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A Spatially-Dynamic Preliminary Risk Assessment of the American Peregrine Falcon at the Los Alamos National Laboratory (Version 1)

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List of Acronyms

BAF	bioaccumulation factor
BMF	biomagnification factor
BODWT	body weight
COPEC	contaminant of potential ecological concern
DARHT	Dual Axis Radiographic Hydrodynamic Test (Facility)
DDD	dichlorodiphenyldichlor
DDE	dichlorodiphenylethelyne
DDT	dichlorodiphenyltrichloroethane
EES-15	Earth and Environmental Sciences Division, Environmental Sciences Group
EEU	ecological exposure unit
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ESH-20	Environmental, Safety and Health Division, Ecology Group
ESRI	Environmental Systems Research Institute
FIMAD	Facility for Information Management, Analysis, and Display
F_s	fraction of food intake as soil
GIS	geographic information system
HI	hazard index
HMP	Habitat Management Plan
HQ	hazard quotient
HR	home range
IAEA	International Atomic Energy Agency
LANL	Los Alamos National Laboratory
LOAEL	lowest observed adverse effects level
NOAEL	no observed adverse effects level
QA/QC	quality assurance/quality control
RfD	reference dose
SAL	screening action level (soil)
SC	soil concentration
TA	technical area
TES	threatened and endangered species
TRV	toxicity reference value (e.g., NOAEL)
UF	uncertainty factor
UTL	upper tolerance level (e.g., 95th percentile)

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Abstract

The Endangered Species Act of 1973 and the Record of Decision on the Dual Axis Radiographic Hydrodynamic Test Facility at the Los Alamos National Laboratory require that the Department of Energy protect the American peregrine falcon *(Falco peregrinus anatum)*. A preliminary risk assessment of the peregrine was performed using a custom FORTRAN model, ECORSK4, and a geographical information system. Estimated doses to the falcon were compared against toxicity reference values to generate hazard indices. Hazard index results indicated no unacceptable risk to the falcon from the soil ingestion pathway, including a measure of cumulative effects from multiple contaminants that assumes a linear additive toxicity type. Scaling home ranges on the basis of maximizing falcon height for viewing prey decreased estimated risk by 69% in a canyons-based home range and increased estimated risk by 40% in a river-based home range. Improving model realism by weighting simulated falcon foraging based on distance from potential nest sites decreased risk by 93% in one exposure unit and by 82% in a second exposure unit. It was demonstrated that choice of toxicity reference values can have a substantial impact on risk estimates. Adding bioaccumulation factors for several organics increased partial hazard quotients by a factor of 110, but increased the mean hazard index by only 0.02 units (from 0.019 to 0.21). Adding a food consumption exposure pathway in the form of biomagnification factors for 15 contaminants of potential ecological concern increased the mean hazard index to 1.16 (± 1.0), which is above the level of acceptability (1.0). Aroclor-1254, dichlorodiphenyltrichloroethane (DDT) and dichlorodiphenylethelyne (DDE) accounted for 81% of the estimated risk that includes soil ingestion and food consumption contaminant pathways and a biomagnification component. Information on risk by specific geographical location was generated, which can be used to manage contaminated areas, falcon habitat, facility siting, and/or facility operations in order to maintain risk from contaminants at acceptably low levels.

1.0 Introduction

The Endangered Species Act of 1973 (16 USC 1531 et seq.) mandates protection, conservation, and perpetuation of species. Consequently, the Record of Decision on the Dual Axis Radiographic Hydrodynamic Test Facility (DARHT) Environmental Impact Statement (EIS) requires that the U.S. Department of Energy take special peregrine precautions to protect the American falcon (*Falco peregrinus anatum*) at the Los Alamos National Laboratory (LANL) (EPA 1995, DOE 1996, DOE 1995). In order to do so, risks to the falcon presented by radiological and nonradiological contaminants must be estimated and reported as part of a Habitat Management Plan (HMP). This report presents the results of a preliminary risk assessment on the American peregrine falcon and is a component of the HMP on threatened and endangered plant and animal species (TES) at LANL. The assessment is regulated by the US Fish and Wildlife Service as the statutory authority of the Endangered Species Act of 1973.

The general approach for performing the assessment was to make a semiquantitative appraisal of the potential effects that soil contaminants might have on the falcon when introduced through soil ingestion and food consumption pathways using a modified Quotient Method described by the US Environmental Protection Agency (EPA) (EPA 1996, EPA 1992). The methodology generally involved comparing calculated doses to the falcon against toxicity reference values (TRVs) either provided in or estimated from the scientific literature. Two potential peregrine habitats at LANL were evaluated. Each consisted of a predetermined potential nesting habitat and a calculated foraging area or home range (HR). Collectively the nesting habitat and the HRs comprised a peregrine "ecological exposure unit" (EEU) (Figure 1).

2.0 Methods

2.1 Background

2.1.1 DDT, Organochlorines, and the Peregrine Population

Added to the Endangered Species list in1970, the peregrine is now making a strong comeback in many areas. The first steps for possible delisting of the falcon are currently being considered (ESB 1995). Population increases are being recorded throughout the falcon's entire range, which stretches from Alaska to Mexico (Lowe et al. 1990). The rapid and severe decline in the peregrine population, which began in the 1950s, was associated with the potential effects of the pesticide dichlorodiphenyltrichloroethane (DDT) (Lowe et al. 1990). Chemical pesticides and chlorinated hydrocarbons were once used indiscriminately in the U.S. to control insects and are still used in some parts of the world. DDT, its metabolites, and other organochlorine pesticide residues build up in the bird's body tissue as a result of the dangerous concentrations within their prey (Burnett et al. 1989). These concentrations are not lethal to the adults, but dichlorodiphenylethelyne (DDE), in particular, results in eggshell thinning and breaking leading to reduced nesting success (Burnett et al. 1989). In 1972, the U.S. banned DDT, and since then DDT levels in falcons have decreased significantly (Lowe et al. 1990). Eggshell thickness in New Mexico peregrines has reflected this DDT ban with a 6% increase (0.225 mm in 1977 to 0.242 mm in 1985) in shell thickness between 1977 and 1985 (Ponton et al. 1988). DDE and dichlorodiphenyldichlor (DDD) levels, both

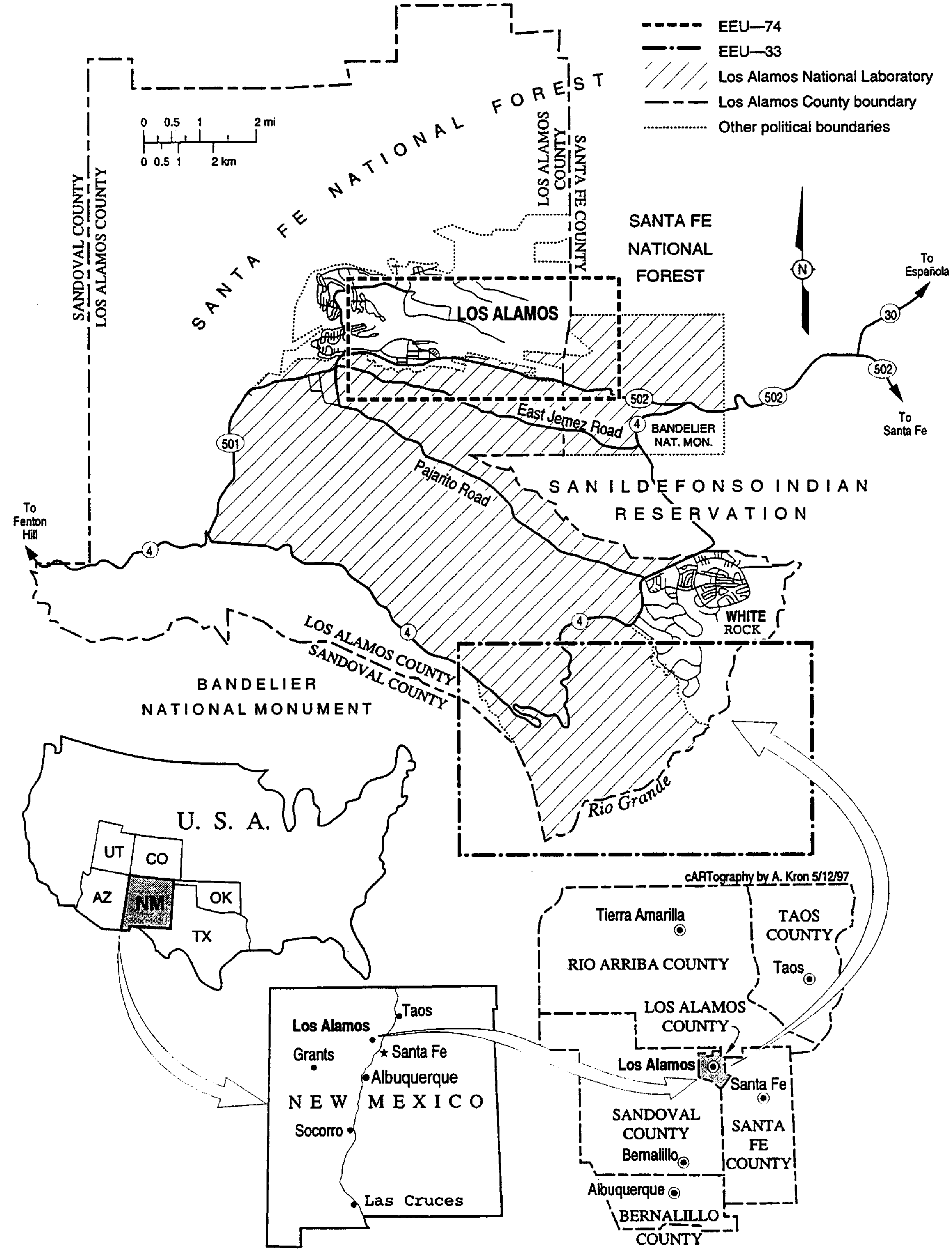

Figure 1. Locations of EEUs for risk assessment of American peregrine falcon.

metabolites of DDT, have also declined in conjunction with the DDT ban. In a study at Padre Island, Texas between 1978 and 1994 the geometric mean of DDE residues dropped from 1.43 to 0.41 μg/g wet wt (Henny et al. 1996). DDT and DDD levels dropped to nondetectable levels in 1994 compared to 0.44 and 0.28 μg/g, respectively in 1984. Locally, the decline of nesting peregrines in the Rocky Mountain/Southwest region was also linked to the presence of DDT and its metabolites, especially DDE, in egg contents (Enderson and Craig 1974). Studies have implied that a peregrine's diet averaging 1.0 ppm DDE or more could be expected to produce the observed shell thinning (Enderson and Berger 1970, Enderson and Wrege 1973, Enderson et al. 1982). This is still a possibility in New Mexico according to Hubbard and Schmitt (1988) and Kennedy et al. (1995). Both authors published results reporting that dangerous organochlorine levels are still being recorded in New Mexico peregrines despite the DDT ban in 1972. Although occupancy of peregrine breeding habitat in New Mexico has increased since 1980, reproduction has been just above the level required to maintain the population, and reproduction has declined since 1988 (Johnson 1996). If reproduction declines, the peregrine population will soon after begin to decline (Johnson 1996). In addition to DDT and its metabolites, Henny et al. (1996) also monitored several organochlorine pesticides and metabolites. Heptachlor epoxide, dieldrin, oxychlordane, and mirex residues were detected at levels greater than 0.02 μg/g wet wt in 1978, but generally decreased over time and were no longer detected in falcons by 1994 (Henny et al. 1996). Polychlorinated biphenyls (PCBs) were found in female peregrine falcons in 1994 at levels higher than 0.10 μg/g, but PCB data collected in 1984 was not comparable (Henny et al. 1996). While DDE does cause egg shell thinning, it is probably a mistake to attribute all reproductive failure to egg breakage (USFWS 1984). Accidents account for some peregrine mortalities, and natural causes of falcon deaths in the wild are difficult to observe (USFWS 1984). Ratcliffe (1958) noted a female peregrine in Britain eating her eggs. Also, Zimmerman (1975) associated pesticides with adult inattentiveness that resulted in the death of nesting arctic peregrines. Nelson (1969) attributed a decline in active peregrine eyries in the Northwestern U.S. prior to 1948 to a change in climate (increase in temperature and decrease in precipitation) between 1860 and 1960. Finally, it is important to note that neither pesticide contamination nor population decline for any species in North America have been uniform (USFWS 1984).

2.1.2 Risk Assessment at LANL

The development of methods for estimating the effects of toxic substances on animal and plant populations at LANL, with particular interest in ecosystem dynamics, is an ongoing program at this laboratory. Recent efforts to standardize the estimation methods have been published for LANL by the Environmental Science Group (EES-15) and are used as a guide for this study (Ferenbaugh et al. 1996). The EES-15 methodology employs a tiered approach whereby conservative risk screening is conducted first, and then successive stages of progressively more complex risk assessments are performed in subsequent "tiers". The HMP risk component for a TES does not include an initial conservative screening of contaminated sites, because, for individual screenings, unlike the proposed methodology of EES-15, the sites are not grouped into potential release sites, but into sampling locations that have identifiable north-south (N-S) and east-west (E-W) coordinates obtained from a geographical information system (GIS) through LANL's Facility for Information, Management, and Display (FIMAD) data base. This study is considered a "Tier 2", or preliminary risk assessment, and the level of detail and complexity of risk parameters are commensurate with the tiered approach.

2.2 Development of Ecological Exposure Units

An EEU, for purposes of this study, is a unit defined by the biology of a species or group, within which an ecological risk assessment is conducted. As mentioned, each EEU for the American peregrine falcon consisted of a predetermined suitable nesting habitat and a calculated HR.

2.2.1 Nesting Habitat

The preferred nesting habitat of the falcon includes cliffs or series of cliffs, generally 200 to 300 feet in height, especially those that dominate the surrounding landscape including mountain valleys and river gorges with cliffs (USFWS 1984). In the Rocky Mountain Southwest, this largely includes mountain cliffs in ponderosa pine or piñon/juniper, depending on prey abundance and diversity, and sometimes near water.

"Habitat identification is based on analysis of foraging and nesting topography and cliff characteristics associated with peregrine falcon breeding areas" (Johnson 1996, 1992). Suitable nesting habitats are monitored for occupancy and nesting activity (Johnson 1996, 1983). Nesting suitability is based on factors of cliff size, structure, position, and temperature. Suitability of breeding territories are indexed to factors of elevation, slope, prey abundance, diversity, and vulnerability. Several suitable breeding areas have been identified in and around what is known as the Los Alamos National Environmental Research Park (Johnson 1996).

2.2.2 Home Range or Foraging Area

The entire Los Alamos National Environmental Research Park is peregrine foraging habitat (Johnson 1996). The peregrine will travel up to 20 km to forage. A local estimate of HR size is 12 km in radius (Johnson 1986). Because the peregrine HR is so large, ≥576 km^2, and the data generated from assessing an area this size would challenge personal computers, we decided to initially model a subset of the true HR. The validity of this scaled HR is discussed in the discussion section. Any indications that unacceptable risk is present to the peregrine might require modeling of the full HR.

As such, the HR or foraging area around any specific nesting site was estimated according to Peters (1993) as

$$HR = 8.3 \times BODWT^{1.37} \quad \text{bird, carnivore,} \qquad (1)$$

where

HR = animal home range, km^2 and
BODWT = animal body weight, kgfwt.

The direction that a peregrine moves away from its nest site to hunt likely depends on the location of its prey and its instinct to attain elevation for viewing its prey (Hosking et al. 1987, USFWS 1984). This could result in a HR with boundaries that have equal distances from the nest such as a circle or square, or an HR with boundaries that are variably distanced from the nest site such as an ellipse or rectangle. Because this variability could cause differences in which contaminant locations are included in the assessment, both square and rectangular HRs were developed. This is discussed further in the model description section of this report.

2.2.3 EEU and HR Mapping

As a result of employing the Peters (1993) method for calculating HR, the maximum HR and the extreme boundaries of each falcon EEU were established by mapping an area that was 4,600 ft from the extreme-most north, south, west, and east boundary of the nesting habitat. The resultant EEUs are shown in Figure 1. EEU-74 encompasses all or portions of LANL Technical Areas (TAs) 2, 21, 41, 43, 60, 61, 73, and 74. EEU-33 encompasses all or portions of LANL TAs 33, 39, 49, 68, and 70.

Each EEU was mapped using a GIS and the GIS software ARC/INFO. ARC/INFO is a GIS software developed by Environmental Systems Research Institute, Inc. (ESRI) (ESRI 1989).

The GIS was used to create spatial data sets, combine information from different spatial data sets, generate a spatial grid, and produce maps. The spatial extent of the nesting falcon habitat was digitized into ARC/INFO to create a coverage (theme or layer). This habitat was assigned an attribute coverage factor (map code value). The modeling also required additional coverages to be developed, a grid set, and a forage habitat coverage.

More specifically, a grid was developed that would encompass the spatial extent needed for the modeling activity. In ARC/INFO, a grid was created using the command GENERATE with the fishnet option. Adequate potential release site areal definition was not available for use in the risk estimation method to be described, therefore, an alternative subunit area definition was sought. The requirements for grid size were that sufficient grid cell density was achieved to allow accurate development of spatial risk estimates within the limits of available personal computer capabilities and that presentation of spatial risk data did not appear to achieve greater resolution than is supported by the limitations of the GIS. Based on these criteria the chosen grid cell size was 100 ft by 100 ft. This assignment was assumed to be a conservative measure in most cases. However, provision is made for modification of the animal occupancy estimates if deemed necessary.

The ecological risk model required that each row and column of the grid be designated by a label. In addition, the coordinates of the center of each grid cell were needed. To accomplish this the *Basic* program listed in Table A-1 in the appendix was developed. These attributes were then added to the grid spatial data set.

The next coverage developed in ARC/INFO was the forage coverage. The forage coverage was created by selecting 46 grid cells above the maximum x, y extent of the falcon habitat and 46 grid cells below the minimum x, y extent, then assigning the HR an attribute factor.

After these three coverages were made, additional information was needed that required combining coverages. First, the grid coverage was intersected with the sample location coverage to create a new coverage. This new coverage contained the sample locations as well as the grid attributes of row, column, and coordinates.

The three coverages were then combined to obtain one coverage with the attribute factor from the grid, the falcon habitat, and the forage habitat. Separate map code values (attribute factors) were assigned for the falcon nesting habitat, for the foraging habitat that was not within the falcon nesting, and for the grid that was not within either (i.e., surrounding the foraging habitat). This was accomplished through a couple of coverage intersects and defining a single new attribute factor.

When all coverages had been developed, maps were generated either in ARC/PLOT of ARC/INFO or ArcView. ArcView is a desktop GIS for map display, production, and query. It was also developed by ESRI (1989).

2.3 Data Compilation

2.3.1 Data Source and Compilation Procedure

Data used for this risk assessment were collected for environmental restoration activities at LANL by sampling and analyzing soils for inorganic, organic, and radioactive contaminants. Analytical results from this sampling are maintained in an Oracle data base by FIMAD. FIMAD data can be accessed through the command line Structured Query Language or through the graphical interface Databrowser. The data for the risk assessment component of the TES project was accessed primarily with the latter.

Soil sampling data are stored in several tables, depending on the attribute of the data, when the data was collected, and the field unit from which the data was collected. If a sample was taken before April 1, 1995, the results are stored in one of the "analytical_info" tables, and if a sample was taken after April 1, 1995, the results are stored in the "stage" tables.

The data for the TES project were compiled from the FIMAD data base for each HR according to the following procedure:

- In order to determine which samples were relevant to the TES study, all FIMAD-identified sampling locations within each HR were identified graphically from a map showing all the sampling locations stored in FIMAD.
- Sampling locations were then linked to sample identification numbers and field units to determine where the analytical results would be stored.
- Five FIMAD tables were queried for the analytical results:
  - analytical_info_fu01,
  - analytical_info_fu02,
  - analytical_info_fu03,
  - analytical_info, and
  - sample_request_header_stage (verified).

  The "analytical" tables contain data for the field units 1–5 gathered prior to April 1, 1995, and the "stage" table contains data for samples gathered after April 1, 1995. Analytical table data are quality assured prior to loading into FIMAD. Stage table data were submitted for special quality assurance review.
- As part of the query language, analytical results were screened to contain only samples with a beginning depth equal to zero. The data was then exported to a personal computer and modified further using Microsoft Access® software.
- All records were screened by "sample units", and those records not given in grams or kilograms were discarded. All remaining records were converted to mg/kg for organic elements and heavy metals or to pCi/g for radioactive

elements, leaving only the surface soil sample data relevant to the TES study. Although higher quantities of contaminants have been found at intermediate soil depths than at shallow depths elsewhere at LANL (Gonzales and Newell 1996), their bioavailability to aboveground biota is unknown.

- For the organics and inorganics, measured soil concentrations reported as below the detection limits of the instrumentation used in the analysis were assigned one-half the detection limit per Gilbert (1987).
- For radionuclides, "less-than-detectable" values were included without change per DOE (1991).
- Every sample record was assigned the appropriate cell (100 ft by 100 ft) of the grid covering the feeding area. The grid cells are labeled with the row and column in which they are found.Averages were calculated for each analyte within every grid cell containing at least one record of data. The "grid" was superimposed onto a map of sampling locations that were concentrated around preidentified "potential release sites". Sample locations were not scattered evenly throughout cells of the grid because generally more samples were taken where higher levels, greater variation, or larger spread of contamination were expected. Consequently, some cell averages include the data from several samples, others include the data from only one sample, while still others have no analytical data.

Many models exist for assigning contaminant concentrations to unsampled points. Of these, most assume continuity or gradation in contamination levels between sampling points (Clifford et al. 1995). In this study the large HR of the American peregrine falcon resulted in the creation of such large EEUs that the contaminant distribution was very heterogeneous, not continuous. Although there are sophisticated extrapolation methods that do not presume continuity, they also were deemed inappropriate for the level of risk assessment applied in this study. For example, use of the Thiessen polygon technique (ESRI 1989) would have applied a "nearest neighbor" approach to assigning each and every spatial sample value to its own polygon such that any location within the polygon is closer to the polygon's sample location than to any other sample point (Clifford et al. 1995). Applied to this study, the Thiessen technique would likely more accurately represent soil concentrations in areas of high sample number density but would overestimate soil concentrations in areas of low sample densities or where no sampling was conducted. Since the areas of low or no sampling are vast within the EEUs, and it is assumed with some degree of confidence that contaminant concentrations in these unsampled areas are low, assigning concentrations to these grid cells using the Thiessen technique would result in overestimates for the EEU as a whole. This is undesirable because the location of sampling is already biased toward areas known or likely to contain or concentrate contaminants. Thus while more sophisticated estimation techniques are available, they are not always appropriate. For the TES HMP, spatial weighting will be more important for animals with small HRs where differences in contaminant concentrations between points of relatively small distance within the 10,000-ft^2 grid cell would have more of an impact. Such is likely the case for the New Mexico meadow jumping mouse (*Zapus hudsonius luteus*) and the Jemez Mountains salamander (*Plethodon neomexicanus*) as examples. In cases like this a spatial weighting is more appropriate.

- Not all cells have analytical results for the same set of analytes, because the same analyses were not performed for all the "potential release sites" in the area. Lastly, an entire 100- by 100-ft area was assumed to contain an analyte concentration that was measured in as few as one sample. This would be considered a conservative assumption in many cases in which contamination is confined to an area less than 10,000 ft^2.
- The number of analytes with sample results was calculated for each cell.
- The grid cells were assigned the x- and y-coordinates calculated at the center of each cell.
- Mean "natural" (inorganics) or "regional" (radionuclides) soil background concentration values of analytes were assigned to each analyte within each grid cell, and zeros were assigned in the absence of a background value such as for organics. Sources of background values were Fresquez et al. (1996) and Longmire et al. (1996).
- TRVs, TRV adjustment factors, occupancy factors, and bioaccumulation or biomagnification factors (BAFs or BMFs) (all discussed in a later section) were then assigned to each analyte within each grid cell.

The final data contained the fields: grid cell identification, analyte name, analyte code, analyte average (by grid cell), TRV, TRV adjustment factor, occupancy factor, background value, number of analytes per cell, x-coordinate, y-coordinate, and BAF or BMF. Finally, the fields were formatted as a data base ("eeuinp.dat") for input to the model "ECORSK4".

