marine mammal carcass tissues may allow for assessment of year to year variation in residue concentrations, as well as potentially capture changes in residue concentrations during El Nino years. As marine mammal carcass tissues are collected, we will discuss results with the scientific experts to determine the need for continued collections.

Collection of seabird egg and whole body samples and fish for residue analysis could occur anytime during the study, but would be best collected in the early part of the study so that trends in data can be evaluated and a determination made whether additional samples are needed. In order to provide some lead time to organizing a collection effort (development of protocols, analytical methods, etc.), seabird egg collections for contaminant trend analysis should occur in years 2 or 3 of the study. Collecting prey samples for analysis in years 2 or 3 would also coincide with collection of bald eagle blood for residue analysis, thereby allowing better interpretation the bald eagle blood data, and better quantification of contaminant exposure in the risk assessment model.

Capturing bald eagles to take samples on the Northern Channel Islands, Catalina Island, and potentially a reference location, would be conducted in the 2nd through 5th years of the study. It is not known what capture success will be achieved, so attempts to capture should occur throughout the study. There is no need to capture bald eagles during the first year since the contaminant body burdens of the released eagles would not have had time to come into equilibrium with dietary concentrations. Since the bald eagles will be marked with wing tags, collection of blood samples from recently released eagles can be avoided. Blood samples will be collected prior to release to provide a baseline for individual birds.

Stable isotope analysis of archived Catalina samples will occur the first year to evaluate the usefulness of the technique to differentiate between food habits of the various bald eagle territories and to determine whether there is a discernible relationship to stable isotope signature and DDE egg residues or other eagle tissues.

The fifth and sixth years of the study is potentially a transition to nest monitoring and hatch success evaluation, should data collected earlier indicate that DDE exposure is lower than on Catalina Island and a decision in made to continue the bald eagle releases.

Impacts of Monitoring Plan on the Environment

There are potential impacts on bald eagles from the capturing of eagles for blood analysis and other non-lethal sampling (e.g. feathers). The effects on bald eagles from this activity are likely to be insignificant because capturing techniques will be employed that have been used successfully by other raptor biologists.

Of the 44 bald eagles fostered into nests or hacked onto Catalina Island since 1989, six have died within the first year. This is considered to be within the normal range of eagle survival in the wild and for a reintroduction program. One adult eagle died, in all likelihood due to DDE poisoning, out of 81 eagles released on Catalina over the 20 years of reintroduction efforts (Garcelon 2000; Sharpe and Garcelon 2000). The Northern Channel Islands are not expected to be more contaminated than the Santa Catalina Island and so DDE exposure to bald eagles is not expected to be greater on the Northern Channel Islands.

As for impacts from collection of seabird eggs and adults for contaminant trend analysis, no more than 50 eggs of a species will be collected, and it is likely that the statistical power analysis will indicate that sufficient differences can be detected with fewer number of eggs. No more than 10 adults of any species will be collected, and no collection of adult brown pelican will occur. Collection of seabird eggs and adults are limited and are therefore not expected to impact the population.

Table 1: Elements and Timeline for Northern Channel Island (NCI) Bald Eagle Reintroduction Feasibility Study

Element	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year
Release bald eagles to Santa Cruz Island with satellite and conventional radio transmitters; about 12 birds/year. Collect baseline blood data from each bird prior to release.	X X	X X	X X	? ?	? ?	
Monitor movement of released birds, intensive monitoring of feeding areas for any birds that remain on islands, or return	X	X	X	X	X	
Conduct beach watch surveys monthly on all Santa Cruz Island for marine mammal carcass diet component of eagles. Potentially also add monitoring of other islands if telemetry warrants.	X	X	X	X	X	
Potentially video monitor eagles feeding on marine mammal carcasses	X	X	X	X	X	
Collect marine mammal carcass tissues for residue analysis. Taking samples each year would provide data on yearly variability in the event of an El Nino event	X	X	X	X	X	
Collect seabird eggs and whole body birds for DDE and PCB residues to evaluate 10-year trend and for predictive model		X	X ?			
Collect whole body fish and invertebrate samples for DDE and PCB residues for predictive model		X	X?			
Analyze any existing, unanalyzed blood from Catalina eagles and conduct statistical assessment on all available blood residue data	X					
Capture juvenile bald eagles on NCI and Catalina Island for DDE residue and other analysis in blood		X	X	X	X	
Capture juvenile bald eagles at reference area for blood samples, or analyze archived samples from Canada, Oregon, Washington		X	X?	X?	X?	
Stable Isotope Analysis of Catalina egg contents, eggshells, membranes (approximately 30 samples of each)	X	?	?	?	?	
Stable Isotope Analysis of eagle carcass from Catalina (1 carcass, various tissues)	X	?	?	?	?	
Stable Isotope Analysis of blood and feather samples from Catalina birds, construction of a stable isotope food web model, and non-lethal sampling of NCI eagles		?	?	?	?	
Evaluate reproductive success of bald eagle nests (number of eggs laid and hatch success)					?	?

X = conduct monitoring activity during that year
? = whether to conduct activity depends on analysis of previously conducted analysis
X? = potentially conduct analysis during this year

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