2.3.2 Data Quality Assurance

2.3.2.1 FIMAD Data

The basic assumption in this study was that FIMAD data was sufficiently current and sufficiently accurate such that any deviation in accuracy and currency that was not taken into account would not impact the major conclusion on risk. There is evidence supporting this assumption as will be discussed below.

The data that is available for the ecological risk data base is in three different electronic data systems maintained by FIMAD: "analytical_info tables", "stage_tables", and the "an95_output table". Data accessed for this study were comprised of

- 87% analytical_info tables and 13% staging tables for EEU-74, and
- 100% analytical_info tables for EEU-33.

The Environmental Restoration (ER) Office has committed vast resources to quality assurance/quality control (QA/QC) issues to ensure that the electronic data is reliable. This process generally includes a comparison between hard copy results received from the laboratories and the electronic version of the data. Estimates are that analytical_info table data are highly accurate, i.e., generally between 95% and 98% (Manzel 1997). Approximately 75% of the data in the stage_tables have been edited, and the data which have yet to be edited are only 50% accurate. However, based on the source-distribution of the data used in this study as stated above, and the estimated accuracies, only 4.9% (13% x 0.75 x 0.5) of the stage table data used and 2 to 5% of the analytical info table data used are potentially inaccurate. Known unedited stage table data is sent to FIMAD for special verification.

Although the accuracy estimates are subjective, the expenditure of resources to eliminate or further reduce the small remaining uncertainty in FIMAD data would have little impact on risk values and no impact on risk conclusions primarily because the populations of contaminant data for each EEU are large (72,670 records for EEU-74 and 7,064 records for EEU-33 excluding "nondetect" cells). Therefore any single contaminant value or small set of values that are erroneous would impact the entire data population by negligible amounts.

Perhaps of more significance is (1) the currency of data and (2) the spatial completeness of sampling in an EEU as based on the status of ER's RFI Work Plans. The first addresses the time lag between the date of sampling and the date when the analytical results are available in FIMAD. The process of compiling data for ecorisk data bases is inextricably linked to availability of spatial data for analytical samples. Only those samples which have coordinates stored electronically in FIMAD have been included in the analysis, and FIMAD updates its libraries weekly. However, if samples were taken and analytical results were uploaded to FIMAD, but location information was not submitted by field units to be uploaded, the sample was not included in the ecorisk data base. Coordinates for nearly 75% of the sample results stored in an95_output have not been submitted to FIMAD, and consequently were not included in the analysis. The latter issue—completeness or totality of sampling—addresses the underestimate of risk associated with there being potentially contaminated areas that are yet to be sampled. Both of these sources of uncertainty will be addressed by periodically repeating the data compilation and risk assessment process as currently planned. This will also take advantage of any increases in data base accuracy.

2.3.2.2 Data Retrieval

Downloading analytical results from FIMAD is fairly straightforward. All sampling locations within a given EEU are identified through ArcView and compiled into a location table. The location table is then queried against the analytical tables and relevant sample data are downloaded. Each location is assigned to an exclusive cell id and the averages for each analyte within each cell are calculated. Occasional spot checks are performed to ensure that the proper cell identification is assigned to each location. As a final check, each contaminated grid cell is mapped over the ER locations to visually check that contaminated cells correspond to ER locations. Finally, as many of the EEUs are reviewed periodically, the new cell averages are compared with the old cell averages to insure that the data is reproducible. For example, a data base originally compiled in August 1996 for a previous study (Gallegos et al. 1997) was updated in January 1997 to include any new data that may have been uploaded since the original compilation. Most grid cell averages remain unchanged, indicating that inconsequential amounts of new data were uploaded.

Although some relevant data is lost in the process of downloading and averaging, roughly 95% of the data that should be in the ecorisk data base is actually used. Because of the large number of records used, the loss of a small number of records has an insignificant impact on the final data base. Furthermore, the data retrieval process and risk estimation will be repeated periodically.

One final issue relates to the kinds of sample values used to compile the ecorisk data base. Specifically, it is not known whether a given sample was collected as part of the initial investigation of a site or if it was collected as a confirmation sample after a site was cleaned. This is a problem that is being addressed by the ER data managers, and in the future, samples are likely to be flagged for this identification. In the FIMAD data base, investigative and confirmation samples are indistinguishable, but this would tend to force a high bias for grid cells which contain cleaned-up sites, leading to a conservative or overestimate of risk. If this became important because an unacceptable level of risk were estimated, efforts should be made to identify and eliminate pre-cleanup values that are no longer valid.

2.3.2.3 Conclusion on Data Quality Assurance

The majority of the relevant available data used for this preliminary ecological risk assessment provides an accurate representation of the soil contamination within each EEU. Improvements for future EEUs will be with the inclusion of data from the an95_output table. As the EEUs considered in this study contain grid cells that are also components of previous studies (Gallegos et al. 1997) and are likely to be components on future studies, review of data quality is a continuous, sometimes repetitive, process that will provide added assurance that the data are reliable and accurate.

2.4 Preliminary List of Contaminants of Potential Ecological Concern

Contaminants of potential ecological concern (COPECs) are those

- known to have been used or to be present in the EEU,
- to which receptors within the EEU are known to be sensitive,
- identified as of concern during any human health risk assessment conducted in the same area, and
- which warrant concern because of other factors such as toxicity, persistence, exposure potential, or food chain transfer (Ferenbaugh et al. 1996).

A preliminary list of COPECs for each EEU was generated by querying LANL's FIMAD data base for surface layer soil analytical results. Any analyte listed in the FIMAD data base for which no analytical detections were made in the entire EEU were not included in the list.

Contribution to risk by any given COPEC could be calculated, as discussed later, only if a TRV was available for that COPEC. The preliminary COPEC list for the American peregrine falcon should ultimately be revised on the basis of its sensitivity, and whether complete pathways exist from the sources to the falcon (Ferenbaugh et al. 1996).

2.5 Food Web Definition

The American peregrine falcon is a first-order carnivore. Peregrines specialize in the capture of other birds as their prey, with several hundred prey species on record worldwide (USFWS 1984). In the Rocky

Mountain Southwest, common food items include blackbirds, jays, doves, shorebirds, and small song birds (USFWS 1984). Locally, the mourning dove (*Zenaida macroura*) is one of the peregrines major foods (Foxx and Tierney 1982).

2.6 Pathways of Exposure

Based on a general conceptual model of pathways of contaminant exposure at LANL (Ferenbaugh et al. 1996), pathways for the American peregrine falcon are generally established as:

- Primary Source of Contamination: Burial and outfalls;
- Primary Release Mechanisms: Burial and disposal of liquids through drains;
- Migration Pathways: Infiltration/sorption, biodegradation, organic volatilization, chemical reactions, and radioactive decay;
- Contact Pathways: Soil, plant uptake, volatiles/airborne dust, sediment, surface water;
- Intermediate Pathways: Transport from soil, soil contaminated vegetation and herbivores to peregrine prey species; and
- Primary Direct Exposure Routes:
  - ⇒ Part-plucking of prey,
  - ⇒ Ingestion of contaminated soil and sediment within prey species,
  - ⇒ Ingestion of tissue-deposited contamination in prey species.

The preceding section on food web definition (Section 2.5) established consumption of birds as the main activity leading to potential contamination of the falcon.

2.7 Risk Calculation

Defined simplistically, ecological risk is the actual or potential effects of contaminants on flora and fauna. The measure used in this study to quantitatively appraise risk from contaminants to the American peregrine falcon is a modified Quotient Method (EPA 1996, 1992) whereby the Hazard Quotient (HQ) serves as the measure of potential risk.

2.7.1 Nonradionuclide Contaminants

The general form of the HQ used for the inorganic metal and organic contaminants is defined as

$$HQ = \text{Exposure (mg/kg-d)}/\text{TRV (mg/kg-d)}, \qquad (2)$$

which is the ratio of exposure to a TRV. When HQs for all contaminants are summed, it becomes a cumulative HQ and is termed Hazard Index (HI). With a threshold evaluative criteria of 1.0, HIs or HQs >1.0 are considered indicative of potentially unacceptable risk and, more conclusively, indicate the need to further assess risk to the species in a more complex risk assessment. A more detailed version of the formula above for computing the HI from multiple contaminants and multiple contaminated areas is

$$HI=[I \times (F_S + \text{BAF or BMF})/BW] \textstyle\sum_j O_i \sum_l C_{i,j}/TRV_j, \qquad (3)$$

where

- HI = cumulative HQ over all contaminated grid cells and contaminants (COPECs),
- I = food intake, kgfwt/d (5.64 by 10^{-2} kgfwt/d for falcon)
- BW = body wt = 0.952 kgfwt for falcon,

- F_s = fraction of food intake as soil (0.03 used for the peregrine)
- BAF = bioaccumulation factor (for aldrin, dieldrin, endrin, DDT, and DDE)

or

- BMF = biomagnification factor (for 15 COPECs)
- $C_{i,j}$ = contaminant concentration in soil, mg/kg, for the ith contaminated grid cell, and the jth contaminant,
- TRV_j = receptor (falcon) toxicity reference value in mg/kg-d for the jth contaminant (Note: TRVs are discussed in the next section), and
- O_i = the fraction of time that an animal spends feeding in a given area.

Two cases of O_i were considered:

(1) "Unweighted foraging": the falcon feeds within its calculated HR with no regard to distance of any feeding area from a potential nest site; and

(2) "Weighted foraging": $O_i = e^{-r/3000}$ (Johnson 1986), which estimates the relative probability of foraging as a function of radial distance in meters from the nest. This results in approximately 91% of the foraging within 12 km of the nest site (Johnson 1986). The exponential factor used, as based on the proportional scaling of the HR to a 1.4-km radius (discussed in section 2.2) was $O_i = e^{-r/350}$.

2.7.2 Radionuclides

Animal toxicity data such as no observed adverse effects levels (NOAELs) for radionuclides are largely unavailable, therefore an alternative method must be employed. Levels of radionuclides in soil called screening action levels (SALs) have been estimated for use as standards protective of humans. The SALs for radionuclides are estimated using the RESRAD code for radionuclide exposure to humans from elements of the food chain and non-food chain deposition processes (LANL 1993). The application of human standards to animals is conservative as discussed in section 2.7.5.2.

The HQ method applying human SALs to animals is similar to the HQ method involving ingested doses:

$$HQ = SC / SAL, \qquad (4)$$

where

HQ = hazard quotient,
SC = soil concentration of radioactive COPEC, pCi-COPEC/kg-soil, and
SAL = screening action level, pCi-COPEC/kg-soil.

This study uses the above relationship for estimating radionuclide HQs. They are then added to HQs developed from dose information for nonradionuclides. As with the nonradionuclides, two cases of foraging were considered for the radionuclides—unweighted foraging and weighted foraging.

2.7.3 Fraction of Food Intake as Soil, F_s

The fraction of food intake as soil, F_s, is currently an issue under consideration at LANL. The amount of soil consumed by wildlife animals during feeding varies considerably depending on feeding strategy and type of food consumed (Beyer et al. 1994). According to Ferenbaugh et al. (1996), EPA guidance is that, for screening purposes, this parameter should be 50%, given that soil ingestion can range from less than 2% in some small birds and small mammals to approximately 100% in earthworms. LANL guidance is that the screening approach to this parameter may be examined to determine if the use of less conservative assumptions is justified in order to better reflect specific site and/or receptor conditions (Ferenbaugh et al. 1996). Studies on cattle, sheep, and swine have shown that soil was the main source of exposure to environmental contaminants that included lead, PCBs, PBBs [polybrominated biphenyls], hexachlorobenzene, and DDT (Fries 1982, Russel et al. 1985, Fries and Jacobs 1986, Fries and Marrow 1982, Fries et al. 1982). Because soil-ingestion rates of some wildlife species are estimated to be at least as great as those for domestic species, soil ingestion is an important route of exposure to environmental contaminants for wildlife (Beyer et al. 1994). Wildlife may ingest amounts of soil while feeding that are substantial enough to constitute the main source of exposure to environmental contaminants. To begin to verify the extent to which this may be true, Beyer et al. (1994) conducted laboratory and field studies to estimate F_s in 28 herbivore or carnivore avian, mammal, and reptile species. Although the range in mean F_s for the avian species was <2–30%, all of the avian species evaluated either consume soil organisms as a dominant source of food or deliberately consume sediment for proper functioning of the gizzard, activities which would cause relatively high F_s values. Since the peregrine does neither, the range in F_s published in the Beyer study is not directly applicable. Perhaps an indirect application of the Beyer study is the F_s value of 9.3% for the wild turkey. If one assumes that

- the mourning dove, as one of the peregrines major foods locally (Foxx and Tierney 1982), constitutes 50% of the peregrines diet,
- the estimated F_s for dove, considering its similarity in diet to the wild turkey, is 9.3% as based on Beyer et al. (1984), and
- digestibility for the peregrine is 40%,

then the F_s for the peregrine from the dove portion of its diet is estimated at 1.86%. For the additional 50% of the peregrine's diet, consider a few of the other birds (blackbirds, jays, shorebirds, and small song birds) that would serve as food to the peregrine. Only shorebirds would possibly have an F_s value close to the dove because the dove consumes soil for the normal functioning of its gizzard (Orr 1982, Korschgen 1980, Pettengill 1985). On these bases, a total F_s of 3.0% is considered adequately conservative for the peregrine. Additional support of this value is as follows. A previous study (Gallegos et al. 1997) estimated 2.8–3.0% as an accurate F_s value for a species (Mexican spotted owl) that consumes predominantly rodents (including pelts) that have direct contact with soil on a daily basis. Beyond the two high-F_s species accounted for above, peregrine prey do not have as much direct contact of soil as that of Mexican spotted owl prey. Peregrines often part-pluck their prey before eating them therefore there could be some ingestion of soil from feathers; however, since they don't consume the feathers like the owl consumes pelts, this source to the peregrine would be small in comparison to the owl. Thus, an F_s of 3.0% for the peregrine is adequately conservative.

2.7.4 Bioaccumulation and Biomagnification

A few cases in history have implied that the higher the trophic level of an organism on a food chain, the greater is its susceptibility for biomagnification (Leidy 1980). In this scenario, carnivores such as the American peregrine falcon could be more subject to biomagnification than herbivores. However biomagnification is more apparent in aquatic systems than terrestrial and recent studies question the validity of biomagnification in terrestrial systems (Laskowski 1991). While biomagnification of the chlorinated hydrocarbons (organochlorines) is fairly well proven (Walker 1990), the concentration of heavy metals in animals is not necessarily a property of food chains (Laskowski 1991). Heavy metal biomagnification has been implicated mostly in mammals (Shore and Douben 1994, Hegstrom and West 1989, Ma 1987). Conclusions to the contrary are that

- heavy metal biomagnification is not a rule in terrestrial food chains (Laskowski 1991, Beyer et al. 1985, Grodzinska et al. 1987, Willamo and Nuorteva 1987, Nuorteva 1988),
- "biomagnification alone cannot lead to very high concentrations of most heavy metals in top carnivores" (Laskowski 1991), and
- "biomagnification cannot be responsible for toxic effects of heavy metals in terrestrial carnivores" (Laskowski 1991).

Nevertheless,

- biomagnification of heavy metals to toxic levels can occur from relatively low concentrations in soil (Ma 1987);
- even if a chemical or its metabolites have high NOAELs in long-term ecotoxicity or toxicity tests, incomplete metabolic elimination of contaminants, also known as bound residues, can result in unacceptable risk from bioaccumulation or biomagnification (Franke et al. 1994),

Therefore, scenarios including bioaccumulation and biomagnification phenomena were assessed. A scenario including "unweighted" foraging in an "unscaled" HR was assessed in which the contaminant pathways included soil ingestion and food consumption as contaminant sources. The unweighted/unscaled scenario was chosen for application of BAFs and BMFs because it generated the most conservative estimate of risk.

BAFs for aldrin, dieldrin, endrin, DDT and DDE were 5.35, 5.35, 7.9, 2.62 and 2.62, respectively, taken from Calabrese and Baldwin (1993) for the American kestrel (*Falco sparverius*) in a terrestrial food web. For the same respective COPECs and species in a terrestrial food web, BMFs were 43.0, 43.0, 42.0, 253.0 and 80.4. On average, these terrestrial-based BMFs were 0.301% of the BMFs for aquatic systems published as human health value criteria under the Clean Water Act (EPA 1993a). This fraction was used to adjust mean aquatic BMFs for 10 additional COPECs for use on terrestrial systems in this study. The source of the aquatic BMFs for the 10 additional COPECs was Smith et al. (1988). The terrestrial-adjusted BMFs by COPEC, used in this study were anthracene, 2.75; all aroclors, 93.91; benzo(a)pyrene, 4.55; chlordane, 42.44; 1,4-dichlorobenzene, 0.17; lindane, 0.82; mercury, 16.56; phenanthrene, 0.013; pyrene, 58.68; and thallium, 0.36. BMFs also were calculated for radioactive isotopes of Am, Cs, Pu, and Sr, but were not applied because the estimate of risk from radionuclides is already overestimated by a factor of 185 or 3650 per the discussion in section 2.7.6.2. BAFs and BMFs for additional COPECs will continue to be incorporated into the risk estimate.

2.7.5 Nest Site Selection and Simulated Falcon Foraging

Upon randomly selecting a potential nest site within the defined nesting habitat of an EEU, the model ECORSK4 (described later in this report) developed a HR of 7.76 km^2 for the American peregrine falcon and calculated a HQ for each COPEC within each 100- by 100-ft grid cell of the foraging area. (The obvious assumption is that a prey species captured in the air is associated with the grid cell, and any contamination, directly below the location of its capture). The model repeated this process 99 times, thus there was a total of 100 simulations. Contaminated grid cells "selected" during one simulation were "replaced" for possible selection during a subsequent simulation.

By assuming that the falcon forages in noncontaminated as well as contaminated grid cells, our risk estimate lessens a source of error that Tiebout and Brugger (1995) conclude leads to overestimation of risk; i.e., the error associated with the implicit assumption normally made in the Quotient Method that birds remain in a contaminated zone. This also satisfies EPA guidance that "for many terrestrial animals, adjustments of exposure estimates may be needed to account for the possibility that all food obtained by a given animal may not be from the affected area" (EPA 1989). This is especially true for wide ranging animals such as the American peregrine falcon.

2.7.6 Toxicity Reference Values

2.7.6.1 Nonradionuclides

The TRVs chosen to use in quantifying risk from organic and metal COPECs were the chronic NOAELs in units of mg COPEC per kg body wt of the falcon per day. The NOAELs and related information used are listed in Table A-3 in the appendix. In order of descending use, the manner in which NOAELs were compiled was

1) obtained directly from the scientific literature or from published data bases,
2) computed from chronic intake doses, and
3) computed from LD_{50s}.

Table A-3 identifies (1) the NOAELs used in this assessment; (2) references from which the NOAELs were taken or derived, (3) test species on which they are based; (4) the chemical form on which the NOAEL is based; (5) the toxicological test endpoint; and (6) comparison or alternative NOAELs or TRVs which could have been used. The NOAELs for the metal COPECs are based on avian test species. The NOAELs for the organic COPECs are based on laboratory rats. NOAELs can have a substantial impact on risk estimates, therefore it is important to use NOAELs that are based on toxicity testing of species that are as close phylogenetically to the assessed species as possible. EPA data bases largely contain NOAELs that are based on testing laboratory rats. Examples of the impact that NOAELs can have on risk estimates are provided in the discussion section. The replacement of rat-based NOAELs with NOAELs based on birds is a continuous process in this study and this report is updated periodically as additional NOAELs and other information become available.

In human risk assessments, reference doses (RfDs) are typically adjusted (lowered) by a factor of 10 to account for the uncertainty of extrapolating RfDs within and between species. Because of a broader range of uncertainty in ecological risk, an uncertainty factor (UF) of 10 may be inadequate in ecological risk assessment (Calabrese and Baldwin 1993). Attempts to calculate extrapolations of TRVs have been made by some researchers, however, the bases vary from one researcher to another. For example, Sample et al. (1995) assumed that "smaller animals have higher metabolic rates and are usually more resistant to toxic chemicals because of more rapid rates of detoxification and that metabolism is proportional to body weight." Conversely, in a study of risk to vertebrates from pesticides, Tiebout and Brugger (1995) predicted that small-bodied insectivores faced the highest risk.

Other possible sources of uncertainty that are not necessarily exclusive of each other include

- extrapolation of acute dose derived NOAELs to chronic responses,
- lowest observed adverse effect level (LOAEL) to NOAEL conversions,
- extrapolation of sensitive-test-species data to nonsensitive or "normal" life stages,
- extrapolation of less-than-life-span toxicological data to life span,
- time to achievement of contaminant steady-state in laboratory tests on which NOAELs are based, and
- laboratory to field extrapolation (Calabrese and Baldwin 1993).

Some of the above-listed factors have the potential to increase or decrease (under- or overestimate) toxicological values. Also, several instances of interdependence of UFs exist, therefore the assumption that these factors are independent in their application as UFs would likely lead to over-conservatism (Calabrese and Baldwin 1993). For these reasons, the authors believe that the collective amount of uncertainty originating from different sources is great enough and/or variable enough such that adjustment for such uncertainty would make the results unusable because of large total margins of introduced error.

2.7.6.2 Radionuclides

Because TRVs for radionuclides in avian species were unavailable, human risk SALs, in mg of radionuclide per kg of soil were used in place of TRVs. A list of SALs used appears in Table A-3.

An International Atomic Energy Agency (IAEA) proposed standard for the protection of animal populations from the effects of radiation is 100 mrads/d (IAEA 1992). Ecological risk assessment at LANL sometimes does not address risk from radiation because of guidance by the IAEA which says that if humans are adequately protected from the effects of radiation, then other organism populations are likely to be sufficiently protected (IAEA 1992). Under this assumption, if the results of human risk assessment(s) of the same contaminated areas as assessed for the American peregrine falcon indicated that humans are adequately protected, the conclusion would be that populations of other organisms are adequately protected. This could also be applied to individuals in a population because the inference is based on the fact that the 100 mrem/year exposure dose limit for protection of humans includes a level of safety which is thought to provide adequate safety to individuals in the population. Providing radiation protection for humans tends to center around individual protection, while providing protection for plant and animal biota is mostly population centered. The recommended dose rate of 100 mrads/day for protecting animals converts to 100 mrems/day if the effects on animals were assumed to be similar to that on humans and if the quality factor of the radiation equals 1.0. This is about 365 times less protective than the human standard. The human protection standard assumed by RESRAD in deriving SALs is 10 mrem/year, so that a protection factor of 3650 times is actually being applied to the TES of concern or, assuming a quality factor of 20, about 185 times more protective. Since the RESRAD code employed in making human SAL estimates includes all the major pathways of exposure, it is reasonable to assume that individuals of the animal population in question are given adequate protection using human dose criteria. Additionally, comparison with other models, sensitivity analyses, and verification analyses have demonstrated that the model which is used to calculate SALs is conservative (Wolbarst et al. 1996).

However, the theory has never been formally defended, "sufficient protection" has never been quantified nor the assumption proven and sensitivity to chronic radiation varies markedly among different taxa (IAEA 1992). For these reasons, TES are being assessed for potential impact from radionuclides.

2.8 Risk Sources and Hazard Value Types

The option exists in ECORSK4 to generate HQs and HIs for three "Hazard Value Types" and three "Risk Sources" as follows:

Hazard Value Type

- HI (Hazard Index) - A sum of the HQs for all COPECs and all grid cells in a foraging area (or HR) averaged across the number of "simulations".
- Mean Partial HQ × Location (Grid Cell) - A sum of the HQs for all COPECs separated by location.
- Mean Partial HQ × Location (Grid Cell) × COPEC. A sum of the HQs separated by location (grid cell) and COPEC.

Risk Sources

- Unadjusted Risk - Quantified impact associated with sampling within the LANL boundaries. Sources of HQ values include (i) HQs associated with contaminated grid cells, making no adjustment for background soil concentrations; and (ii) for grid cells where sampled COPEC soil concentrations are less than background values, then the soil background value is entered for calculation of HQs.
- Background Risk - Quantified impact associated with "natural" (nonradionuclides) and "regional" (radionuclides) mean concentrations of COPECs. The mean natural or regional background soil concentration is entered into the HQ formula for grid cells within a HR for which COPECs existed in the Unadjusted Risk data set. Since for Unadjusted Risk, soil background values may be included only for grid cells that

were sampled, the same practice for determining Background Risk makes it comparable to Unadjusted Risk. Clifford et al. (1995) have shown that assignment of background levels in Quotient Method risk estimation can be inconsequential in terms of final results.

- Contaminated Nest Site - Represents the unadjusted risk resulting from "situating" potential nest sites on contaminated grid cells within the "nesting" zone. Although this was intended to be a worst case of sorts, but not the absolute worst case, a previous study (Gallegos et al. 1997) showed no appreciable difference between Unadjusted Risk and Contaminated Nest Site risk.

The most useful Hazard Value Type for conveying total risk is the Hazard Index (HI). For each of 100 randomly selected potential nest sites of the American peregrine falcon and thus 100 simulations, an HQ was calculated for a 7.76-km^2 HR, or foraging area, for each COPEC at each grid cell. The HI (or Mean Total HQ) sums the HQs for all COPECs and all grid cells in a HR and is an average of the 100 sets of data (simulations). Because the HI is the sum of the HQs for all COPECs, it serves as an index of cumulative effects from multiple contaminants and is the most conservative (bias, if any, toward overestimation of risk) of the three Hazard Value Types.

2.9 Model

Some of the approach and methodology discussed earlier is presented again in this section to illustrate the method by which ECORSK4 develops the basic building blocks of the risk assessment.

2.9.1. Computer Code Software Development for Ecorisk Determination

A set of computer codes with graphics capabilities, written in FORTRAN 77 (Salford Software Limited 1994), was developed to perform risk assessments of federally listed TES for the HMP. The executable code, ECORSK4, integrates spatial data (EEU, nesting habitat, HR) with toxicological substances locations and concentrations within a given EEU to estimate risk to a specific animal. The source code, ECORSK4.for, is attached in appendix Table A-2. Figure 2 illustrates how the codes were integrated to

1. utilize the data in a given EEU to perform the risk assessment of the peregrine,
2. transform GIS-FIMAD into three-dimensional graphics, and
3. produce visual and statistical representations of these estimates.

The ECORSK4 code estimates partial and total HQs and HIs, respectively, from GIS-located contaminants. Potential nesting sites are also located by GIS mapping, and it is from these focal points that HQs and HIs are estimated using a number of files briefly defined below:

- gis.dat(d) – verification copy of eeuinp.dat input data
- outrsk.dat(o,d) – a summary output file of input parameters and statistical output including the HI averaged for the number of nest sites (simulations) selected and the partial HQ by COPEC averaged for the number of nest sites selected
- entrsk.dat(p) – copy of entered data from inrsk.dat and from mapcde.dat
- inrsk.dat(i) – contains parameter statements on grid and eeuinp.dat

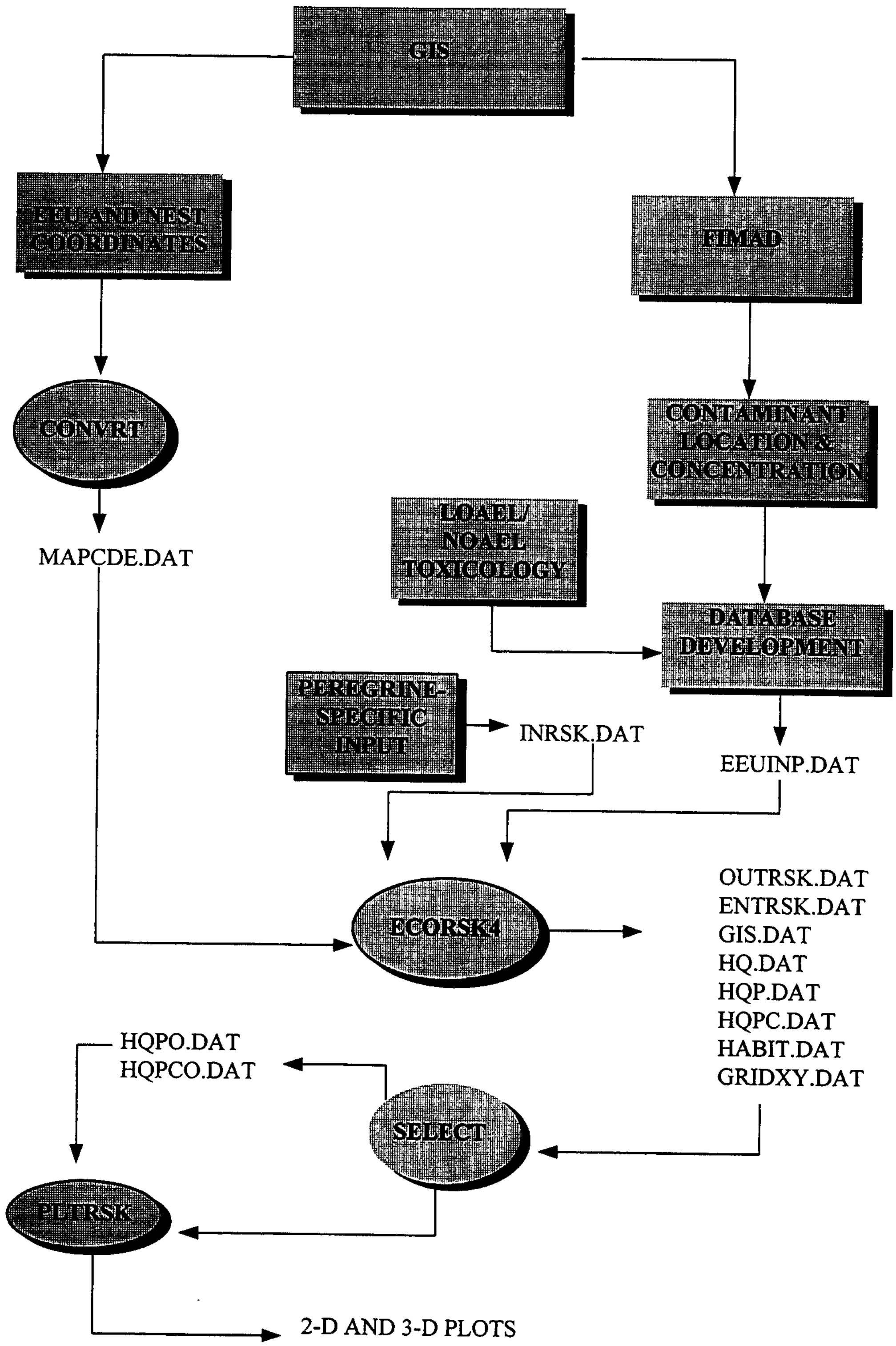

Figure 2. Schematic of strategy for integrating FORTRAN code with GIS and FIMAD data.

specifications, animal type, food habit, animal characteristics, Soilf, EEU, and HR dimensions and maximal EEU universal transverse mercator extents

- hqp.dat(o) – contains output of partial HQs for every grid in an HR for each potential nest site sum across COPECs
- eeuinp.dat(i) – contains 10 fields of integer data and 2 fields of noninteger data (number of analytes in the given grid cell, analyte average concentration, analyte background concentration, x-coordinate, y-coordinate, TRV, TRV adjustment factor, occupancy factor, grid cell area, BAF or BMF, grid cell identification code, and analyte name)
- mapcde.dat(i) – contains map code value, identification code, and x- and y-coordinate for each grid cell
- hqpc.dat(o) – partial HQs for every grid in an HR for each potential nest site summed across COPECs
- hq.dat(o) – HIs (cumulative HQs) by nest site number and nest site location
- habit.dat(o) – stores specific nest site information
- gridxy.dat(o) – contains x- and y-coordinates by grid cell

All files above are used for input(i), output(o), diagnostics(d) on input data, and to preserve created files(p) for future use.

2.9.1.1 Cumulative HQ Estimation Method using ECORSK4

COPEC ingestion must be integrated from HR and potential nest site considerations. The method of cumulative HQ quantification is presented again in this section to illustrate how ECORSK4 develops the basic building blocks of the risk estimate. The model ECORSK4 integrates GIS information with basic toxicological information on a number of COPECs with basic physiological data to estimate HIs (cumulative HQs) for multiple COPECs in the EEU of a specific animal such as the American peregrine falcon:

for nonradionuclides

$$HI = Food \times (Soilf + BAF \text{ or } BMF)/Bodwt \times \sum_{j=1}^{ncs} Occup_j \sum_{l=1}^{ncoc} Dc_{j,l}/(Dr_l \times Dar_l), \quad (5a)$$

or,

for radionuclides

$$HI = \sum_{j=1}^{ncs} Occup_j \sum_{l=1}^{ncoc} SC_{j,l}/(SAL_l \times SALa_l), \quad (5b)$$

where

HI	=	cumulative HQ for all COPECs,
Food	=	amount of food consumed by a given animal, kg/day,
Soilf	=	fraction of food ingestion consumed as soil,
BAF	=	bioaccumulation factor (for aldrin, dieldrin, endrin, DDT and DDE)
BMF	=	biomagnification factor (for 15 (COPECs)
$Occup_j$	=	occupancy factor on the jth contamination site,
$Dc_{j,l}$	=	chronically consumed dose, mg-COPEC/kg-body weight-day for the jth contamination site (exposure dose) of the lth COPEC
Dr_l	=	consumed dose above which observable adverse effects may occur, mg-COPEC/kg-body weight-day of the lth COPEC,
Dar_l	=	adjustment factor for Dr_l above for the lth COPEC,

$SC_{j,l}$ = soil concentration of COPEC, pCi-COPEC/kg-soil for the jth contamination site of the lth COPEC,

SAL_l = screening action level, pCi-COPEC/kg-soil of the lth COPEC,

$SALa_l$ = adjustment factor for SAL_l above for the lth COPEC,

ncs = number of contamination sites,

and

ncoc = number of contaminants in the jth contamination site.

This approach assumes that sublethal doses of various contaminants are additive in their effect, rather than synergistic, antagonistic, or independent.

The following subsections will present a discussion of those elements in the above relationships which have not received adequate attention to clarify the model's use of the equations.

2.9.1.2 Daily Food Consumption (Food)

Daily food consumption of a given animal is estimated in ECORSK4 using the following relationships (EPA 1993b):

$$\text{Food} = 0.0687 \times \text{BODWT}^{0.886} \text{ mammals,} \quad (6a)$$

$$\text{Food} = 582 \times \text{BODWT}^{0.651} \text{ birds,} \quad (6b)$$

$$\text{Food} = 0.0135 \times (\text{BODWT*1000})^{0.773} \text{ reptiles and amphibians,} \quad (6c)$$

where;

Food = food consumption rate, kg/day, of dry matter and

BODWT= body weight of animal, kgfwt.

It should be noted that these equations represent relationships that can be applied to the general types of animals specified above, however, more specific relationships for special subtypes are also available if greater accuracy is required.

2.9.1.3 Soil Intake Fraction (Soilf) and Body Weight (BODWT)

A detailed discussion on the selection of Soilf (or F_s) was presented in Section 2.7.3 of this report. A body weight of 0.952 kgfwt was assumed for both male and female American peregrine falcon, although some variation occurs between and within sexes.

2.9.1.4 Occupancy Factor (Occup)

Occupancy factors are defined in this study as the fraction of the time in a given day that an animal spends feeding in a given area. Occupancy is assumed to be time averaged over a long period to obtain a probabilistic relationship. This factor can be determined on an areal basis if it is assumed that any given area within an animal's habitat is equally likely to serve as a feeding location for a given animal over the long term. However, many factors could restrict or enhance a given area to support feeding activities depending on the distribution of food in the EEU, the relative accessibility of feeding areas, and feeding patterns/habits of the predator. Two different cases were considered regarding the occupancy factor used for this study involving the American peregrine falcon:

(1) all grid areas are equally accessible if they are within the HR of the animal:

$$\text{Occup}_i = A_i / \sum_{j=1}^{ng} A_j \, Ef_j \, , \quad (7)$$

where

Occup_i = occupancy factor of the ith grid,

A_i = area, km^2, of the ith grid within the HR of a given animal,

A_j = area, km^2, of the jth grid within the HR of a given animal,

Ef_j = enhancement factor of the jth grid within the HR of a given animal, and

ng = number of grid cell sites within the HR of a given animal.

(2) occupancy is weighted based on the distance from a potential nest site following the form

$e^{-r/350}$ (scaled from Johnson 1986), (8)

where r is the distance of a grid cell from the potential nest. This results in 74% of the foraging within about 256 km^2 and 91% within 576 km^2 (Johnson 1986).

Since the occupancy factor is part of the ECORSK4 input, the user is able to modify this relationship to reflect increased or decreased feeding in a specific grid area. The location of the potential nesting site within an EEU determines which contaminated and noncontaminated grid cells are included in the summation portion of Eq. 7. The selection process is discussed in the following subsection.

2.9.2 ECORSK4 Model Operation Strategies

Model operation follows an ordered procedure that can be summarized as follows:

- Create output files and enter input parameters;
- From input parameters
  - create grid system,
  - define EEU on grid system,
  - define potential nesting habitat on grid system,
  - locate COPECs on EEU,
  - define the HR from animal allometric data, and
  - define food intake rate from animal allometric data.
- Establish potential nesting sites in nesting habitat on
  - contaminated grids within the nesting habitat,
  - random nest sites within the nesting habitat, or
  - selected or known nesting sites within the nesting habitat.
- Establish grid cells to be included within the HR from a given potential nest site.
- Determine contaminated grid cells within the HR from a given nest site.
- Estimate HI from all contaminated grid cells in HR from a given nest site for a given COPEC.
- Repeat for each COPEC.
- Repeat for another potential nest site.
- Output partial and total HQ estimates.
- Plot 3-d graphics of partial and total HQ estimates.

2.9.2.1 Nest Site Establishment

ECORSK4 has the option of selecting potential nest sites within the nesting habitat on the basis of:

- randomness,
- automated placement on "contaminated" grid cells (that are within the nesting habitat),
- user-specific locations, or
- any combination of the above three.

2.9.2.2 Model Selection of Foraging Area (Home Range)

In this study it was assumed that the American peregrine falcon would not have nesting sites outside of the nesting habitats, but could forage in both the nesting and adjoining EEU-designated areas. After establishment of a given nest site to be used in the HQ determination, the model uses the HR estimate to determine specific grid cells within the EEU that are included around the specific nest site.

This is accomplished by systematically increasing the coordinates around a potential nest site in inscribed squares within increasing concentric circles formed around the nest site that results in a "square doughnut" appearance, and increasing square doughnut holes in the middle. This iterative process is repeated until the sum of the enclosed grid cells equals the HR of the animal in question. The selected grid cells must be within the EEU of the animal in question, or they are ejected. Consequently, the final pattern of the selected grid cells may deviate from a perfect square around the potential nest site. This routine is repeated for each potential nest site selected in the model.

2.9.2.3 HR Dimension Scaling and Slope

To account for variation in the shape of the peregrine HR resulting from hunting pattern influence such as prey location, an option was programmed into the ECORSK4 that enables the user to select a square HR or a rectangular HR with a variable width to height (X/Y) ratio. For example, with the selection of an X/Y ratio of 4, ECORSK4 would scale the HR dimensions so that its width was four times wider than its height. A rectangle with this particular scaling would generally follow the shape and X/Y ratio of the two nesting habitats in EEU-74 (Figure 3).

The user also has the option of sloping the HR. This may be useful in cases such as when hunting patterns form an HR that was shaped proportionally to an angled canyon.

The HR shaping and sloping attributes of ECORSK4 are new capabilities that were unavailable in a previously reported study on the Mexican spotted owl (Gallegos et al. 1997).

2.9.2.4 Identification of Contaminated Grid Cells in the HR for a Given Nest Site

The model searches each grid cell within a HR around a nest site for COPECs to be included in HQ calculations. The obvious assumption is that a prey species captured in the air is associated with the grid cell—and any contamination—directly below the location of its capture. In addition, it searches the perimeter of the HR and includes contaminated grid cells within one grid cell length in the HQ calculations for a given nest site. This strategy is followed because all contaminated grid cells are assigned the next highest cell numbers on both grid axes. For example, if the grid coordinates of a given contaminated grid are estimated as 15.5 and 120.2, for x- and y-axes, respectively, they are coded as 16 and 121 for use in the model. The model also addresses contamination areas which may exceed the area of a grid cell. If the latter is made to occupy more than one grid area, then the overlap from the perimeter of the HR can exceed the length of a grid cell.

2.9.2.5 HQ Estimation Procedure

The model tests each contaminated grid cell within the HR of an animal at a given potential nest site for completeness of information required for executing Eqs. 5a

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Figure 3. EEU-74, HR examples, and location of sampled grid cells.

and 5b. This is necessary because the data base obtained through FIMAD may not have information for all COPECs it identifies within the EEU of a given animal such as the American peregrine falcon. Hence, all concentration values that are reported as being less than zero are set to zero. Furthermore, if the reported contaminant concentration is below mean background (organic contaminants excluded), then the sample concentrations are made equal to the reported background levels. Similarly, if the toxicity reference value (Dr) described in Eq. 5a was not included or reported as zero, then the corresponding COPEC is excluded from the HQ calculations. The same criteria applies to SAL data reporting (Eq. 5b). Hence, the number of COPECs for which an HQ is estimated may vary from one grid cell to another. The data base containing this information (eeuinp.dat) should be updated, and HQ estimates should be recalculated periodically.

2.9.3 Model Output

The reporting of results in this section from the output of ECORSK4 will be limited to examples of 3-d graphical output. A more complete set of results from other analytical output is discussed in the results and discussion sections of this report. The presentation given here is only a small portion of the potential output for this model, but should suffice in illustrating 3-d output capabilities. Plotting options are summarized below.

2.9.3.1 Three-Dimensional Graphics

The ECORSK4 model outputs (hqp.dat) partial HQs contributed by all contaminated grid cells within the HR surrounding each potential nest site. Using the SELECT code (hqpo.dat), the user can select a specific nest site and view the partial HQs by COPEC from each contaminated grid within the HR of a given animal's nest. ECORSK4 sums HQs for all COPECs to generate HIs by nest site and places this summary data in hq.dat. All 3-d plots are generated from the code PLTRSK as indicated in the Figure 2 schematic. The model also outputs total HQs by COPEC for 3-d graphics presentation (hqpc.dat) which can then be used as input to SELECT to produce an output (hqpco.dat) which is then used as input to PLTRSK to create the desired plots.

For example, the files obtained from ECORSK4 output can be processed to produce graphics via overlays onto the EEU mapping — the three dimensional (3-d) plot of EEU-74 and its nesting habitat shown in Figure 4 was produced from the gridxy.dat output file from the EEU-74 run of ECORSK4. Specific nesting site information is stored in the output file habit.dat. The user of the model also has the option of entering the variables such as the HR directly into the code.

The executable versions of the codes are MS-DOS PC versions which are transportable to other PCs (for PC users without Salford/Interacter software) by appropriate Run DBOS software that is provided by Salford for this purpose. Satisfactory transport and use of these codes, in particular ECORSK4, has been demonstrated at LANL's Ecology Group (ESH-20).

2.10 Statistical Analyses

2.10.1 Simple Distribution

Model output data were imported to spreadsheet format and COPECs and contaminated grid cell locations were sorted by HQ in descending order. This enabled the

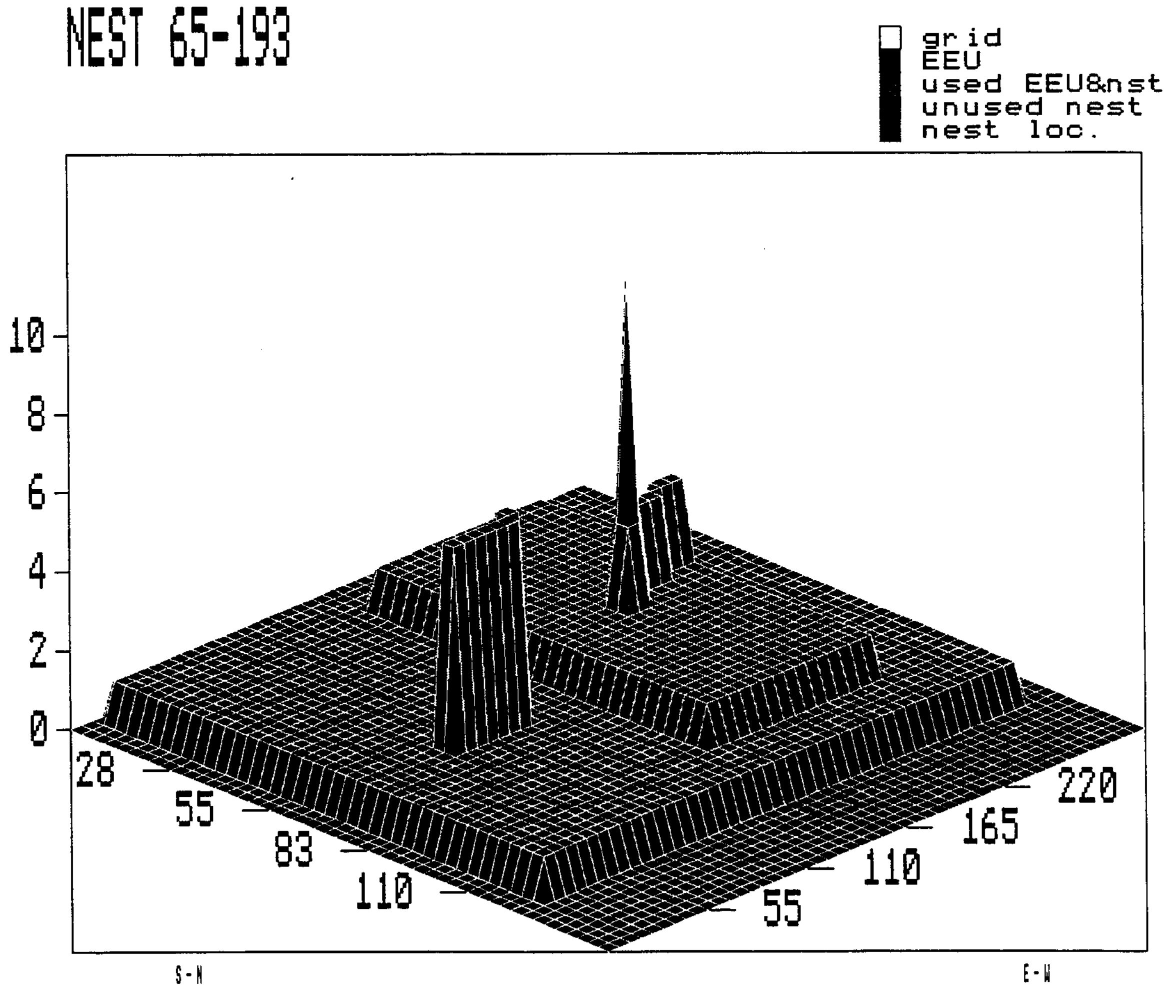

Figure 4. Demonstrated three-dimensional plots of EEU-74 and potential nesting habitat of the American peregrine falcon.

identification of the most problematic COPECs and locations on a relative basis. HI distributions were listed in table format and arithmetic means were computed by Risk Source and Hazard Value Type as defined in Section 2.8.

2.10.2 Hypothesis Testing

In comparison to issues regarding the parameters used to quantify risk and the values derived or chosen to represent those parameters, statistical analyses of differences in Risk Source means is relatively unimportant.

It is important not to use "natural" background levels of COPECs to screen contaminants from further consideration. Because COPECs can exert their effect on a threshold basis even in small amounts, statistics are not presented in this report for testing hypotheses of Risk Source parameter or distribution differences.

For those interested in separating risk associated with different sources, statistical analyses should be performed. The key question likely to confront those who perform this type of analysis would be whether to apply *parametric* or *nonparametric* statistics. For example, if one considers the data on concentration of COPECs in soil, the collection of sampling data is not a complete population in the truest sense because it does not consist of this type of information for each and every grid cell in the EEUs. The data, however, represent the complete population of "known" values sampled for each EEU and entered into FIMAD at some point in time. Finally, the assumption that the distributions of data underlying the risk source estimates made in this study are normal would not be unlike assumptions of independence and randomness made in similar studies accepted by refereed peer review (Clifford et al. 1995).

3.0 Results

3.1 Unadjusted Mean Hazard Index

Table 1 reports the average, maximum and minimum HI for 100 potential nest sites for (A) EEU-74 and (B) EEU-33; for scenarios including (1) unscaled HR (2) scaled HR; and (a) "weighted" and (b) "unweighted" foraging scenarios. As stated previously, the weighted foraging scenario is more realistic. The unweighted occupancy case is presented for comparison purposes in order to gain an understanding of how risk distributions and their variance are affected by improvements in model realism.

The Unadjusted HI for the soil ingestion contaminant pathway is 0.19 and 2.17E-02 for EEU-74 and -40, respectively (Table 1). The HI is a sum of the HQs for all COPECs, thus serving as an index of cumulative effects from multiple contaminants and multiple sites. Hazard indices less than 1.0 indicate that, under the assumptions and conditions applied, the sites pose no unacceptable risk to the American peregrine falcon. The HI measures additive or linear effects, making no measure of synergistic nor amelioristic effects.

Adding BAFs to the soil ingestion exposure pathway for aldrin, dieldrin, endrin, DDT, and DDE increased individual COPEC partial hazard quotients by a factor of 110, but increased the mean hazard index by only 0.02 units (from 0.019 to 0.21).

The HQs for the COPECs for which BMFs were included are shown in Table A-7 of the appendix. Adding BMFs for 15 COPECs to the food consumption pathway increased individual COPEC partial HQs by a factor of 1888 on average, and increased

Table 1. Mean hazard index (HI) by Risk Sources for (A) EEU-74 and (B) EEU-33, for cases in which the home range was (1) unscaled and (2) scaled in dimension based on the width to height ratio of the nesting habitat, and for cases in which (a) the foraging process was unweighted or (b) weighted based on distance from nesting site. Mean HI values are followed by the mean standard error. The number of observations for each value is 100. EEU-33 is for soil ingestion pathway only.

A. Ecological Exposure Unit - 74

	Mean Hazard Index (Cumulative Hazard Quotient)				
1. Home Range Unscaled*				**Max.**	**Min.**
	Soil Ingestion Pathway		**Food Consumption Pathway**		
a. Foraging Unweighted**		**w/BAFs**	**w/BMFs**		
Unadjusted Risk† **Background Risk‡**	0.19 (±0.15) 0.033 (±0.014)	0.21 (±0.15)	1.16 (± 1.0)	3.4	1.48E-02
b. Foraging Weighted***					
Unadjusted Risk	0.02 (±0.07)			0.43	1.49E-04
2. Home Range Scaled** 4:1**					
a. Foraging Unweighted					
Unadjusted Risk	0.09 (±0.09)			0.30	1.87E-02
b. Foraging Weighted					
Unadjusted Risk	2.83E-03 (±1.29E-03)			0.10	4.89E-05

B. Ecological Exposure Unit - 33

	Mean Hazard Index (Cumulative Hazard Quotient)		
1. Home Range Unscaled		**Max.**	**Min.**
a. Foraging Unweighted			
Unadjusted Risk **Background Risk**	8.10E-03 (±5.67E-03) 6.06E-03 (±4.2E-03)	1.33E-02	0.00
b. Foraging Weighted			
Unadjusted Risk	2.07E-03 (±4.20E-03)	1.31E-02	0.00
2. Home Range Scaled 4:1			
a. Foraging Unweighted			
Unadjusted Risk	2.17E-03 (±4.20E-03)	3.22E-02	0.00
b. Foraging Weighted			
Unadjusted Risk	2.48E-03 (±6.31E-03)	1.96E-02	0.00

*Unscaled – Refers to a home range with equal border dimensions; i.e., a circle or square.
**Unweighted – Refers to a foraging scheme in which foraging occurs equally throughout a HR.
***Weighted – Refers to a foraging scheme in which foraging is proportional to distance from a nest site; i.e., foraging decreases with distance from the nest site.
****Scaled – Refers to a home range (HR) with unequal border dimensions; i.e., an ellipse or rectangle.
†Unadjusted Risk – Quantified impact associated with sampling within the LANL boundaries.
‡Background risk – Quantified impact associated with "natural" (nonradionuclides) and "regional" (radionuclides) mean concentrations of COPECs exterior to LANL.

the mean HI to 1.16 (± 1.0), which is slightly above the level of acceptability. Aroclor-1254 accounted for 36% of the risk, DDT for 30%, and DDE for 15%. The BMF component was added shortly before finalization of this report, therefore a full presentation of the results was not made here, but will be made in a subsequent report.

3.2 Hazard Index Distribution—EEU-74, Soil Ingestion Pathway, Unweighted Foraging, Unscaled HR

3.2.1 Internest and Intergrid Variation

Figure 5 is a 3-d plot of the HIs for each of 100 randomly selected nest sites and Figure 6 shows partial HQs that contributed to the HIs in Figure 5. The plotted values are listed in Table A-4, and Table A-5 lists the values (not plotted) for EEU-33. EEU-74 is relatively large and this is reflected in the observed variation in plot heights. This variation is caused by the inclusion of different grid cells from one HR to another. The origin of this variation between simulations is spatial changes in sampling results.

3.2.2 Spatial Distribution

Figure 7 is a map of the spatial distribution of Unadjusted HIs for each of 100 random potential nest sites of EEU-74. For the western-most nesting habitat, the potential nest sites with the highest relative risk are clustered generally in the eastern one-third of the habitat. The spatial distribution of HIs for EEU-33 was not mapped because the estimated risk for this area was low and of no consequence.

Figure 8 shows the spatial distribution of partial HQs for contaminated grid cells in EEU-74 for Nest Site #22. The plotted HQs represent the risk contributed ("source") by each contaminated grid cell to the total risk (HI) for potential nest #22 ("sink") of EEU-74 that is shown in Figure 7. Thirty-two percent of the risk is contributed by six grid cells out of a total of 471 in the HR (Table A-6).

3.2.3 Risk by COPEC

Tables A-7 and A-8 in the appendix present ranked HQs by COPEC totaled across contaminated sites (grid cells). These results also indicate that the sites pose no unacceptable risk to the American peregrine falcon. Pentachlorophenol, Cs-137, Al, Zn, Ni, and Pb are among the highest ranked COPECs common to the two EEUs. The COPEC with the highest HQ for either EEU, pentachlorophenol (Table A-7), is about an order of magnitude below the value necessary to present an unacceptable potential risk to the falcon. The partial HQs of pentachlorophenol are shown in Figure 9. Since radionuclides accounted for a substantial portion of the relative risk (Tables A-7 and A-8), it is important to recall from the discussion in Section 2.7.5.2 that risk from radionuclides has likely been overestimated because the radionuclide TRVs (SALs) used are more protective than comparative standards suggested by the IAEA.

3.2.4 Frequency Distribution

Figure 10 shows the frequency distribution of HIs for the 100 simulations of model nest location for EEU-74. The actual values for EEU-74 and -33 are listed in Tables A-4 and A-5, respectively, in the appendix. When each set of 100 values is averaged, the result is the unadjusted mean HIs of Table 1. Table A-4 (A) values are also plotted in 3-d view in Figure 5.

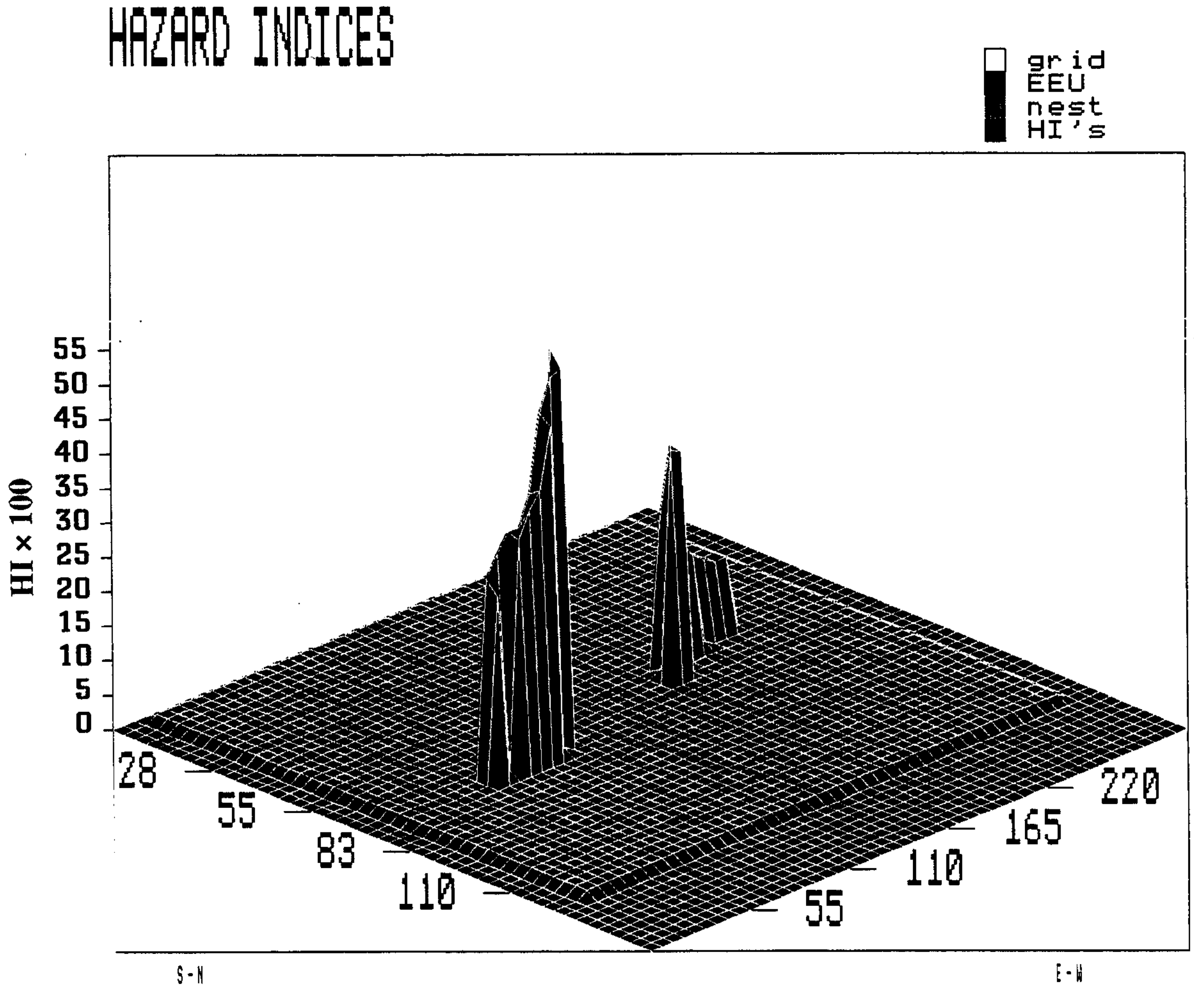

Figure 5. **Three-dimensional plot showing variation in unadjusted HIs for randomly selected potential nest sites of the American peregrine falcon in EEU-74 for the simulated scenario of unweighted foraging in an unscaled square HR.**

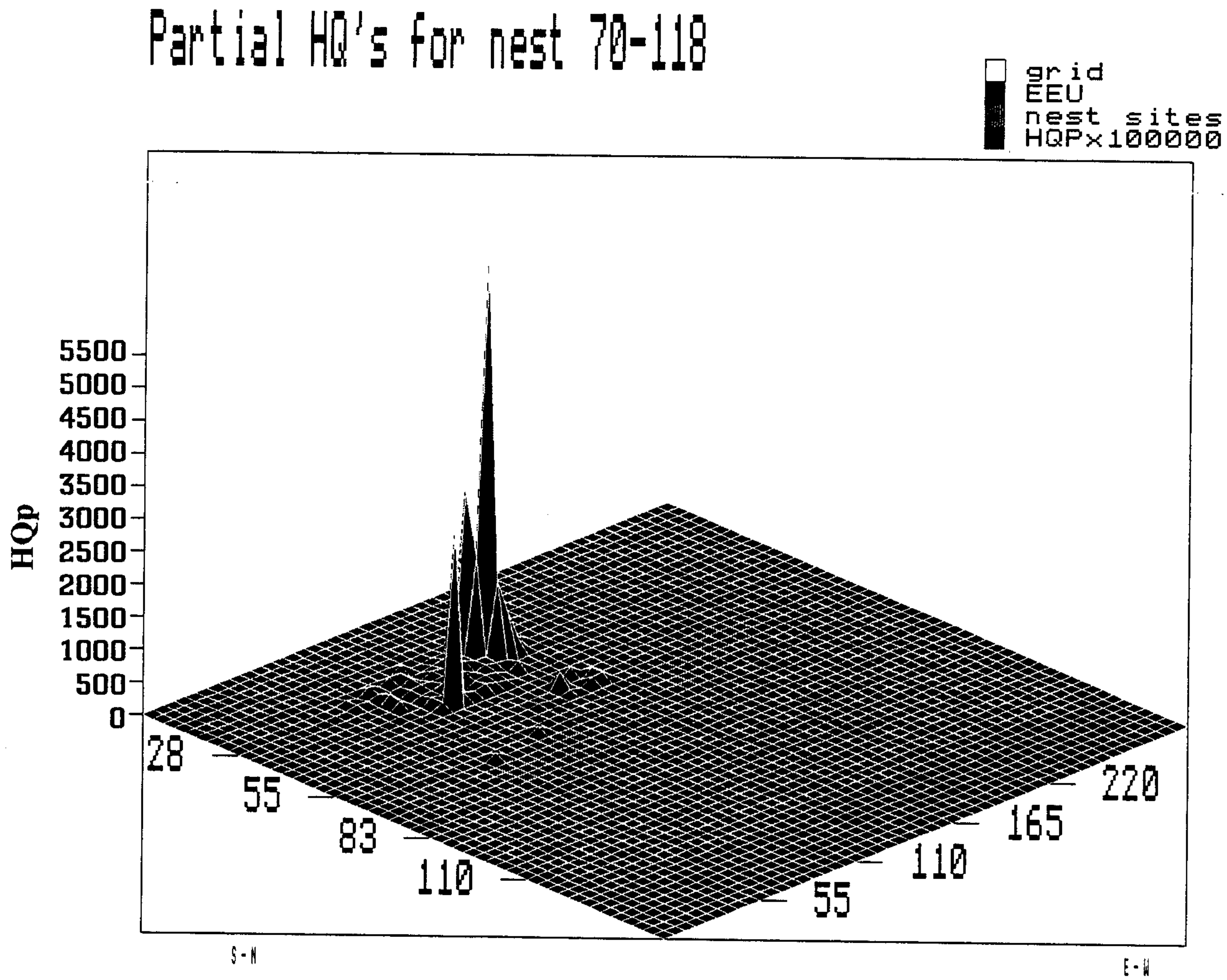

Figure 6. Three-dimensional plot showing variation in partial HQs for the 22nd (y- and x-coordinates are 70 and 118, respectively) of 100 random potential nest sites of the American peregrine falcon in EEU-74.

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Figure 7. Spatial distribution of unadjusted HIs for each of 100 random potential nest sites of the American peregrine falcon in EEU-74 in the simulated scenario of unweighted foraging in an unscaled square HR.

Disclosure Limit: This figure is on file at LANL's Ecology Group (ESH-20) and can be viewed on a need-to-know basis. It is copyrighted in voluntary adherence to Master Interagency Agreement (MIA) 16-R3-85-0019 between the U.S. Department of Agriculture Forest Service, Region 3, the U.S. Department of Interior Fish and Wildlife Service, Region 2, and the New Mexico Department of Game and Fish.

Figure 8. Spatial distribution of unadjusted partial HQs for the 22nd of 100 random potential nest sites of the American peregrine falcon in EEU-74. This figure identifies the "sources" of partial risk contributing to the total risk at potential nest site No. 22 (y- and x-coordinates are 70 and 118, respectively), which was shown in Figure 7.

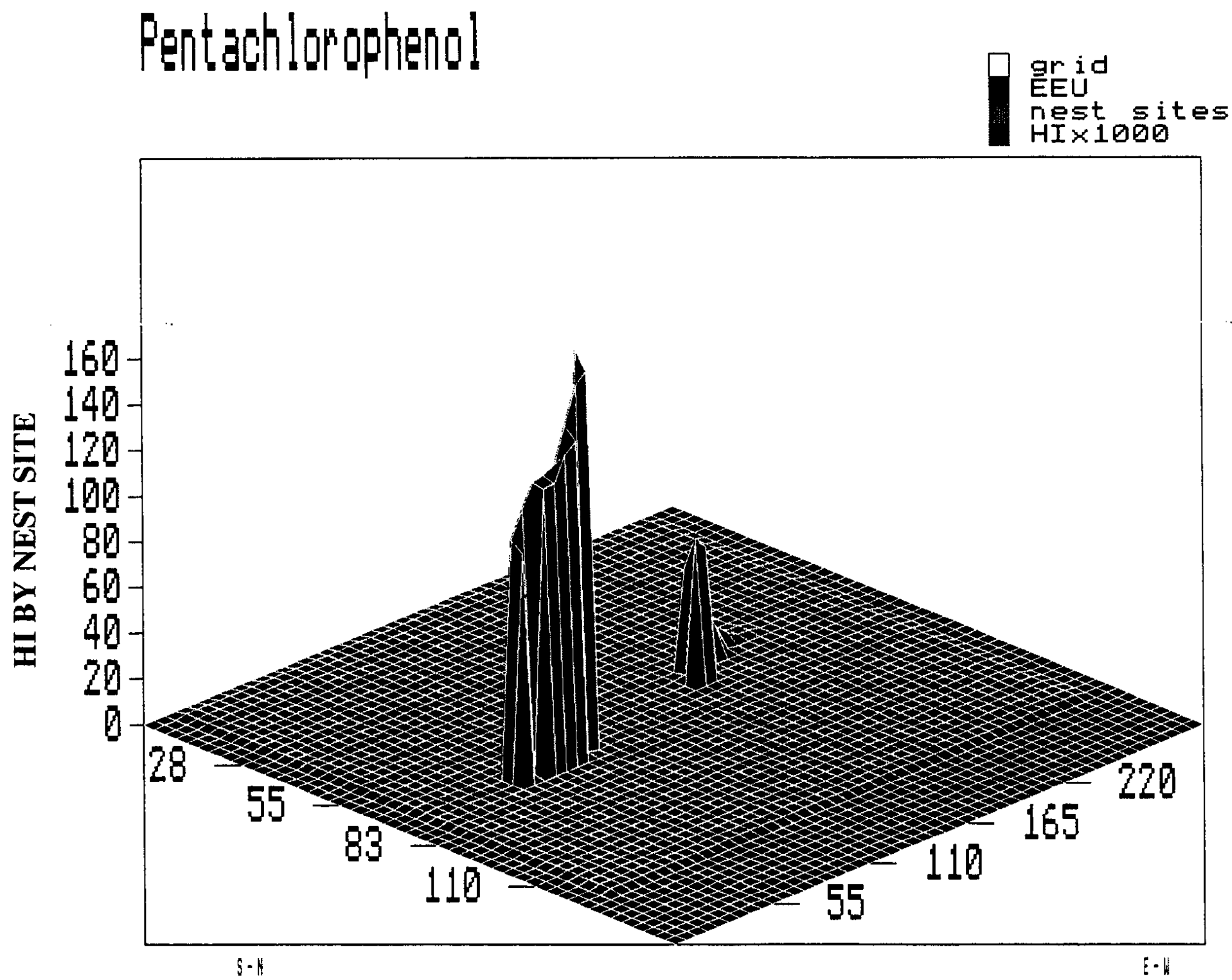

Figure 9. HQs for pentachlorophenol at random potential nest sites of EEU-74.

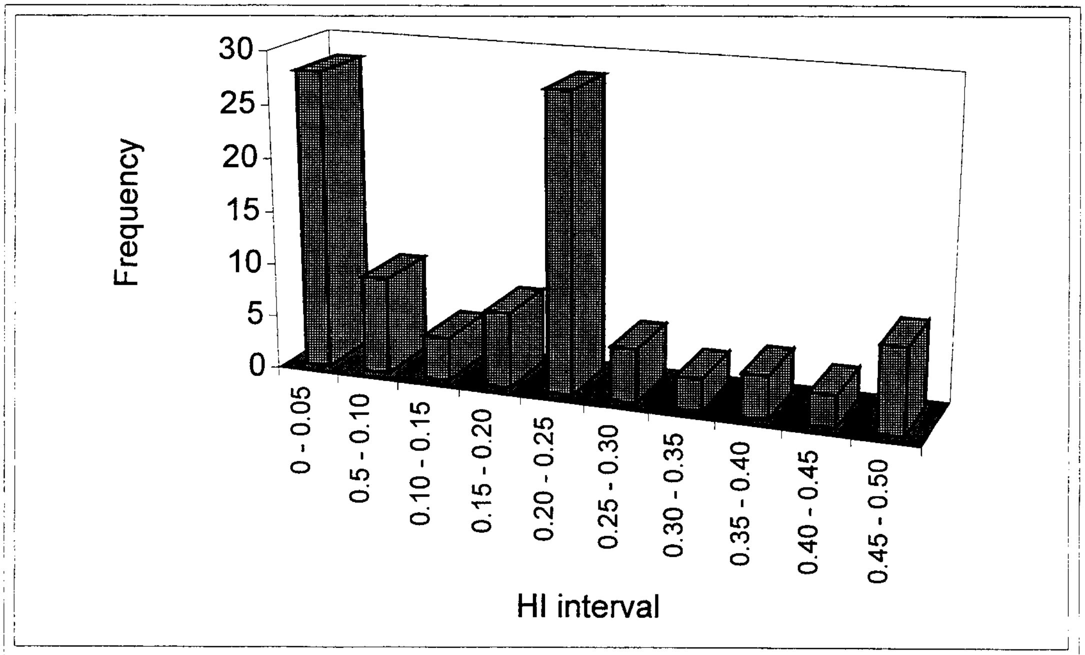

Figure 10. Distribution of HI values across range of 100 randomly selected potential nest sites of the American peregrine falcon in EEU-74.

4.0 Discussion

4.1 Utility of HR Subset

As discussed in the methods section, a subset (7.76 km^2) of the true HR (~576 km^2) for the peregrine was assessed to serve as an indicator of whether an assessment of the true HR is necessary. Increasing the modeled HR to dimensions of the true HR is not expected to increase the HIs because uncontaminated grid cells would be encountered in three (N, W, and E for EEU-74; S, W, and E for EEU-33) of the four directions and additional contaminated cells would be encountered in only one of the four directions (S for EEU-74; N for EEU-33). Therefore, the modeled subset of the true HR is a conservative, and therefore valid, representation of the true peregrine HR.

4.2 Management Use of Results

Data such as that in Figure 8 can be used to identify the particular source locations of contamination, which if managed, would most effectively maintain the risk to the falcon from contamination at acceptably low levels. Data such as that in Figure 7 on the geographical distribution of risk by nest location can be used to identify how to manage the spatial aspects of falcon habitat so that risk to the falcon is maintained at acceptably low levels; this could include the management of falcon habitat, facility operations, and/or siting of new facilities.

4.3 Foraging Strategy and Scaling the HR Dimension

In the weighted case, occupancy is inversely related to distance from potential nest sites such that a falcon spends more time foraging close to the theoretical nest. Improving model realism by weighting simulated falcon foraging based on distance from potential nest sites decreased risk by 93% in EEU-74 and by 82% in EEU-33.

The standard error of the mean around HIs represents the variability associated with spatial changes in sampling results within and between simulations. This variation was substantially greater (precision lower) when occupancy was weighted for both EEUs. In the unweighted cases, in effect there is more "foraging" on the same grid cells from one simulation to another.

Scaling HRs on the basis of maximizing falcon height for viewing prey decreased estimated risk by 69% in EEU-74, the canyons-based HR, and increased estimated risk by 40% in EEU-33, the river-based HR.

4.4 Limitations and Uncertainty

NOAELs can have a substantial impact on risk estimates. EPA data bases accessed for this study have NOAELs that are largely based on the toxicological testing of laboratory rats. The replacement of NOAELs based on rats with NOAELs that are based on the toxicological testing of birds is a continuous process in this study. To demonstrate the impact of NOAEL selection on the risk estimate, changes in the mean HI as caused by changes in NOAELs were calculated for two cases:

(1) Changing the As NOAEL from a rat-based NOAEL (8.0E-04 mg As/mg body wt of the falcon) to one based on the mallard duck as the experimental animal—1.16 mg/kg—decreased the mean HI by 94%. The decrease changed the risk conclusion from unacceptable (HI=1.88) to acceptable (HI=0.12). For the inorganic metals, it was observed that NOAELs are generally more restrictive (lower) when based on rats than when based on birds as the toxicological test species. This can be seen in Table A-3.

(2) Changing the NOAEL for several organic COPECs from values based on rats to values based on birds increased the mean HI by 37% (HI 0.12 to 0.19). The majority of the increase was caused by pentachlorophenol. For the organic COPECs, a comparison of rat-based NOAELs to NOAELs based on birds (Table A-3) revealed no definite pattern of increase or decrease.

A food consumption contaminant exposure pathway included BMFs for 15 COPECs. The BMFs increased the mean HI by a factor of 6. Because this increased the mean HI slightly above the level of acceptability, the accuracy of the BMFs used must be further investigated. The BMF component was added to the risk calculation shortly before finalization of this report, therefore a full presentation of the results will be made in a subsequent report. Selection and calculation of BAFs and BMFs is an ongoing process and this report will be updated periodically as substantial numbers of new values avail.

The Quotient Method does not assess the likelihood of the effect(s) under consideration. Using a more sophisticated ecological transport model such as BIOTRAN.2 (Gallegos 1996), greater insight into the magnitude of the effects expected at various levels of exposure can be obtained by evaluating the full stressor-response curve instead of a single point and by considering the frequency, timing, and duration of the exposure (EPA 1996, EPA 1992).

Some of the uncertainties associated with the use of TRVs have been discussed or listed in Section 2.7. Limitations of this study with regard to the potential for contaminant biomagnification have been discussed in this section. Other sources of uncertainty have been discussed throughout the report and additional discussion is provided by Calabrese and Baldwin (1993) and Clifford et al. (1995). Table 2 summarizes the assumptions made in this study, categorized according to whether we consider them "conservative", "realistic", or "nonconservative". As previously stated, an adjustment of TRVs using uncertainty factors was not made because the collective amount of uncertainty originating from different sources is great enough and/or variable enough so that the results would be unusable because of large total margins of introduced error.

Finally, this study assessed the potential risk to the American peregrine falcon from existing soil contaminants at LANL. The existing contamination studied has no particular relevance to the DARHT except for any, if any, additional contribution that the DARHT may make to the existing contaminant load. Potential effects to the American peregrine falcon from activities related specifically to the DARHT have only been qualitatively postulated (DOE 1996; Keller and Risberg 1995). Potential contaminant releases from normal and off-normal operations and from postulated accidents involving the DARHT as identified in the DARHT EIS (DOE 1996) and in the DARHT Biological Assessment (Keller and Risberg 1995) should be quantitatively assessed for potential impact to the peregrine. In a pilot study at LANL (LANL 1995) a method was developed which can be modified for making this assessment.

Additional TES to be assessed in fiscal year 1997 include the bald eagle (*Haliaeetus leucocephalus*). As with the falcon, EEUs specific to the eagle will be developed and corresponding toxicological reference data based on species that are closest to the eagle phylogenetically will be used so that any particularly sensitivities to contaminants are given some consideration.

5.0 Conclusions

Considering soil ingestion and food consumption contaminant pathways, including a biomagnification component, estimated risk to the peregrine was slightly above the level of acceptability.

The assumptions in Table 2 were made in calculating risk from contaminants to the peregrine. An assumption of importance is that the use of human-based TRVs for radionuclides most likely leads to an overestimate of risk to the falcon.

Additional assessment is needed in the areas of

- potential biomagnification,
- the continued establishment of NOAELs for the organic and radionuclide COPECs that are more directly applicable to avian species,
- exposure pathway definition,
- toxicological information on the American peregrine falcon, and
- grouping of COPECs by biological effect types, including the consideration of synergism and/or ameliorism.

The integration of the custom FORTRAN computer code ECORSK4 with the GIS and a contaminant data base was successfully demonstrated for estimating risk to the American peregrine falcon from

Table 2. The assumptions, conditions, and factors used in calculating risk from contaminants.

Conservative (overestimate risk)	Realistic	Nonconservative (underestimate risk)
all COPECs assumed to have same biological effect	FIMAD data base is current and accurate	risk not estimated for contaminants for which TRVs not available
radioactive decay of radionuclides not calculated	TRVs/NOAELs for metals based on avian test species and are chronic	environmental restoration not factored
antagonism not assessed		quotient method not probabilistic
FIMAD data base is current and accurate	mean natural background COPEC values, not UTLs, used for inorganics	FIMAD data base is current and accurate
	average, not maximum, COPEC soil concentrations used	
TRVs (SALs) for radionuclides based on humans, which are between 185 and 3650 times more protective of animals than IAEA standard for protection of animals	uncertainty factor not applied to across-animal-class NOAELs for organic COPECs	
contamination level measured at sampling points assumed for 100- by 100-ft area		
assumed bioavailability of COPECs = 100%		
% of dietary food intake as soil = 3		

contaminants.

Impact to the peregrine from potential contaminant releases identified in the DARHT EIS as related to normal, off-normal, and accident conditions remain to be quantitatively assessed.

Acknowledgments

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Appendix A

Table A-1. *Basic* program used to label grid cells and to generate x- and y-coordinate values by grid cell.

```
REM GRID Program
REM This program generates the label id for the rows and columns of the grid
REM It also generates the x,y coordinate of the center of each grid cell.
REM The input #1 file should contain the x minimum and y minimum values.
REM The user must edit the program with the input and output filename.
REM The user must input the number of rows and columns needed for the grid.
REM This information is required at the DO WHILE statements.
countr = 0
OPEN "c:\<filename>" FOR INPUT AS #1
OPEN "c:\<filename>" FOR OUTPUT AS #2
  INPUT #1, x, y
  LET yo = y
  DO
    LET countr = countr + 1
    LET rowo = countr
    LET countc = 0
    LET xo = x
    DO WHILE (countc) <= 259
      LET countc = countc + 1
      LET colo = countc
      WRITE #2, rowo, colo, xo, yo
      LET xo = xo + 100
      LOOP
    LET yo = yo + 100
  LOOP WHILE countr <= 199
```

Table A-2. FORTRAN source code ECORSK4.for.

```
c +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
c
    program ecorisk
c
c +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
c
c        ecological risk model
c
c  ecorsk is used to estimate hazard quotient (HQ) to a specific
c  animal from Contaminants of Concern (COC's) present in a given
c  Ecological Exposure Unit (EEU) which contains any number of Potential
c  Release sites (PRS's) or sampling areas that have COC's
c
    INCLUDE 'ecorsk3.inc'
    DIMENSION SUM(20),XVAL(10),sumc(8,nc),cewr(nr),cnsr(nr),occur(np),
   1slbaf(np,nc),slfrr(np)
    character *5 test
    character *8 date@
    CHARACTER *20 ANMAL,AVAL(5),rad(30),prs(np),conc(np,nc),concc(nc),
   1conum(nc),rconc
    character *50 name
c
    open (unit=4,file='gis.dat',status='old')
    open (unit=5,file='outrsk.dat',status='old')
    open (unit=6,file='entrsk.dat',status='old')
    open (unit=7,file='inrsk.dat',status='old')
    open (unit=8,file='hqp.dat',status='old')
    OPEN (UNIT=9,FILE='EEUINP.DAT',STATUS='OLD')
    OPEN (UNIT=10,FILE='MAPCDE.DAT',STATUS='OLD')
    OPEN (UNIT=11,FILE='HQPC.DAT',STATUS='OLD')
    OPEN (UNIT=12,FILE='HQ.DAT',STATUS='OLD')
    OPEN (UNIT=13,FILE='HABIT.DAT',STATUS='OLD')
    OPEN (UNIT=14,FILE='GRIDXY.DAT',STATUS='OLD')
    open (unit=15,file='river.dat' ,status='old')
c
 10 call scinit(' ')
    call atcol('black','yellow')
    call wnactn('cfp')
    call wnopen(0,0,50,10)
    call wnoust('                                                  ')
    call wnoust('     LOS ALAMOS NATIONAL LABORATORY               ')
    call wnoust('                                                  ')
    call wnoust('          ECOLOGICAL RISK MODEL                   ')
    call wnoust('                                                  ')
    call wnoust('               (ECORSK)                           ')
    call wnoust('                                                  ')
    call wnoust('              VERSION 1.0                         ')
    call wnoust('                                                  ')
    call wnouce(10,'press any key')
    call inkey(key)
    call wnclos(1)
    call atcol('white','red')
    call atbold('on')
    call wnopen(0,0,51,19)
    call wnoust('**************************************************')
    call wnoust('This program was prepared by the Regents of the   ')
    call wnoust('University of California at Los Alamos National   ')
    call wnoust('Laboratory (the University) under contract No.    ')
    call wnoust('W-7405-ENG-36 with the U.S. Department of Energy  ')
    call wnoust('(DOE).  The University has certain rights in the  ')
```

```
      call wnoust('program pursuant to the contract and the program   ')
      call wnoust('should not be copied or distributed outside your   ')
      call wnoust('organization.  All rights in the program are       ')
      call wnoust('reserved by DOE and the University.  Neither the   ')
      call wnoust('U.S. Government nor the University makes any       ')
      call wnoust('warranty, expressed or implied, or assumes any     ')
      call wnoust('liability or responsibiliy for the use of this     ')
      call wnoust('software.                                          ')
      call wnoust('Contact A.F. Gallegos, EES-15 at 505-665-0862 for  ')
      call wnoust('further information or questions on the use of     ')
      call wnoust('this software.                                     ')
      call wnoust('*****************************************************')
      call wnouce(19,'press any key')
      call inkey(key)
      call wnclos(1)
      call atbold('off')
      call atcol('black','green')
      call wnopen(0,0,51,9)
      call wnoust('*****************************************************')
      call wnoust('ECORSK is used to estimate the hazard quotient or  ')
      call wnoust('HQ to an animal from Contaminants of Concern or    ')
      call wnoust('or COCs present in a given EEU which contains any  ')
      call wnoust('number of Potential Release or sampling sites that ')
      call wnoust('contain COC''s ')
      call wnoust('*****************************************************')
      call wnouce(8,'press any key')
      call inkey(key)
      call wnclos(1)
      call atbold('on')
      call atcol('white','blue')
      call wnopen(0,0,44,10)
      call wnoust('*********************************************')
      call wnoust('          BEGIN ECORSK INPUT                ')
      call wnoust('AFTER EVERY ENTRY PRESS RETURN or ENTER..  ')
      call wnoust('IF ENTER STATEMENT REPEATS ITSELF, THEN DATA')
      call wnoust('HAS BEEN ENTERED IMPROPERLY: REPEAT ENTRY  ')
      call wnoust('IF A LEADING QUOTE; ("), IS ENTERED, THEN  ')
      call wnoust('MODEL WILL WAIT FOR ENDING (") BEFORE      ')
      call wnoust('*********************************************')
      call wnouce(9,'press any key')
      call inkey(key)
      call atbold('off')
 5001 call wnclos(1)
      call atcol('black','yellow')
      iseed=1000
      call wnclos(1)
      call wnopen(0,0,51,9)
      call wnoust('random number seed is set to 1000 to start sequence')
      call wnoust('  TO change random number seed:                  ')
      call wnoust('   choose "true" = no change, same sequence      ')
      call wnoust('   choose "false" = different sequence           ')
      call wnoust('   choose "end" = exit, run successful           ')
      call wnoust(' ENTER choice now, use single quotes as shown    ')
      call wnouce(7,'press any key and enter above')
      call inkey(key)
      call wncuxy(1,9)
      read(*,*,err=5001) test
 5099 call wnclos(1)
      if(test.eq.'end')call clear_screen@
      if(test.eq.'end')goto 120
      if(test.eq.'true')goto 5012
      call wnopen(0,0,51,4)
```

```
    call wnoust('CHOOSE an integer random seed...10, 1000, 200, etc.')
    call wnoust('ENTER selected random number seed now            ')
    call wnouce(3,'press any key and enter above')
    call inkey(key)
    call wncuxy(1,4)
    read(*,*,err=5099) iseed
5012 call wnclos(1)
    call wnopen(0,0,80,9)
    print *,'enter your name, group, etc.. (50 characters maximum)'
    read(*,5) name
5014 call wnclos(1)
    call wnopen(0,0,51,12)
    call wnoust('ENTER 0 if creating input; ENTER 1 if input is     ')
    call wnoust('is to come from a free format file(input.dat)      ')
    call wnoust('obtained by renaming file(enter.dat) created       ')
    call wnoust('automatically by ecorsk during each run.           ')
    call wnoust('A partial file with any number of COMPLETE         ')
    call wnoust('subroutine inputs may be used to save time         ')
    call wnoust('model will shift to create mode after all          ')
    call wnoust('input has been entered from partial file           ')
    call wnoust('PARTIAL subroutine input not acceptable            ')
    call wnoust('Enter 0 or 1                                       ')
    call wnouce(11,'press any key and enter above')
    call inkey(key)
    call wncuxy(1,12)
    read(*,*,err=5014) nu
5013 call wnclos(1)
    call wnopen(0,0,51,4)
    call wnoust('Do you want an echo of each input variable?        ')
    call wnoust('yes= 1,no= 0; ENTER now! (1 or 0)                  ')
    call wnouce(3,'press any key and enter above')
    call inkey(key)
    call wncuxy(1,4)
    read(*,*,err=5013)iu
7013 call wnclos(1)
    call wnopen(0,0,51,5)
    call wnoust('Enter modulus parameter for the file: HABIT.DAT ')
    call wnoust('HABIT.DAT consists of nest sites, eeu sites, grid')
    call wnoust('sites, specific nest location,.etc..')
    call wnouce(4,'press any key and enter above')
    call inkey(key)
    call wncuxy(1,5)
    read(*,*,err=7013) habtmd
    call wnclos(1)
    call wnopen(0,0,51,4)
    call wnoust('ENTER THE FOLLOWING OPTIONS FOR COC SPECIFICATION: ')
    call wnoust('1=UNADJUSTED SAMPLE CONCENTRATION,2=BACKGROUND ONLY')
    CALL WNOUST('3= SAMPLE - BACKGROUND CONCENTRATION')
    call wnouce(5,'press any key and enter above')
    call inkey(key)
    call wncuxy(1,5)
    read(*,*,err=5013) CHOICE
    write(5,*) 'you have selected coc specification = ', choice
    call wnclos(1)
    call wnopen(0,0,51,7)
    call wnoust('ENTER THE FOLLOWING OPTIONS FOR A SPECIFIC RUN: ')
    call wnoust('1= BOTH PRS AND RANDOM NEST SITES,2=PRS SITES ONLY')
    CALL WNOUST('3= RANDOM SITES ONLY,4=SELECTED NEST SITES ONLY')
    CALL WNOUST('5= SELECTED AND RANDOM NEST SITES,6=SELECTED AND')
    CALL WNOUST('PRS NESTING SITES')
    call wnouce(8,'press any key and enter above')
    call inkey(key)
```

```
      call wncuxy(1,8)
      read(*,*,err=5013) CHOIC2
      write(5,*) 'you have selected specific run option = ', choic2
       CALL WNCLOS(1)
       ANSEL=0.0
       ich2=choic2
       IF(ich2.LE.3.0)GOTO5015
       call wnopen(0,0,51,4)
       call wnoust('ENTER THE NUMBER OF SELECTED SITES TO BE INCLUDED ')
       call wnoust('IN THIS RUN.')
      call wnouce(4,'press any key and enter above')
      call inkey(key)
      call wncuxy(1,5)
      read(*,*,err=5013) ANSEL
      write(5,*) 'the number of contaminated sites =  ', ansel
 5015 CALL WNCLOS(1)
       call wnopen(0,0,51,5)
       call wnoust('DO YOU WANT TO USE EXPONENTIAL FEEDING OPTION?')
       call wnoust('ENTER 1.0 OR 0.0 FOR YES OR NO, RESPECTIVELY ')
      call wnouce(4,'press any key and enter above')
      call inkey(key)
      call wncuxy(1,5)
      read(*,*,err=5015) EXPFED
      write(5,*)'*******************************************************'
      write(5,*)'you have selected exponential feeding option = ',expfed
       call wnclos(1)
       if(expfed.le.0.0)goto3015
       call wnopen(0,0,51,5)
        call wnoust('PLEASE ENTER THE VALUE OF THE CONSTANT,C, METERS,IN')
       call wnoust('THE EQUATION: Y= EXP(-X/C) FOR EXPONENTIAL FEEDING')
      call wnouce(4,'press any key and enter above')
       call inkey(key)
       call wncuxy(1,5)
      read(*,*,err=5016) cexp
      write(5,*)'you have selected exponent function constant = ',cexp
 3015 CALL WNCLOS(1)
       call wnopen(0,0,51,5)
       call wnoust('DO YOU WANT TO INCLINE THE HOME-RANGE ON THE EEU?')
       call wnoust('ENTER 0.0 FOR NO INCLINE; OR SLOPE FRACTION ')
      call wnouce(4,'press any key and enter above')
       call inkey(key)
       call wncuxy(1,5)
       read(*,*,err=3015) slope
       write(5,*)'the home-range slope frac  around a nest site = ',slope
 2015 CALL WNCLOS(1)
        call wnopen(0,0,51,5)
        call wnoust('ENTER X/Y RATIO FOR HOME RANGE AROUND NEST SITE')
         call wnoust('ENTER 1,2,3...FOR ELLIPSOID RATIOS, 1=SQUARE..')
       call wnouce(4,'press any key and enter above')
        call inkey(key)
        call wncuxy(1,5)
        read(*,*,err=2015) AXR
        write(5,*)'you have selected X/Y ratio around nest site = ',axr
        write(5,*)'*******************************************************'
        IAXR=AXR
        call wnclos(1)
C*********************************************************************
 5016 call atcol('white','red')
        call atbold('on')
        call wnopen(0,0,51,13)
        call wnoust('**************************************************** ')
        call wnoust('unless specified, all input is NON-INTEGER type    ')
```

```
      call wnoust('HOWEVER, whole numbers can be entered as integers  ')
      call wnoust('and are converted to real numbers as shown on ECHO ')
      call wnoust('SEPARATE more than 1 input/line by commas or blanks')
      call wnoust('1.0,2.0e5 4.5,2.; repetitive numbers admitted..ex. ')
      call wnoust('1.0,4*5.0,2*0.0 2.0e4,..;IF next ENTER prompt does ')
      call wnoust('not appear,THEN not enough data has been entered   ')
      call wnoust('and will remain so until complete;CONTINUE to add  ')
      call wnoust('until complete; IF more data are required than can ')
      call wnoust('go on one line, then RETURN and continue as needed ')
      call wnoust('***************************************************')
      call wnouce(13,'press any key')
      call inkey(key)
      nuu=nu
 5700 call wnclos(1)
      call wnopen(0,0,51,8)
      call wnoust('***************************************************')
      call wnoust('1=file input, 0=keyboard input: you have selected  ')
      call wnoust('                                                   ')
      call wnoust('ENTER yes=1, no=0                                  ')
      call wnoust('***************************************************')
      call wncuxy(1,6)
      print *,'mode=',nu,'; want to reverse temporarily?'
      call wnouce(7,'press any key and enter above')
      call inkey(key)
      call wncuxy(1,8)
      read(*,*,err=5700)ans
      nun=nu
      if(ans.gt.0.0.and.nu.eq.0)nun=1
      if(ans.gt.0.0.and.nu.eq.1)nun=0
      call wnclos(1)
 5002 if(nun.eq.1)goto4000
 5102 call wnclos(1)
      nun=0
      call wnopen(1,1,80,8)
      call wnoust('ENTER the number of CONTAMINATED CELLS in test,')
      call wnoust('number of E-W grids, number of N-S grids, the ')
      call wnoust('number of random locations for nesting sites, and')
      call wnoust(' the number of rows in the EEUINP.DAT database')
      call wnoust('if creating own input,otherwise enter 0.0 for both')
      call wnoust('number of cont. cells, and no. of rows in database')
      call wnoust(' Include selected locations if required:5 inputs')
      call wnouce(8,'press any key and enter above')
      call inkey(key)
      call wncuxy(1,8)
      READ(*,*,ERR=5002) ANPRS,ANX,ANY,ANR,ANDAT
      if(iu.eq.1)print *,'value(s)=',ANPRS,anX,anY,anr,andat
      if(iu.eq.1)call sleep@(5.0)
 4002 call wnclos(1)
 4000 if(nun.eq.1)read(7,*,end=5102)ANPRS,anX,anY,anr,ANDAT
      if(nun.eq.1)goto4001
      call wnopen(0,0,51,4)
      call wnoust('do you wish to re-enter line? ENTER y=1, n=0')
      call wnouce(2,'press any key and enter above')
      call inkey(key)
      call wncuxy(1,3)
      read(*,*,err=4002) ans
      if(ans.gt.0.)goto5002
 4001 write(6,*) ANPRS,anX,anY,andat
      if(iu.eq.1.and.nun.eq.1) print *,ANPRS,anX,anY,anr,ANDAT
      if(nun.eq.0)call wnclos(1)
      ny=any
      nx=anx
```

```
      nq=anr
      write(5,*)'                                          '
      write(5,*)'**********ECOLOGICAL RISK INPUT SUMMARY***************'
      write(5,*)'                                          '
      write(5,*)'*************using ECORSK, Version 1******************'
      write(5,*)'                                          '
      write(5,*)'program run on  ',date@(),'  by ', name
      write(5,*)'                                          '
      write(5,*)'you have selected random seed number = ',iseed
      write(5,*)'                                          '
      call wnclos(1)
      if(nu.eq.1)goto9000
 9107 call wnclos(1)
      nu=0
 9007 call wnopen(1,1,80,8)
      print *,'ENTER the name of ANIMAL designated for ecological'
      print *,'risk analysis on its EEU'
      call wnouce(4,'press any key and enter above')
      call inkey(key)
      call wncuxy(1,6)
      READ(*,*,ERR=9007) ANMAL
      IF(IU.EQ.1)PRINT *,'NAME=',ANMAL
      if(iu.eq.1)call sleep@(5.0)
      call wnclos(1)
      goto9002
    5 format(a)
 9000 IF(NU.EQ.1) READ(7,5,END=9107) ANMAL
      IF(IU.EQ.1)PRINT *,'NAME=',ANMAL
      if(nu.eq.1)goto9005
 9002 call wnclos(1)
      call wnopen(0,0,51,4)
      call wnoust('do you wish to re-enter line? ENTER y=1, n=0        ')
      call wnouce(2,'press any key and enter above')
      call inkey(key)
      call wncuxy(1,3)
      read(*,*,err=9002) ans
      if(ans.gt.0) call wnclos(1)
      if(ans.gt.0.)goto9007
 9005 WRITE(6,5) ANMAL
      write(5,*)'*******************************************************'
      WRITE(5,*) 'ANIMAL = ', ANMAL
      IF(IU.EQ.1.AND.NU.EQ.1) PRINT *,'NAME=',ANMAL
 5003 call wnclos(1)
      call wnopen(0,0,51,8)
      call wnoust('***************************************************')
      call wnoust('1=file input, 0=keyboard input: you have selected  ')
      call wnoust('                                                   ')
      call wnoust('ENTER yes=1, no=0                                  ')
      call wnoust('***************************************************')
      call wncuxy(1,6)
      print *,'mode=',nu,'; want to reverse temporarily?'
      call wnouce(7,'press any key and enter above')
      call inkey(key)
      call wncuxy(1,8)
      read(*,*,err=5700)ans
      nun=nu
      if(ans.gt.0.0.and.nu.eq.0)nun=1
      if(ans.gt.0.0.and.nu.eq.1)nun=0
      call wnclos(1)
      ndat=0
      k=1
      knn=0
```

```
      do5531kss=1,nc
      conum(kss)='blank'
 5531 continue
      if(nu.eq.0)goto5535
 5534 read(9,*,end=5535,err=5536)(XVAL(J),J=1,10),AVAL(1),AVAL(2)
      ndat=ndat+1
      do5530kss=1,nc
      if(conum(kss).ne.'blank')goto5530
      do5532koo=1,kss
      if(aval(2).eq.conum(koo))goto4430
 5532 continue
      conum(kss)=aval(2)
      knn=knn+1
 5530 continue
 4430 ival1=xval(4)
      ival2=xval(5)
      IF(ndat.eq.1)goto5537
      if(iyid.eq.ival2.and.ixid.eq.ival1)goto5534
      if(iyid.ne.ival2.or.ixid.ne.ival1)K=K+1
 5537 ixid=ival1
      iyid=ival2
      goto5534
 5536 print *,(XVAL(J),J=1,10),AVAL(1),AVAL(2),ndat,k
      print *,'error in line after the above'
      goto120
 5535 if(nu.eq.0)goto5538
      rewind 9
      nsel=ansel
      NPRS=k-nsel
      k=1
      nsdat=0
      do1131kss=1,nc
      conum(kss)='blank'
 1131 continue
      do1134jj=1,ndat
      read(9,*)(XVAL(J),J=1,10),AVAL(1),AVAL(2)
      if(k.gt.nprs)nsdat=nsdat+1
      do1130kss=1,nc
      if(conum(kss).ne.'blank')goto1130
      do1132koo=1,kss
      if(aval(2).eq.conum(koo))goto2230
 1132 continue
      conum(kss)=aval(2)
 1130 continue
 2230 ival1=xval(4)
      ival2=xval(5)
      IF(jj.eq.1)goto1137
      if(iyid.eq.ival2.and.ixid.eq.ival1)goto1134
      if(iyid.ne.ival2.or.ixid.ne.ival1)K=K+1
 1137 ixid=ival1
      iyid=ival2
 1134 continue
      rewind 9
      print *,'number of data points = ',ndat
      print *,'number of PRS"s = ',nprs, ' set to ',np,' maximum'
      print *,'number of selected sites = ',nsel
      print *,'number of selected site data points = ',nsdat
      print *,'number of diff. contaminants= ',knn,' set to ',nc,' max'
      pause
 5538 K=1
      NSEL=ANSEL
      NDATS=NDAT
```

```
      IF(ICH2.GT.3)NDATS=NDAT+NSDAT
      IF(ICH2.GT.3)NPRS=NPRS+NSEL
      icon=1
      do5533KK=1,NDATS
      if(nun.eq.1)goto4003
 5103 call wnclos(1)
      nun=0
 5334 call wnopen(1,1,80,10)
      PRINT *,'ENTER TOTAL NUMBER OF COCS PRESENT IN A GIVEN PRS'
      PRINT *,' FOR ',ANMAL
      call wnouce(4,'press any key and enter above')
      call inkey(key)
      call wncuxy(1,5)
      READ(*,*,ERR=5003) ACCON(KK)
      K=KK
      IF(IU.EQ.1)PRINT *,'VALUE(S)=',ACCON(K)
      IF(IU.EQ.1)CALL SLEEP@(5.0)
      CALL WNCLOS(1)
      GOTO4004
 4003 READ(9,*,END=5103) (XVAL(J),J=1,10),AVAL(1),AVAL(2)
      ival1=xval(4)
      ival2=xval(5)
      if(kk.eq.1)ixid=xval(4)
      if(kk.eq.1)iyid=xval(5)
      IF(KK.eq.1)GOTO4033
      if(iyid.eq.ival2.and.ixid.eq.ival1)icon=icon+1
      if(iyid.eq.ival2.and.ixid.eq.ival1)goto5533
      ird=accon(k)
      if(icon.ne.ird) accon(k)=icon
      icon=1
      if(iyid.ne.ival2.or.ixid.ne.ival1)K=K+1
 4033 ixid=ival1
      iyid=ival2
      ACCON(K)=XVAL(1)
      goto4004
 4005 call wnopen(0,0,51,4)
      call wnoust('do you wish to re-enter line? ENTER y=1, n=0         ')
      call wnouce(2,'press any key and enter above')
      call inkey (key)
      call wncuxy(1,3)
      read(*,*,err=4005) ans
      call wnclos(1)
      if(ans.gt.0.)goto5334
 4004 WRITE(4,*)ACCON(K)
      IF(IU.EQ.1.AND.NUN.EQ.1) PRINT *,ACCON(K)
 5533 CONTINUE
      rewind 9
      call wnclos(1)
      call wnopen(1,1,80,8)
      call wnclos(1)
      call wnopen(0,0,51,8)
      call wnoust('***************************************************')
      call wnoust('1=file input, 0=keyboard input: you have selected  ')
      call wnoust('                                                   ')
      call wnoust('ENTER yes=1, no=0                                  ')
      call wnoust('***************************************************')
      call wncuxy(1,6)
      print *,'mode=',nu,'; want to reverse temporarily?'
      call wnouce(7,'press any key and enter above')
      call inkey(key)
      call wncuxy(1,8)
      read(*,*,err=5700)ans
```

```
 nun=nu
 if(ans.gt.0.0.and.nu.eq.0)nun=1
 if(ans.gt.0.0.and.nu.eq.1)nun=0
 call wnclos(1)
 K=1
 DO9018KK=1,NDATS
 if(nun.eq.1)goto9010
9117 call wnclos(1)
 nun=0
9017 call wnopen(1,1,80,20)
 PRINT *,'ENTER NAMES OF ',NPRS,'PRSS FOR ',ANMAL
 print *,' remember that name is enclosed in single quotes'
 call wnouce(4,'press any key and enter above')
 call inkey(key)
 call wncuxy(1,6)
 AK=KK
 K=KK
 READ(*,*,ERR=9017) PRS(K)
 IF(IU.EQ.1)PRINT *,'NAME=',PRS(K), 'ENTER PRS NUMBER',AK
 if(iu.eq.1)call sleep@(5.0)
 CALL WNCLOS(1)
 GOTO9015
9010 READ(9,*,END=9117) (XVAL(J),J=1,10),AVAL(1),AVAL(2)
 ival1=xval(4)
 ival2=xval(5)
 if(kk.eq.1)ixid=xval(4)
 if(kk.eq.1)iyid=xval(5)
 IF(KK.eq.1)GOTO9011
 if(iyid.eq.ival2.and.ixid.eq.ival1)goto9018
 if(iyid.ne.ival2.or.ixid.ne.ival1)K=K+1
9011 iyid=ival2
 ixid=ival1
 PRS(K)=AVAL(1)
 goto9015
9012 call wnclos(1)
 call wnopen(0,0,51,4)
 call wnoust('do you wish to re-enter line? ENTER y=1, n=0       ')
 call wnouce(2,'press any key and enter above')
 call inkey(key)
 call wncuxy(1,3)
 read(*,*,err=9012) ans
 if(ans.gt.0) call wnclos(1)
 if(ans.gt.0.)goto9017
9015 WRITE(4,5) PRS(K)
 IF(IU.EQ.1.AND.NUN.EQ.1) PRINT *,PRS(K),k
9018 CONTINUE
 REWIND 9
 call wnclos(1)
 call wnopen(0,0,51,8)
 call wnoust('***************************************************')
 call wnoust('1=file input, 0=keyboard input: you have selected  ')
 call wnoust('                                                   ')
 call wnoust('ENTER yes=1, no=0                                  ')
 call wnoust('***************************************************')
 call wncuxy(1,6)
 print *,'mode=',nu,'; want to reverse temporarily?'
 call wnouce(7,'press any key and enter above')
 call inkey(key)
 call wncuxy(1,8)
 read(*,*,err=5700)ans
 nun=nu
 if(ans.gt.0.0.and.nu.eq.0)nun=1
```

```
      if(ans.gt.0.0.and.nu.eq.1)nun=0
       do567j=1,NPRS
      NCON=ACCON(J)
       do569l=1,ncon
       al=1
      if(nun.eq.1)goto412
 516 nun=0.0
      call wnclos(1)
 506 call wnclos(1)
      call wnopen(1,1,80,8)
       PRINT *,'ENTER SOIL COC NAMES FOR',PRS(j),'FOR', ANMAL
      print *,'in the EEU. Enter 1 name at a time and hit return/enter'
      print *,'remember to use single quotes around name'
      call wncuxy(1,5)
      call wnouce(5,'press any key and enter above')
      call inkey(key)
      call wncuxy(1,7)
       READ(*,*,ERR=506) CONC(J,L)
       IF(IU.EQ.1)PRINT *,'NAME=',CONC(J,L),'ENTER COC NUMBER',AL
      if(iu.eq.1)call sleep@(5.0)
 414 if(nun.eq.0)call wnclos(1)
 412 IF(NUN.EQ.1)READ(9,*,END=516) (XVAL(JJ),JJ=1,10),AVAL(1),AVAL(2)
      if(nun.eq.1)CONC(J,L)=AVAL(2)
      if(nun.eq.1)goto413
      call wnopen(0,0,51,3)
      call wnoust('do you wish to re-enter line? ENTER y=1, n=0        ')
      call wnouce(2,'press any key and enter above')
      call inkey(key)
      call wncuxy(1,3)
      if(nun.eq.0)read(*,*,err=414) ans
      call wnclos(1)
      if(ans.gt.0.)goto516
 413 WRITE(4,*) CONC(J,L)
       IF(IU.EQ.1.AND.NUn.EQ.1)PRINT *,CONC(J,L),L,j
 569 continue
 567 continue
      REWIND 9
5004 call wnclos(1)
      if(nu.eq.1)goto4006
5104 call wnclos(1)
       nu=0
      call wnopen(1,1,80,10)
       PRINT *,'ENTER THE TYPE OF ANIMAL SIMULATED IN THIS TEST'
       print *,' selection: 1= mammal, 2= bird, 3= reptile, 4= amphibian'
      print *,'Also enter food strategy: 10= carnivore,100= herbivore,'
       PRINT *,'AND 1000= OMNIVORE FOR THE ANIMAL; REPTILES AND'
       PRINT *,'AMPHIBIANS ARE CONSIDERED AS CARNIVORES'
      call wnouce(6,'press any key and enter above')
      call inkey(key)
      call wncuxy(1,8)
       READ(*,*,ERR=5004) ANTP, FODTP
       IF(IU.EQ.1)PRINT *,'VALUES=', ANTP,FODTP
      if(iu.eq.1)call sleep@(5.0)
4008 if(nu.eq.0)call wnclos(1)
4006 IF(NU.EQ.1)READ(7,*,END=5104) ANTP,FODTP
      if(nu.eq.1)goto4007
      call wnopen(0,0,51,3)
      call wnoust('do you wish to re-enter line? ENTER y=1, n=0        ')
      call wnouce(2,'press any key and enter above')
      call inkey(key)
      call wncuxy(1,3)
      if(nu.eq.0)read(*,*,err=4008) ans
```

```
    call wnclos(1)
    if(ans.gt.0)goto5004
 4007 WRITE(6,*) ANTP,FODTP
    write(5,*)'*******************************************************'
     WRITE(5,*) 'ANIMAL TYPE SELECTED FOR ',ANMAL,'IS SPECIFIED AS'
     WRITE(5,*) ANTP,'1=MAMMAL,2=BIRD,3=REPTILE, AND 4=AMPHIBIAN'
     WRITE(5,*) 'FEEDING TYPE FOR',ANMAL, 'IS SELECTED AS'
     WRITE(5,*) FODTP,' 10=CARNIVORE,100=HERBIVORE, AND 1000=AMPHIBIAN'
     IF(IU.EQ.1.AND.NU.EQ.1)PRINT *, ANTP,FODTP
 3005 call wnclos(1)
    if(nu.eq.1)goto2003
 3105 call wnclos(1)
    nu=0
 3334 call wnopen(1,1,80,8)
    print *,' ENTER the body weight, kgfwt, the fraction of the'
    print *,' daily intake which consists of consumed soil, and the'
    PRINT *,'effective sediment intake fraction (set=0.0 if not used)'
    print *,'for ', ANMAL
    call wnouce(6,'press any key and enter above')
    call inkey(key)
    call wncuxy(1,8)
     READ(*,*,ERR=3005) BODWT,SOILF,SEDMF
     IF(IU.EQ.1)PRINT *,'VALUES =',BODWT,SOILF,SEDMF
    if(iu.eq.1)call sleep@(5.0)
    if(nu.eq.0)call wnclos(1)
 2003 IF(NU.EQ.1)READ(7,*,END=3105) BODWT,SOILF,SEDMF
    if(nu.eq.1)goto2004
    call wnopen(0,0,51,4)
    call wnoust('do you wish to re-enter line? ENTER y=1, n=0       ')
    call wnouce(2,'press any key and enter above')
    call inkey (key)
    call wncuxy(1,3)
    read(*,*,err=3005) ans
    call wnclos(1)
    if(ans.gt.0.)goto3334
 2004 WRITE(6,*) BODWT,SOILF,SEDMF
    write(5,*)'*******************************************************'
     WRITE(5,*)'BODY WEIGHT,KGFWT,FOR',ANMAL,' = ',BODWT
    write(5,*) 'soil intake,fraction of food ingestion, for'
     WRITE(5,*) ANMAL,' = ',SOILF
     WRITE(5,*)'EFFECTIVE SED. INTAKE FRAC. FOR ',ANMAL,' = ',SEDMF
     IF(IU.EQ.1.AND.NU.EQ.1) PRINT *,BODWT,SOILF,SEDMF
 5005 call wnclos(1)
    call wnopen(0,0,51,8)
    call wnoust('***************************************************')
    call wnoust('1=file input, 0=keyboard input: you have selected  ')
    call wnoust('                                                   ')
    call wnoust('ENTER yes=1, no=0                                  ')
    call wnoust('***************************************************')
    call wncuxy(1,6)
    print *,'mode=',nu,'; want to reverse temporarily?'
    call wnouce(7,'press any key and enter above')
    call inkey(key)
    call wncuxy(1,8)
    read(*,*,err=5700)ans
    nun=nu
    if(ans.gt.0.0.and.nu.eq.0)nun=1
    if(ans.gt.0.0.and.nu.eq.1)nun=0
    call wnclos(1)
    K=1
    DO5555KK=1,NDATS
    if(nun.eq.1)goto4009
```

```
5105 call wnclos(1)
    nun=0
5556 call wnopen(1,1,80,10)
    print *,'ENTER area, km2, of each PRS in the EEU for'
     PRINT *,ANMAL,'. ',ANPRS,' PRS ENTRIES REQUIRED'
    print *,'also enter mean N-S and E-W UTM coordinates for each PRS'
     PRINT *,'ENTER',ANPRS,'UTM N-S COORDINATES FOLLOWED BY THE SAME'
    print *,'number of E-W coordinates in sequence. Enter zeros for '
    print *,'coordinates if not using in run'
    call wnouce(8,'press any key and enter above')
    call inkey(key)
    call wncuxy(1,9)
     K=KK
     READ(*,*,ERR=5005) PAREA(K),CEWC(K),CNSC(K)
     IF(IU.EQ.1)PRINT *,'VALUES =',PAREA(K),CEWC(K),CNSC(K)
    if(iu.eq.1)call sleep@(5.0)
    call wnclos(1)
     GOTO4010
4009 READ(9,*,END=5105) (XVAL(J),J=1,10),AVAL(1),AVAL(2)
    ival1=xval(4)
    ival2=xval(5)
    if(kk.eq.1)ixid=xval(4)
    if(kk.eq.1)iyid=xval(5)
    IF(KK.eq.1)GOTO4099
    if(iyid.eq.ival2.and.ixid.eq.ival1)goto5555
    if(iyid.ne.ival2.or.ixid.ne.ival1)K=K+1
4099 iyid=ival2
     ixid=ival1
    PAREA(K)=XVAL(9)
    CEWC(K)=XVAL(4)
    CNSC(K)=XVAL(5)
     GOTO4010
4011 call wnopen(0,0,51,4)
    call wnoust('do you wish to re-enter line? ENTER y=1, n=0         ')
    call wnouce(2,'press any key')
    call inkey(key)
    call wncuxy(1,3)
   if(nun.eq.0)read(*,*,err=4011) ans
    call wnclos(1)
    if(ans.gt.0.)goto5556
4010 WRITE(4,*) PAREA(K),CEWC(K),CNSC(K)
    IF(IU.EQ.1.AND.NUn.EQ.1)PRINT *, PAREA(K),CEWC(K),CNSC(K),K
5555 continue
    REWIND 9
    call wnclos(1)
    call wnopen(0,0,51,8)
    call wnoust('***************************************************')
    call wnoust('1=file input, 0=keyboard input: you have selected  ')
    call wnoust('                                                   ')
    call wnoust('ENTER yes=1, no=0                                  ')
    call wnoust('***************************************************')
    call wncuxy(1,6)
    print *,'mode=',nu,'; want to reverse temporarily?'
   call wnouce(7,'press any key and enter above')
    call inkey(key)
    call wncuxy(1,8)
   read(*,*,err=5700)ans
    nun=nu
    if(ans.gt.0.0.and.nu.eq.0)nun=1
    if(ans.gt.0.0.and.nu.eq.1)nun=0
    call wnclos(1)
     do5666j=1,NPRS
```

```
    NCON=ACCON(J)
    DO5667L=1,NCON
    IF(NUN.EQ.1)GOTO4012
5106 nun=0
5006 call wnclos(1)
5668 call wnopen(1,1,80,8)
     PRINT *,'ENTER',NCON,'COC SOIL CONC., THE COC BACKGROUND,UG/GDWT,'
     PRINT *,'FOR',PRS(J),'OF',ANMAL,'IN THE EEU;EVEN IF PRESENT ABOVE'
    PRINT *,'BACKGROUND concentrations OR enter 0.0 IF NOT KNOWN; AND'
     PRINT *,'ENTER THE BAF X SOIL CONC. PRODUCT;ENTER 0.0 IF NOT USED'
     PRINT *,'THE COC IS',CONC(J,L)
    call wncuxy(1,6)
    call wnouce(6,'press any key and enter above')
    call inkey(key)
    call wncuxy(1,8)
     READ(*,*,ERR=5006) COC(J,L),BKG(J,L),SLBAF(J,L)
    call wnopen(0,0,51,3)
    call wnoust('do you wish to re-enter line? ENTER y=1, n=0       ')
    call wnouce(2,'press any key and enter above')
    call inkey(key)
    call wncuxy(1,3)
    if(nun.eq.0)read(*,*,err=4014) ans
    call wnclos(1)
    if(ans.gt.0.)goto5668
    IF(IU.EQ.1)PRINT *,'VALUE=',COC(J,L),BKG(J,L),SLBAF(J,L)
    if(iu.eq.1)call sleep@(5.0)
4014 if(nun.eq.0)call wnclos(1)
4012 IF(NUn.EQ.1)READ(9,*,END=5106) (XVAL(JJ),JJ=1,10),AVAL(1),AVAL(2)
    COC(J,L)=XVAL(2)
    BKG(J,L)=XVAL(3)
    SLBAF(J,L)=XVAL(10)
    if(coc(j,l).le.0.0)coc(j,l)=0.0
    if(bkg(j,l).le.0.0)bkg(j,l)=0.0
    if(coc(j,l).lt.bkg(j,l))coc(j,l)=bkg(j,l)
    ichs=choice
    if(ichs.eq.2)coc(j,l)=bkg(j,l)
    if(ichs.eq.3)coc(j,l)=coc(j,l)-bkg(j,l)
     WRITE(4,*) COC(J,L),BKG(J,L)
    IF(IU.EQ.1.AND.NUn.EQ.1) PRINT *,COC(J,L),BKG(J,L),J,L
5667 continue
5666 continue
    REWIND 9
5007 call wnclos(1)
    if(nu.eq.1)goto4015
5107 call wnclos(1)
    nu=0
    call wnopen(1,1,80,9)
     PRINT *,'ENTER EEU AREA, KM2, FOR ',ANMAL,' THEN ENTER THE'
     PRINT *,'HOME-RANGE,KM2, FOR THAT ANIMAL'
    print *, 'A value of zero for any home-range defaults to an '
    print *, 'internally estimated value'
    call wnouce(6,'press any key and enter above')
    call inkey(key)
    call wncuxy(1,8)
     READ(*,*,ERR=5007) EEU,HMR
     IF(IU.EQ.1) PRINT *,'VALUES =',EEU,HMR
    if(iu.eq.1)call sleep@(5.0)
4017 call wnclos(1)
4015 IF(NU.EQ.1)READ(7,*,END=5107) EEU,HMR
    if(nu.eq.1)goto4016
    call wnopen(0,0,51,3)
    call wnoust('do you wish to re-enter line? ENTER y=1, n=0       ')
```

```
   call wnouce(2,'press any key and enter above')
   call inkey(key)
   call wncuxy(1,3)
   if(nu.eq.0)read(*,*,err=4017) ans
   call wnclos(1)
   if(ans.gt.0.)goto5007
4016 WRITE(6,*) EEU,HMR
   write(5,*)'*******************************************************'
    WRITE(5,*)'THE AREA, KM2, OF THE EEU FOR ',ANMAL,' IS',EEU
    IF(IU.EQ.1.AND.NU.EQ.1)PRINT *, EEU,HMR
1007 call wnclos(1)
   if(nu.eq.1)goto1015
1107 call wnclos(1)
   nu=0
   call wnopen(1,1,80,9)
   print *,'ENTER EEU maximum and minimum UTM N-S coordinates for'
   PRINT *,ANMAL,' (2 VALUES REQUIRED). THEN'
   print *, 'enter maximum and minimum UTM E-W coordinates for'
   PRINT *,ANMAL,' (2 VALUES REQUIRED)'
   call wnouce(6,'press any key and enter above')
   call inkey(key)
   call wncuxy(1,8)
   READ(*,*,ERR=1007)EUEWMX,EUEWMN,EUNSMX,EUNSMN
   IF(IU.EQ.1)PRINT *,'VALUES =',EUEWMX,EUEWMN,EUNSMX,EUNSMN
   if(iu.eq.1)call sleep@(5.0)
1017 call wnclos(1)
1015 IF(NU.EQ.1)READ(7,*,END=1107) EUEWMX,EUEWMN,EUNSMX,EUNSMN
   if(nu.eq.1)goto1016
   call wnopen(0,0,51,3)
   call wnoust('do you wish to re-enter line? ENTER y=1, n=0       ')
   call wnouce(2,'press any key and enter above')
   call inkey(key)
   call wncuxy(1,3)
   if(nu.eq.0)read(*,*,err=1017) ans
   call wnclos(1)
   if(ans.gt.0.)goto1007
1016 WRITE(6,*) EUEWMX,EUEWMN,EUNSMX,EUNSMN
   write(5,*)'*******************************************************'
    WRITE(5,*)'THE MAX. AND MIN. N-S UTM COORDINATES FOR',ANMAL
    WRITE(5,*)'ARE',EUNSMX,EUNSMN
    WRITE(5,*)'THE MAX. AND MIN. E-W UTM COORDINATES FOR',ANMAL
    WRITE(5,*)'ARE',EUEWMX,EUEWMN
    IF(IU.EQ.1.AND.NU.EQ.1)PRINT *,EUEWMN,EUEWMX,EUNSMN,EUNSMX
1008 call wnclos(1)
   call wnopen(0,0,51,8)
   call wnoust('***************************************************')
   call wnoust('1=file input, 0=keyboard input: you have selected  ')
    call wnoust('                                                  ')
    call wnoust('ENTER yes=1, no=0                                 ')
   call wnoust('***************************************************')
   call wncuxy(1,6)
    print *,'mode=',nu,'; want to reverse temporarily?'
   call wnouce(7,'press any key and enter above')
   call inkey(key)
   call wncuxy(1,8)
   read(*,*,err=5700)ans
    nun=nu
    if(ans.gt.0.0.and.nu.eq.0)nun=1
    if(ans.gt.0.0.and.nu.eq.1)nun=0
   call wnclos(1)
    K=1
    DO5888KK=1,NDATS
```

```
      if(nun.eq.1)goto4018
 1108 call wnclos(1)
      nun=0
 5889 call wnopen(1,1,80,7)
      print *,'ENTER',NPRS,' PRS enhancement factors for '
      PRINT *,ANMAL, 'IN EACH PRS OF THE EEU'
      call wncuxy(1,4)
      call wnouce(4,'press any key and enter above')
      call inkey(key)
      call wncuxy(1,6)
      K=KK
      READ(*,*,ERR=1008) ENH(K)
      IF(IU.EQ.1)PRINT *,'VALUE= ',ENH(K)
      if(iu.eq.1)call sleep@(5.0)
      CALL WNCLOS(1)
      GOTO4019
 4018 IF(NUN.EQ.1)READ(9,*,END=1108)(XVAL(J),J=1,10),AVAL(1),AVAL(2)
      ival1=xval(4)
      ival2=xval(5)
      if(kk.eq.1)ixid=xval(4)
      if(kk.eq.1)iyid=xval(5)
      IF(KK.eq.1)GOTO4081
      if(iyid.eq.ival2.and.ixid.eq.ival1)goto5888
      if(iyid.ne.ival2.or.ixid.ne.ival1)K=K+1
 4081 iyid=ival2
      ixid=ival1
      ENH(K)=XVAL(7)
      goto4019
 4020 call wnopen(0,0,51,3)
      call wnoust('do you wish to re-enter line? ENTER y=1, n=0        ')
      call wnouce(2,'press any key and enter above')
      call inkey(key)
      call wncuxy(1,3)
      if(nun.eq.0)read(*,*,err=4020) ans
      call wnclos(1)
      if(ans.gt.0.)goto5889
 4019 WRITE(4,*) ENH(K)
      IF(IU.EQ.1.AND.NUn.EQ.1)PRINT *, ENH(K),k
 5888 continue
      REWIND 9
 5009 call wnclos(1)
      call wnopen(0,0,51,8)
      call wnoust('***************************************************')
      call wnoust('1=file input, 0=keyboard input: you have selected  ')
      call wnoust('                                                   ')
      call wnoust('ENTER yes=1, no=0                                  ')
      call wnoust('***************************************************')
      call wncuxy(1,6)
      print *,'mode=',nu,'; want to reverse temporarily?'
      call wnouce(7,'press any key and enter above')
      call inkey(key)
      call wncuxy(1,8)
      read(*,*,err=5700)ans
      nun=nu
      if(ans.gt.0.0.and.nu.eq.0)nun=1
      if(ans.gt.0.0.and.nu.eq.1)nun=0
      call wnclos(1)
      DO5999K=1,NPRS
      NCON=ACCON(K)
      DO5998L=1,NCON
      IF(NUN.EQ.1)GOTO4021
 5109 NUN=0
```

```
   call wnclos(1)
6666 call wnopen(1,1,80,7)
   print *,'ENTER the toxicological reference doses or RFDs'
    PRINT *,'CORRESPONDING TO THE COC',COC(K,L),'FOR ',ANMAL
   call wnouce(3,'press any key and enter above')
   call inkey(key)
   call wncuxy(1,5)
    READ(*,*,ERR=5009) RFD(K,L)
    call wnopen(0,0,51,3)
    call wnoust('do you wish to re-enter line? ENTER y=1, n=0        ')
   call wnouce(2,'press any key and enter above')
   call inkey(key)
   call wncuxy(1,3)
   if(nun.eq.0)read(*,*,err=4023) ans
   call wnclos(1)
   if(ans.gt.0.)goto 6666
   IF(IU.EQ.1)PRINT *,'VALUE= ',RFD(K,L)
   if(iu.eq.1)call sleep@(5.0)
4023 call wnclos(1)
4021 IF(NUn.EQ.1) READ(9,*,END=5109) (XVAL(J),J=1,10),AVAL(1),AVAL(2)
   IF(NUN.EQ.1)RFD(K,L)=XVAL(6)
    WRITE(4,*) RFD(K,L)
    IF(IU.EQ.1.AND.NUN.EQ.1)PRINT *, RFD(K,L),K,L
5998 CONTINUE
5999 CONTINUE
    REWIND 9
5010 call wnclos(1)
   call wnopen(0,0,51,8)
   call wnoust('***************************************************')
   call wnoust('1=file input, 0=keyboard input: you have selected  ')
    call wnoust('                                                   ')
    call wnoust('ENTER yes=1, no=0                                  ')
   call wnoust('***************************************************')
   call wncuxy(1,6)
   print *,'mode=',nu,'; want to reverse temporarily?'
   call wnouce(7,'press any key and enter above')
   call inkey(key)
   call wncuxy(1,8)
   read(*,*,err=5700)ans
    nun=nu
    if(ans.gt.0.0.and.nu.eq.0)nun=1
    if(ans.gt.0.0.and.nu.eq.1)nun=0
   call wnclos(1)
    DO7777K=1,NPRS
   NCON=ACCON(K)
    DO7778L=1,NCON
    IF(NUN.EQ.1)GOTO4024
5110 NUN=0
   call wnclos(1)
    nun=0
5669 call wnopen(1,1,80,7)
    PRINT *,'ENTER RFD ADJUSTMENT MULTIPLIERS FOR THE COC'
    PRINT *,CONC(K,L),' PERTAINING TO ',ANMAL
   call wnouce(4,'press any key and enter above')
   call inkey(key)
   call wncuxy(1,6)
    READ(*,*,ERR=5010) RFDA(K,L)
    call wnopen(0,0,51,3)
    call wnoust('do you wish to re-enter line? ENTER y=1, n=0        ')
   call wnouce(2,'press any key and enter above')
   call inkey(key)
   call wncuxy(1,4)
```

```
      if(nun.eq.0)read(*,*,err=4026) ans
       call wnclos(1)
       if(ans.gt.0.)goto5669
       IF(IU.EQ.1)PRINT *,'VALUE = ',RFDA(K,L)
      if(iu.eq.1)call sleep@(5.0)
4026 call wnclos(1)
4024 IF(NUn.EQ.1)READ(9,*,END=5110)(XVAL(J),J=1,10),AVAL(1),AVAL(2)
       RFDA(K,L)=XVAL(8)
       WRITE(4,*) RFDA(K,L)
       IF(IU.EQ.1.AND.NUn.EQ.1)PRINT *,RFDA(K,L),L,K
7778 continue
7777 CONTINUE
       rewind 9
8010 call wnclos(1)
       do8777j=1,ny
       JY=NY-J+1
       if(nu.eq.1)goto8024
8110 call wnclos(1)
       nu=0
8669 call wnopen(1,1,80,9)
        PRINT *,'ENTER',NG,'OCCUPANCY GATES (1.0,0.0,99) FOR',ANMAL, 'IN'
        PRINT *,'ROW',J,'. 1,99=CELL IN EEU,2=CELL NOT IN EEU. CELL'
      print *,'locations start at NORTHwest corner to the east(columns)'
      print *,'and proceed upwards to the north (rows)'
      call wnouce(6,'press any key and enter above')
       call inkey(key)
       call wncuxy(1,8)
       READ ( *,*,ERR=8010) (ICELL(JY,L),L=1,nx)
       IF(IU.EQ.1)PRINT *, '100I3','VALUES = ',(ICELL(JY,L),L=1,NX)
      if(iu.eq.1)call sleep@(5.0)
8026 call wnclos(1)
8024 IF(NU.EQ.1)READ(10,*,END=8110) (ICELL(JY,L),L=1,NX)
       if(nu.eq.1)goto8025
       call wnopen(0,0,51,3)
       call wnoust('do you wish to re-enter line? ENTER y=1, n=0         ')
      call wnouce(2,'press any key and enter above')
       call inkey(key)
       call wncuxy(1,4)
      if(nu.eq.0)read(*,*,err=8026) ans
       call wnclos(1)
       if(ans.gt.0.)goto8669
8025 WRITE(6,'(100I3)') (ICELL(JY,L),L=1,NX),jy
       IF(IU.EQ.1.AND.NU.EQ.1)PRINT *,(ICELL(JY,L),L=1,NX),JY
8777 continue
       rad(1)='Plutonium-239'
       rad(2)='Plutonium-238'
       rad(3)='Strontium-90'
      rad(4)='Americium-241'
       rad(5)='Thorium-228'
       rad(6)='Thorium-230'
       rad(7)='Thorium-232'
      rad(8)='Uranium-234'
      rad(9)='Uranium-235'
      rad(10)='Uranium-238'
      rad(11)='Cesium-137'
      rad(12)='Cesium-134'
      rad(13)='Cobalt-60'
      rad(14)='Technetium'
      rad(15)='Cerium-144'
      rad(16)='Cobalt-57'
      rad(17)='Potassium-40'
      rad(18)='Radium-226'
```

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      rad(19)='Radium-228'
      rad(20)='Ruthenium-106'
      rad(21)='Sodium-22'
      rad(22)='Manganese-54'
      rad(23)='Iodine-129'
      rad(24)='Aroclor [Mixed-]'
      rad(25)='Aroclor 1254'
      rad(26)='Aroclor 1260'
      rad(27)='blank'
      rad(27)='blank'
      rad(28)='blank'
      rad(29)='blank'
      rad(30)='blank'
      write(5,*)'*************END OF ECORSK INPUT SUMMARY**************'
      call wnclos(1)
      if(nu.eq.1) print *,'********** END OF INPUT TO ECORSK **********'
      if(nu.eq.1)goto5500
      call wnclos(1)
      call clear_screen@
      call wnopen(0,0,51,2)
      call wnoust('*********** END OF INPUT TO ECORSK ****************')
      call wnouce(2,'press any key')
      call inkey(key)
 5011 call wnclos(1)
      call clear_screen@
      call wnopen(0,0,51,4)
      call wnoust('Do you wish to RE-ENTER input for ECORSK?          ')
      call wnoust('yes: ENTER 1.0; no: ENTER 0.0; ENTER now           ')
      call wnouce(3,'press any key and enter above')
      call inkey(key)
      call wncuxy(1,4)
      read(*,*,err=5011) ans
      if(ans .lt.1.0)goto5500
      rewind 6
      nu=nuu
      call clear_screen@
      goto10
 5500 continue
      nu=nuu
      call clear_screen@
c estimates food intake, kgfwt day, depending on type of animal..mammal,
c bird, reptile, or amphibian. Also, estimates home-range, km2.
       JF=FODTP
       GOTO (1,2,3,4), ANTP
c mammals
    1 FOODI=0.0687*BODWT**0.886
      hmra=1.39*BODWT**1.37
      hmrp=0.032*BODWT
      hmro=(hmra+hmrp)/2.0
      IF(HMR.LE.0.0.AND.JF.EQ.10)HMR=HMRA
      if(HMR.le.0.0.and.jf.eq.100)HMR=hmrp
      if(HMR.le.0.0.and.jf.eq.1000)HMR=hmro
      HMRSD=SQRT(HMR)
      goto20
c birds
    2 FOODI= 0.0582*BODWT**0.651
      hmra=8.3*BODWT**1.37
      hmrp=0.026*BODWT**0.701
      hmro=(hmra+hmrp)/2.0
      if(HMR.le.0.0.and.jf.eq.10)HMR=hmra
      if(HMR.le.0.0.and.jf.eq.100)HMR=hmrp
      IF(HMR.LE.0.0.AND.JF.EQ.1000)HMR=HMRO
```

```
      HMRSD=sqrt(HMR)
      goto20
c reptiles
    3 FOODI= 0.0135*(BODWT*1000.)**0.799
      if(HMR.le.0.0)HMR=(0.12*BODWT**0.95)
      HMRSD=sqrt(HMR)
      goto20
c amphibians (same as reptiles)
    4 FOODI= 0.0135*(BODWT*1000.)**0.799
      if(HMR.le.0.0)HMR=(0.12*BODWT**0.95)
      hmrsd=sqrt(HMR)
   20 continue
      write(14,*)'grid-cell index numbers, col. 1,2=x,y-coord., col. 3='
      write(14,*)'cell index number'
      write(14,*)' '
      write(14,*)' '
      write(14,*)' '
      write(14,*)' '
c construct an (nx x ny) grid of EEU
      anx=nx
      any=ny
      XDIST=EUEWMX-EUEWMN
      ydist=eunsmx-eunsmn
      XCRD(1)=(euewmn+ 0.5*XDIST/anx)
      YCRD(1)=(eunsmn+ 0.5*YDIST/any)
c establishes x and y coordinates (1 to ng for each axis)
      jnn=nx
      if(ny.gt.nx)jnn=ny
      do200j=2,jnn
      if(j.le.nx) xcrd(J)=xcrd(J-1)+xdist/anx
      if(j.le.ny) ycrd(J)=ycrd(J-1)+ydist/any
  200 continue
      nprsp=nprs
      ict=0
      do222j=1,ny
      yj=j
      jr=ny-j+1
      do222l=1,nx
      xl=l
      if(icell(j,l).ne.98)goto333
      ict=ict+1
      nprs=nprs+1
      if(ict.gt.1)goto334
      if(nu.eq.1)goto335
      print *,'Enter area,km2, of individual river grid cells'
      read(*,*) ppar
      print *,'Enter area enhancement factor of river grid cells'
      read(*,*) renh
      print *,'Enter number of contaminants in river grid cells'
      read(*,*) rncon
      goto334
  335 read(15,*) ppar,renh,rncon
  334 jncon=rncon
      cnsc(nprs)=eunsmn+(yj-1.0)*100.
      cewc(nprs)=euewmn+(xl-1.0)*100.
      parea(nprs)=ppar
      enh(nprs)=renh
      prs(nprs)='river'
      accon(nprs)=rncon
  333 jcell(1,j,l)=icell(j,l)
      write(14,*) l,jr,icell(jr,l)
  222 continue
```

```
      print *,'there are  ',ict,'  river grids'
      pause
       do22j=1,nprs
       XDIST=EUEWMX-EUEWMN
       ydist=eunsmx-eunsmn
      iy=1+(-eunsmn+cnsc(j))*any/ydist
      ix=1+(-euewmn+cewc(j))*anx/xdist
      slfrr(j)=0.0
      if(icell(iy,ix).eq.98)slfrr(j)=1.0
      ncon=accon(j)
       do22l=1,ncon
      if(j.ne.nprsp+1)goto988
      if(nu.eq.1)goto988
      print *,'Enter name of river sediment contaminant = ' ,l
      read(*,*) rconc
       print *,'Enter contaminant conc.,mg/kg, pci/g.., contaminant bkg.'
       print *,'conc., mg/kg, pci/g..,and BAF for contaminant ',rconc
      print *,'of river sediment;enter 0.0 for latter if not applicable'
      read(*,*) rcoc,rbkg,rbaf
      print *,'Enter toxicological reference dose and toxicological'
      print *,'reference dose adjustment factor for contaminant ',rconc
      read(*,*)rrfd,rrfda
  988 if(j.le.nprsp)goto986
      if(j.ne.nprsp+1)goto999
      if(nu.eq.1)read(15,*) rconc,rcoc,rbkg,rbaf,rrfd,rrfda
       conc(j,l)=rconc
       coc(j,l)=rcoc
       bkg(j,l)=rbkg
      slbaf(j,l)=rbaf
      rfd(j,l)=rrfd
      rfda(j,l)=rrfda
       goto986
  999 continue
       conc(j,l)=conc(j-1,l)
       coc(j,l)=coc(j-1,l)
       bkg(j,l)=bkg(j-1,l)
      slbaf(j,l)=slbaf(j-1,l)
      rfd(j,l)=rfd(j-1,l)
      rfda(j,l)=rfda(j-1,l)
  986 do21k=1,30
       soilr=soilf
      if(slfrr(j).gt.0.0)soilr=sedmf
      if(rad(k).ne.conc(j,l))goto21
      if(k.lt.24)rfd(j,l)=rfd(j,l)*foodi*soilr/bodwt
       if(k.gt.23)rfd(j,l)=0.007
   21 continue
   22 continue
       write(5,*)'                                                        '
       write(5,*)'***********ECOLOGICAL RISK OUTPUT SUMMARY*************'
       write(5,*)'                                                        '
       write(5,*)'*********using ECORSK, Version 1**********************'
       write(5,*)'*******************************************************'
        WRITE(5,*)'THE AREA,KM2, OF THE HOME-RANGE FOR',ANMAL,' IS',HMR
       write(5,*)'*******************************************************'
        WRITE(5,*)'FOOD CONSUMPTION,KGFWT/DAY, FOR',ANMAL,'IS',FOODI
c unadjusted occupancy factors based on PRS and home-range areas without
c enhancement factors
        do30j=1,NPRS
       occup(J)= parea(J)/hmr
   30 continue
c construct an (nx x ny) grid of EEU
       write(5,*)'*******************************************************'
```

```
      write(5,*) 'for',ANMAL,'maximum E-W distance of EEU in'
       write(5,*)'FEET = ',xdist
      write(5,*) 'for',ANMAL,'maximum N-S distance of EEU in'
       write(5,*)'FEET = ',ydist
       do637jj=1,nprs
       OCCUR(JJ)=0.0
       prsx(jj)=0.0
       prsy(jj)=0.0
       do637ll=1,nc
       hqc(jj,ll)=0.0
       anj(jj,ll)=0.0
  637 continue
c contructs prs cell from eeu template specific to each PRS
      KK=0
       JPRS=1
       IF(ICH2.EQ.4.OR.ICH2.EQ.5)JPRS=NPRSP+1
      IF(ICH2.EQ.3)GOTO6355
       DO633JJ=JPRS,NPRS
      ipx=1+(-euewmn+cewc(JJ))*anx/xdist
      ipy=1+(-eunsmn+cnsc(JJ))*any/ydist
      if(icell(ipy,ipx).ne.99)goto633
      jcell(1,ipy,ipx)=1.0
      idx=2
      arxy=0.0
c estimates home-range area around PRS focal point
      DY=YDIST/ANY
      DX=XDIST/ANX
      jn=-1
      arct=0
      iyct=0
  201 jn=jn+2
      iyct=iyct+1
      jnx=jn
      ixcp=iyct
      if(iaxr.eq.1)goto202
      jnx=jn*iaxr-iaxr+1
      ixcp=(jnx+1)/2
  202 do204ky=1,jn
      aky=ky-iyct
      iycd=aky+ipy
      do205kx=1,jnx
      akx=kx-ixcp
      ixcd=akx+ipx
c if prs focal point x-coord not on eeu skip hq calculations
      if(ixcd.lt.1)goto205
      if(ixcd.gt.NX)goto205
      if(jn.eq.1)PRSY(JJ)=IYCD
      if(jn.eq.1)PRSX(JJ)=IXCD
      axcd=ixcd
      iyinc=(axcd-prsx(jj))*slope
      iycp=iycd+iyinc
c if prs focal point y-coord not on eeu skip hq calculations
      if(iycp.lt.1)goto205
      if(iycp.gt.NY)goto205
      if(icell(iycp,ixcd).eq.0)goto205
      if(jcell(1,iycp,ixcd).ge.98)jcell(1,iycp,ixcd)=1
      if(jcell(1,iycp,ixcd).gt.1)goto205
      jcell(1,iycp,ixcd)=idx
      arxy=arxy+abs(dy*dx)
      arct=arct+1.0
      hmrr=hmr*1.0e06*10.76
      if(arxy.ge.hmrr)goto61
```

```
 205 continue
 204 continue
     GOTO201
  61 continue
c estimates hazard quotient for a given animal on its eeu using each
c prs as a focal point
     do6000jp=1,nprs
     OCCUR(JP)=0.0
     pck(1,jp)=1.0
     insm0=(-eunsmn+cnsc(jp))*any/ydist
     insmx1=(-eunsmn+(cnsc(jp)+0.5*ydist/any))*any/ydist
     para=0.5*sqrt(parea(jp)*1.076E07)
     insmx2=(-eunsmn+(cnsc(jp)+0.5*ydist/any+para))*any/ydist
     insmn1=(-eunsmn+(cnsc(jp)-0.5*ydist/any))*any/ydist
     insmn2=(-eunsmn+(cnsc(jp)-0.5*ydist/any-para))*any/ydist
     iewm0=(-euewmn+cewc(jp))*anx/xdist
     iewmx1=(-euewmn+(cewc(jp)+0.5*xdist/anx))*anx/xdist
     iewmx2=(-euewmn+(cewc(jp)+0.5*xdist/anx+para))*anx/xdist
     iewmn1=(-euewmn+(cewc(jp)-0.5*xdist/anx))*anx/xdist
     iewmn2=(-euewmn+(cewc(JP)-0.5*xdist/anx-para))*anx/xdist
     if(jcell(1,insm0,iewmx1).eq.idx)goto5112
     if(jcell(1,insm0,iewmx2).eq.idx)goto5112
     if(jcell(1,insmx1,iewm0).eq.idx)goto5112
     if(jcell(1,insmx2,iewm0).eq.idx)goto5112
     if(jcell(1,insm0,iewmn1).eq.idx)goto5112
     if(jcell(1,insm0,iewmn2).eq.idx)goto5112
     if(jcell(1,insmx1,iewm0).eq.idx)goto5112
     if(jcell(1,insmx2,iewm0).eq.idx)goto5112
     if(jcell(1,insmx1,iewmx1).eq.idx)goto5112
     if(jcell(1,insmx1,iewmx2).eq.idx)goto5112
     if(jcell(1,insmx2,iewmx1).eq.idx)goto5112
     if(jcell(1,insmx2,iewmx2).eq.idx)goto5112
     if(jcell(1,insmn1,iewmx1).eq.idx)goto5112
     if(jcell(1,insmn1,iewmx2).eq.idx)goto5112
     if(jcell(1,insmn2,iewmx1).eq.idx)goto5112
     if(jcell(1,insmn2,iewmx2).eq.idx)goto5112
     if(jcell(1,insmn1,iewmn1).eq.idx)goto5112
     if(jcell(1,insmn1,iewmn2).eq.idx)goto5112
     if(jcell(1,insmn2,iewmn1).eq.idx)goto5112
     if(jcell(1,insmn2,iewmn2).eq.idx)goto5112
     if(jcell(1,insmx1,iewmn1).eq.idx)goto5112
     if(jcell(1,insmx1,iewmn2).eq.idx)goto5112
     if(jcell(1,insmx2,iewmn1).eq.idx)goto5112
     if(jcell(1,insmx2,iewmn2).eq.idx)goto5112
     pck(1,jp)=0.0
     goto5113
 5112 continue
 5113 do6010kx=1,nx
     if(cewc(jp).gt.xcrd(kx)+0.5*xdist/anx)goto6010
     if(cewc(jp).lt.xcrd(kx)-0.5*xdist/anx)goto6010
     do6020ky=1,ny
c locates prs within coordinate system anywhere with grid cell
     if(cnsc(jp).gt.ycrd(ky)+0.5*ydist/any)goto6020
     if(cnsc(jp).lt.ycrd(ky)-0.5*ydist/any)goto6020
c determines grid cell numbers from pr coordinates
     if(pck(1,jp).le.0.0)goto6020
     ixc=1+(-euewmn+xcrd(kx))*anx/xdist
     iyc=1+(-eunsmn+ycrd(ky))*any/ydist
     if(icell(iyc,ixc).le.0)goto6021
     occur(jp)=occup(jp)*enh(jp)
     if(expfed.le.0.0)goto6020
     ydis=(ixc-prsx(jj))
```

```
      xdis=(iyc-prsy(jj))
      tdis=sqrt(xdis**2+ydis**2)*30.5
     occur(jp)=occup(jp)*exp(-tdis/cexp)-exp(-(tdis+30.5)/cexp)*enh(jp)
      goto6020
c does not allow calculations if cell outside of eeu mapping
 6021 pck(1,jp)=0.0
 6020 continue
 6010 continue
 6000 continue
      sumoca=0.0
      sumocb=0.0
      do6002jp=1,nprs
     if(occur(jp).le.0.0)goto6002
     sumoca=sumoca+occur(jp)
     sumocb=sumocb+occup(jp)
 6002 continue
      do6003jp=1,nprs
     if(occur(jp).le.0.0)goto6003
     occur(jp)=occur(jp)*sumocb/sumoca
 6003 continue
c estimates cumumlative and individual HQ's using each PRS as a focal pt.
      hq(JJ)=0.0
      sumpr=0.0
      do52jp=1,nprs
     ncon=accon(jp)
      hqp(1,JP)=0.0
      do5000l=1,ncon
      HQPRS(1,JP,L)=0.0
     if(rfd(jp,l).le.0.0)goto5000
      IF(COC(JP,L).LE.0.0)GOTO5000
      IF(PCK(1,JP).LE.0.0)GOTO5000
     if(occur(jp).le.0.0)goto5000
     occ=occur(jp)
      soila=soilf
     baf=slbaf(jp,l)
     if(slfrr(jp).gt.0.0)baf=0.0
     if(slfrr(jp).gt.0.0)soila=sedmf
     hqprs(1,jp,l)=(foodi*(soila+baf)/bodwt)*occ
    1*coc(jp,l)/(rfd(jp,l)*rfda(jp,l))
      hqp(1,JP)=hqp(1,JP)+hqprs(1,jp,l)
      sumpr=sumpr+hqprs(1,jp,l)
5000 continue
     hq(jj)=sumpr
  52 continue
     kk=kk+1
     if(kk.gt.1)goto935
     write(8,*)'col. 1,2= x-y-coord of grid, col. 3=partial HQ of'
     write(8,*)'nest site from all PRSs from all COCs for',anmal
     write(8,*)'col. 4=prs index, col. 5,6=x,y-coord. of nest(col. 7)'
     write(8,*)' '
     write(8,*)' '
     write(8,*)' '
 935 do933JPP=1,nprs
     iy=1+(-eunsmn+cnsc(jpp))*any/ydist
     ix=1+(-euewmn+cewc(jpp))*anx/xdist
      write(8,*) ix,iy,hqp(1,jpp),kk,ipx,ipy,prs(jpp),' HQP'
 933 continue
     if(kk.gt.1)goto934
     write(12,*)'col. 1,2 =nest x,y-coord, 3=cummulative HQ of prs'
     write(12,*)'nesting site( col. 5) over all PRSs and COCs, col. 4='
     write(12,*)'prs number'
     write(12,*)' '
```

```
      write(12,*)' '
      write(12,*)' '
  934 PRINT *,'HQ= ',ipx,ipy,HQ(JJ),jj,PRS(JJ)
      write(12,*)ipx,ipy,hq(jj),JJ,PRS(JJ)
      IF(KK.GT.1)GOTO978
      an1=0.0
      an2=0.0
      an3=0.0
      lc=0
      DO976LL=1,20
      SUM(LL)=0.0
  976 CONTINUE
      do972ll=1,nc
      anc(1,ll)=0.0
      anc(2,ll)=0.0
      CONCC(LL)='blank'
      DO972LI=1,8
      SUMC(LI,LL)=0.0
  972 continue
  978 sum(1)=sum(1)+hq(JJ)**2
      sum(2)=sum(2)+hq(JJ)
      an1=an1+1.0
      do979JP=1,nprs
      if(OCCUR(JP).LE.0.0)goto979
      NCON=ACCON(JP)
      sum(3)=sum(3)+hqp(1,jp)**2
      sum(4)=sum(4)+hqp(1,jp)
      an2=an2+1.0
      do9799l=1,ncon
      sum(5)=sum(5)+hqprs(1,jp,l)**2
      sum(6)=sum(6)+hqprs(1,jp,l)
      an3=an3+1.0
      lcc=lc
      if(lc.eq.0)lcc=1
      do9898ll=1,lcc
      if(concc(ll).eq.conc(jp,l))goto9899
 9898 continue
      lc=lc+1
      hqc(jj,lc)=hqprs(1,jp,l)
      sumc(1,lc)=hqprs(1,jp,l)**2
      sumc(2,lc)=hqprs(1,jp,l)
      anc(1,lc)=1.0
      anj(jj,lc)=1.0
      concc(lc)=conc(jp,l)
      goto9799
 9899 lcc=lc
      if(lc.eq.0)lcc=1
      do989ll=1,lcc
      if(concc(ll).ne.conc(jp,l))goto989
      hqc(jj,ll)=hqc(jj,ll)+hqprs(1,jp,l)
      sumc(1,ll)=sumc(1,ll)+hqprs(1,jp,l)**2
      sumc(2,ll)=sumc(2,ll)+hqprs(1,jp,l)
      anc(1,ll)=anc(1,ll)+1.0
      anj(jj,ll)=anj(jj,ll)+1.0
      goto9799
  989 continue
 9799 continue
  979 continue
      if(kk.gt.1)goto936
      write(13,*) ngn,'cells showing home-range location of prs nesting'
      write(13,*)'sites and other PRS types on EEU.  0=outside EEU'
      write(13,*)'grid boundary, 1=eeu,4=home-range, 6=nesting area'
```

```
   write(13,*)'outside home-range, 8= river eeu, 10=nest site for'
   write(13,*)anmal,'col. 1,2=x,y-coord.(col & row), 3=grid value(z)'
    write(13,*)'col. 4=prs count, col. 5= nest site id'
936 akk=kk
   if(amod(akk,habtmd)-0.0) 668,664,668
664 ngn=NY*NX
    do64j=1,ny
    JR=ny-j+1
    do65l=1,nx
    do67mm=1,nprs
    iyp=prsy(jj)
    ixp=prsx(jj)
    if(iyp.eq.jr.and.ixp.eq.l)jcell(1,jr,l)=10
   if(jcell(1,jr,l).eq.10)goto67
   if(icell(jr,l).lt.98) goto67
   if(icell(jr,l).eq.98)jcell(1,jr,l)=8
   if(icell(jr,l).eq.99)jcell(1,jr,l)=6
   if(icell(jr,l).eq.2)jcell(1,jr,l)=4
 67 continue
 65 continue
    do68l=1,nx
    write(13,*) l,jr,jcell(1,JR,l),kk,PRS(JJ)
 68 continue
 64 continue
668 continue
   if(kk.gt.1)goto937
   write(11,*)'col. 1,2=x,y-coord. of nest, col. 3=partial HQ for a'
   write(11,*)'nest site due a given coc (col. 6), col. 4=coc index'
   write(11,*)'col. 5=no. of obs. for coc for nest site, col. 7= prs'
   write(11,*)'index number'
   write(11,*)' '
   write(11,*)' '
937 DO642LL=1,LC
    WRITE(11,*) ipx,ipy,HQC(JJ,LL),LL,anj(jj,ll),CONCC(LL),jj,' HQPC'
642 CONTINUE
    do63j=1,1
    do63l=1,ny
    do63m=1,nx
    jcell(1,l,m)=icell(l,m)
 63 continue
633 CONTINUE
    do634jj=1,nprs
    if(prsx(jj).le.0.0.or.prsy(jj).le.0.0)goto634
    do635ll=1,lc
    sumc(5,ll)=sumc(5,ll)+hqc(jj,ll)**2
    sumc(6,ll)=sumc(6,ll)+hqc(jj,ll)
   anc(2,ll)=anc(2,ll)+1.0
635 continue
634 continue
    do636jj=1,nprs
    OCCUR(JJ)=0.0
    do636ll=1,nc
    hqc(jj,ll)=0.0
    anj(jj,ll)=0.0
636 continue
    sum(7)=0.0
    sum(8)=0.0
    sum(9)=0.0
   IF(AN1.GT.1.0)sum(7)=sqrt((sum(1)-(sum(2)**2)/an1)/(an1-1.0))
   IF(AN2.GT.1.0)sum(8)=sqrt((sum(3)-(sum(4)**2)/an2)/(an2-1.0))
   IF(AN3.GT.1.0)sum(9)=sqrt((sum(5)-(sum(6)**2)/an3)/(an3-1.0))
    IF(AN1.GT.0.0)sum(2)=sum(2)/an1
```

```
      IF(AN2.GT.0.0)sum(4)=sum(4)/an2
      IF(AN3.GT.0.0)sum(6)=sum(6)/an3
      write(5,*)'******************************************************'
      write(5,*)'mean total HQ for',anmal,'all PRSs'
      write(5,*)'col.1=mean, col. 2=mean stnd. error, col. 3= OBS'
      write(5,*) sum(2),sum(7),an1
      PRINT *,'SUM2,7=  ',SUM(2),SUM(7),AN1
      write(5,*)'******************************************************'
      write(5,*)'mean partial HQ for',anmal,'all PRS X PRS'
      write(5,*)'col.1=mean, col. 2=mean stnd. error, col. 3= OBS'
      write(5,*) sum(4),sum(8),an2
      PRINT *,'SUM4,8=  ',SUM(4),SUM(8),AN2
      write(5,*)'******************************************************'
      write(5,*)'mean partial HQ for',anmal,'all PRS X PRS X COC'
      write(5,*)'col.1=mean, col. 2=mean stnd. error, col. 3= OBS'
      write(5,*) sum(6),sum(9),an3
      PRINT *,'SUM6,9=  ',SUM(6),SUM(9),AN3
      WRITE(5,*) 'MEAN HQ FOR ',ANMAL,'BY COC; COL.1=MEAN, COL.2'
      WRITE(5,*)' = MEAN STND. ERROR, COL.3=OBS'
      do643ll=1,lc
      VAL=0.0
      if(anc(1,ll).gt.1.0)
     1val=(sumc(1,ll)-(sumc(2,ll)**2)/anc(1,ll))/(anc(1,ll)-1.0)
      SUMC(3,LL)=0.0
      IF(ANC(1,LL).GT.1.0.and.val.ge.0.0)SUMC(3,LL)=sqrt(val)
      SUMC(4,LL)=0.0
      IF(ANC(1,LL).GT.0.0)SUMC(4,LL)=SUMC(2,LL)/ANC(1,LL)
      PRINT *,'SUMC4,3 ',SUMC(4,LL),SUMC(3,LL),ANC(1,LL),CONCC(LL)
      WRITE(5,*) SUMC(4,LL),SUMC(3,LL),ANC(1,LL),CONCC(LL),LL
      SUMC(1,LL)=0.0
      SUMC(2,LL)=0.0
      ANC(1,LL)=0.0
  643 continue
      WRITE(5,*) 'MEAN TOTAL HQ FOR ',ANMAL,'BY COC; COL.1=MEAN, COL.2'
      WRITE(5,*)' = MEAN STND. ERROR, COL.3=OBS'
      do644ll=1,lc
      VAL=0.0
      IF(ANC(2,LL).GT.1.0)
     1VAL=(SUMC(5,LL)-(SUMC(6,LL)**2)/ANC(2,LL))/(ANC(2,LL)-1.0)
      SUMC(7,LL)=0.0
      SUMC(8,LL)=0.0
      IF(ANC(2,LL).GT.1.0.AND.VAL.GE.0.0)SUMC(7,LL)=SQRT(VAL)
      IF(ANC(2,LL).GT.0.0)SUMC(8,LL)=SUMC(6,LL)/ANC(2,LL)
      PRINT *,'SUMC8,7 ',SUMC(8,LL),SUMC(7,LL),ANC(2,LL),CONCC(LL)
      WRITE(5,*) SUMC(8,LL),SUMC(7,LL),ANC(2,LL),CONCC(LL),LL
  644 CONTINUE
 6355 CONTINUE
      IF(ICH2.EQ.2.OR.ICH2.EQ.4.OR.ICH2.EQ.6)GOTO6356
      do638jj=1,nprs
      prsx(jj)=0.0
      prsy(jj)=0.0
      do638ll=1,nc
      hqc(jj,ll)=0.0
      anj(jj,ll)=0.0
  638 continue
c sets random number generator at given location
      do6565l=1,iseed
      xseed=random(2)
 6565 continue
c ******* HQ selected for random points on eeu ***********************
      KK=0
      do70JJ=1,nq
```

```
c randomly selects nr random focal points on eeu grid, same for all
  77 yrnd= abs(random(2))
     xrnd= abs(random(2))
     cnsr(JJ)=INT(eunsmn+yrnd*ydist)
     cewr(JJ)=INT(euewmn+xrnd*xdist)
     IYV=1+(-EUNSMN+CNSR(JJ))*ANY/YDIST
     IXV=1+(-EUEWMN+CEWR(JJ))*ANX/XDIST
     IF(ICELL(IYV,IXV).ne.99)GOTO77
     jcell(1,iyv,ixv)=1
     IDX=2
     arxy=0.0
c estimates home-range area around random focal point on eeu
     dy=ydist/any
     dx=xdist/anx
     JN=-1
     IYCT=0.0
     ARCT=0.0
 601 JN=JN+2
     iyct=iyct+1
     jnx=jn
     ixcp=iyct
     if(iaxr.eq.1)goto602
     jnx=jn*iaxr-iaxr+1
     ixcp=(jnx+1)/2
 602 do604KY=1,JN
     AKY=KY-IYCT
     iycd=aky+iyv
     do605KX=1,JNX
     akx=kx-ixcp
     ixcd=akx+ixv
     IF(IXCD.LT.1)GOTO605
     IF(IXCD.GT.NX)GOTO605
     if(JN.eq.1)prsy(JJ)=IYCD
     if(JN.eq.1)prsx(JJ)=IXCD
     axcd=ixcd
     iyinc=(axcd-prsx(jj))*slope
     iycp=iycd+iyinc
     if(iycp.lt.1)goto605
     if(iycp.gt.ny)goto605
     if(icell(iycp,ixcd).eq.0)goto605
     IF(JCELL(1,IYCP,IXCD).ge.98)JCELL(1,IYCP,IXCD)=1
     if(jcell(1,iycp,ixcd).gt.1.)goto605
     JCELL(1,iycp,ixcd)=idx
     arxy=arxy+abs(dy*dx)
     ARCT=ARCT+1
     HMRR=HMR*1.0E+06*10.76
     if(arxy.ge.HMRR)goto603
 605 continue
 604 continue
     goto601
 603 continue
c estimates hazard quotient for a given animal on its eeu using each
c random nesting site as a focal point
     do1000jp=1,nprs
     OCCUR(JP)=0.0
     pck(1,jp)=1.0
c does not enter if utm coordinates not used (all are =0.0)
     para=0.5*sqrt(parea(jp)*1.07E07)
     insm0=(-eunsmn+cnsc(jp))*any/ydist
     insmx1=(-eunsmn+(cnsc(jp)+0.5*ydist/any))*any/ydist
     insmx2=(-eunsmn+(cnsc(jp)+0.5*ydist/any+para))*any/ydist
     insmn1=(-eunsmn+(cnsc(jp)-0.5*ydist/any))*any/ydist
```

```
      insmn2=(-eunsmn+(cnsc(jp)-0.5*ydist/any-para))*any/ydist
      iewm0=(-euewmn+cewc(jp))*anx/xdist
      iewmx1=(-euewmn+(cewc(jp)+0.5*xdist/anx))*anx/xdist
      iewmx2=(-euewmn+(cewc(jp)+0.5*xdist/anx+para))*anx/xdist
      iewmn1=(-euewmn+(cewc(jp)-0.5*xdist/anx))*anx/xdist
      iewmn2=(-euewmn+(cewc(jp)-0.5*xdist/anx-para))*anx/xdist
      if(JCELL(1,insm0,iewmx1).eq.idx)goto1112
      if(JCELL(1,insm0,iewmx2).eq.idx)goto1112
      if(JCELL(1,insmx1,iewm0).eq.idx)goto1112
      if(JCELL(1,insmx2,iewm0).eq.idx)goto1112
      if(JCELL(1,insm0,iewmn1).eq.idx)goto1112
      if(JCELL(1,insm0,iewmn2).eq.idx)goto1112
      if(JCELL(1,insmx1,iewm0).eq.idx)goto1112
      if(JCELL(1,insmx2,iewm0).eq.idx)goto1112
      if(JCELL(1,insmx1,iewmx1).eq.idx)goto1112
      if(JCELL(1,insmx1,iewmx2).eq.idx)goto1112
      if(JCELL(1,insmx2,iewmx1).eq.idx)goto1112
      if(JCELL(1,insmx2,iewmx2).eq.idx)goto1112
      if(JCELL(1,insmn1,iewmx1).eq.idx)goto1112
      if(JCELL(1,insmn1,iewmx2).eq.idx)goto1112
      if(JCELL(1,insmn2,iewmx1).eq.idx)goto1112
      if(JCELL(1,insmn2,iewmx2).eq.idx)goto1112
      if(JCELL(1,insmn1,iewmn1).eq.idx)goto1112
      if(JCELL(1,insmn1,iewmn2).eq.idx)goto1112
      if(JCELL(1,insmn2,iewmn1).eq.idx)goto1112
      if(JCELL(1,insmn2,iewmn2).eq.idx)goto1112
      if(JCELL(1,insmx1,iewmn1).eq.idx)goto1112
      if(JCELL(1,insmx1,iewmn2).eq.idx)goto1112
      if(JCELL(1,insmx2,iewmn1).eq.idx)goto1112
      if(JCELL(1,insmx2,iewmn2).eq.idx)goto1112
      pck(1,jp)=0.0
      goto1113
 1112 continue
 1113 do1010kx=1,nx
      if(cewc(jp).gt.xcrd(kx)+0.5*xdist/anx)goto1010
      if(cewc(jp).lt.xcrd(kx)-0.5*xdist/anx)goto1010
      do1020ky=1,ny
c locates prs within coordinate system anywhere with grid cell
      if(cnsc(jp).gt.ycrd(ky)+0.5*ydist/any)goto1020
      if(cnsc(jp).lt.ycrd(ky)-0.5*ydist/any)goto1020
c determines grid cell numbers from pr coordinates
      if(pck(1,jp).le.0.0)goto1020
      ixc=1+(-euewmn+xcrd(kx))*ANX/XDIST
      iyc=1+(-EUNSMN+ycrd(ky))*any/YDIST
      if(icell(iyc,ixc).le.0)goto1021
      occur(jp)=occup(jp)*enh(jp)
      if(expfed.le.0.0)goto1020
      ydis=(ixc-prsx(jj))
      xdis=(iyc-prsy(jj))
      tdis=sqrt(xdis**2+ydis**2)*30.5
      occur(jp)=occup(jp)*exp(-tdis/cexp)-exp(-(tdis+30.5)/cexp)*enh(jp)
      goto1020
c does not allow calculations if cell outside of eeu mapping
 1021 pck(1,jp)=0.0
 1020 continue
 1010 continue
 1000 continue
      sumoca=0.0
      sumocb=0.0
      do1002jp=1,nprs
      if(occur(jp).le.0.0)goto1002
      sumoca=sumoca+occur(jp)
```

```
    sumocb=sumocb+occup(jp)
1002 continue
    do1003jp=1,nprs
    if(occur(jp).le.0.0)goto1003
    occur(jp)=occur(jp)*sumocb/sumoca
1003 continue
    hq(JJ)=0.0
    sumpr=0.0
    do91JP=1,nprs
    NCON=ACCON(JP)
    hqp(1,JP)=0.0
    do9001l=1,ncon
    HQPRS(1,JP,L)=0.0
    IF(RFD(JP,L).LE.0.0)GOTO9001
    IF(COC(JP,L).LE.0.0)GOTO9001
    IF(OCCUR(JP).LE.0.0)GOTO9001
    IF(PCK(1,JP).LE.0.0)GOTO9001
    occ=occur(jp)
    soila=soilf
    baf=slbaf(jp,l)
    if(slfrr(jp).gt.0.0)baf=0.0
    if(slfrr(jp).gt.0.0)soila=sedmf
    hqprs(1,JP,l)=(foodi*(soila+baf)/bodwt)*occ*coc(JP,l)/
   1(rfd(JP,l)*rfda(JP,l))
    hqp(1,JP)=hqp(1,JP)+hqprs(1,JP,l)
    sumpr=sumpr+hqprs(1,JP,l)
    hq(JJ)=sumpr
9001 continue
  91 CONTINUE
     kk=kk+1
     if(kk.gt.1)goto938
    write(8,*)'col. 1,2= x-y-coord of grid, col. 3=partial HQ of'
    write(8,*)'rand. nest site from all PRSs from all COCs for',anmal
    write(8,*)'col. 4=rand. nest index, col. 5,6=x,y-coord. of nest'
    write(8,*)' '
    write(8,*)' '
    write(8,*)' '
938  do966JPP=1,nprs
    iy=1+(-eunsmn+cnsc(jpp))*any/ydist
    ix=1+(-euewmn+cewc(jpp))*anx/xdist
    write(8,*) ix,iy,hqp(1,jpp),kk,ixv,iyv,prs(jpp),' HQP'
 966 continue
    if(kk.gt.1)goto939
    write(12,*)'col. 1,2 =nest x,y-coord, 3=cummulative HQ of random'
    write(12,*)'nesting site index( col. 4) over all PRSs and COCs'
    write(12,*)' '
    write(12,*)' '
    write(12,*)' '
    write(12,*)' '
 939 PRINT *,'HQ= ',ixv,iyv,HQ(JJ),jj
    write(12,*)ixv,iyv,hq(jj),jj
    IF(KK.GT.1)GOTO983
    an1=0.0
    an2=0.0
    an3=0.0
    lc=0
    DO982LL=1,20
    SUM(LL)=0.0
 982 CONTINUE
    DO985LL=1,nc
    anc(1,ll)=0.0
    anc(2,ll)=0.0
```

```
      concc(ll)='blank'
      DO985LI=1,8
      SUMC(LI,LL)=0.0
 985 CONTINUE
 983 sum(1)=sum(1)+hq(JJ)**2
      sum(2)=sum(2)+hq(JJ)
      an1=an1+1.0
      do879jp=1,nprs
      if(OCCUR(JP).LE.0.0)goto879
      NCON=ACCON(JP)
      sum(3)=sum(3)+hqp(1,jp)**2
      sum(4)=sum(4)+hqp(1,jp)
      an2=an2+1.0
      do8799l=1,ncon
      sum(5)=sum(5)+hqprs(1,jp,l)**2
      sum(6)=sum(6)+hqprs(1,jp,l)
      an3=an3+1.0
      lcc=lc
      if(lc.eq.0)lcc=1
      do9892ll=1,lcc
      if(concc(ll).eq.conc(jp,l))goto9891
9892 continue
      lc=lc+1
      hqc(jj,lc)=hqprs(1,jp,l)
      sumc(1,lc)=hqprs(1,jp,l)**2
      sumc(2,lc)=hqprs(1,jp,l)
      anc(1,lc)=1.0
      anj(jj,lc)=1.0
      concc(lc)=conc(jp,l)
      goto9794
9891 lcc=lc
      if(lc.eq.0)lcc=1
      do987ll=1,lcc
      if(concc(ll).ne.conc(jp,l))goto987
      hqc(jj,ll)=hqc(jj,ll)+hqprs(1,jp,l)
      sumc(1,ll)=sumc(1,ll)+hqprs(1,jp,l)**2
      sumc(2,ll)=sumc(2,ll)+hqprs(1,jp,l)
      anc(1,ll)=anc(1,ll)+1.0
      anj(jj,ll)=anj(jj,ll)+1.0
      goto9794
 987 continue
9794 continue
8799 CONTINUE
 879 continue
      ngn=ny*nx
      if(kk.gt.1)goto940
      write(13,*) ngn,'cells showing home-range location of random nest'
      write(13,*)'sites and other grid types on EEU.  0=outside EEU'
      write(13,*)'0=grid boundary, 1=eeu,4=home-range,6=rand. nest area'
      write(13,*)'outside home-range, 8= river eeu, 10=nest site for'
      write(13,*)anmal,'col. 1,2=x,y-coord.(col & row), 3=grid value(z)'
      write(13,*)'col. 4=prs count, col. 5,6=x,y-coord. of nest site'
 940 akk=kk
      if(amod(akk,habtmd)-0.0) 748,756,748
 756 akk=kk
      do74jR=1,ny
      JJJ=ny-jR+1
      do75l=1,nx
      DO76MM=1,NPRS
      iyp=prsy(jj)
      ixp=prsx(jj)
      if(iyp.eq.jjj.and.ixp.eq.l)jcell(1,jjj,l)=10
```

```
    if(jcell(1,jjj,l).eq.10)goto76
    if(icell(jjj,l).lt.98) goto76
    if(icell(jjj,l).eq.98)jcell(1,jjj,l)=8
    if(icell(jjj,l).eq.99)jcell(1,jjj,l)=6
    if(icell(jjj,l).eq.2)jcell(1,jjj,l)=4
 76 continue
 75 continue
    do78l=1,nx
    write(13,*) l,jjj,jcell(1,JJJ,l),kk,prsx(jj),prsy(jj)
 78 continue
 74 continue
748 continue
    if(kk.gt.1)goto941
    write(11,*)'col. 1,2=x,y-coord. of nest, col. 3=partial HQ for a'
    write(11,*)'nest site due a given coc (col. 6), col. 4=coc index'
    write(11,*)'col. 5=no. of obs. for coc for nest site, col. 7=nest'
    write(11,*)'index number'
    write(11,*)' '
    write(11,*)' '
941 DO641LL=1,LC
     WRITE(11,*)ixv,iyv,HQC(JJ,LL),LL,anj(jj,ll),CONCC(LL),kk,' HQPC'
641 CONTINUE
    do62j=1,ny
    do62l=1,nx
    jcell(1,j,l)=icell(j,l)
 62 continue
 70 CONTINUE
    do834jj=1,nq
    do835ll=1,lc
    sumc(5,ll)=sumc(5,ll)+hqc(jj,ll)**2
    sumc(6,ll)=sumc(6,ll)+hqc(jj,ll)
    anc(2,ll)=anc(2,ll)+1.0
835 continue
834 continue
C********************************************************
    IF(AN1.GT.1.0)sum(7)=sqrt((sum(1)-(sum(2)**2)/an1)/(an1-1.0))
    IF(AN2.GT.1.0)sum(8)=sqrt((sum(3)-(sum(4)**2)/an2)/(an2-1.0))
    IF(AN3.GT.1.0)sum(9)=sqrt((sum(5)-(sum(6)**2)/an3)/(an3-1.0))
     IF(AN1.GT.0.0)sum(2)=sum(2)/an1
     IF(AN2.GT.0.0)sum(4)=sum(4)/an2
     IF(AN3.GT.0.0)sum(6)=sum(6)/an3
    write(5,*)'******************************************************'
    write(5,*)'mean total HQ for',anmal,'all RANDOM sites'
     write(5,*)'col.1=mean, col. 2=mean stnd. error, col. 3=DF'
    write(5,*) sum(2),sum(7),an1
     PRINT *,'SUM2,7= ',SUM(2),SUM(7),AN1
    write(5,*)'******************************************************'
    write(5,*)'mean partial HQ for',anmal,'all RANDOM X PRS'
     write(5,*)'col.1=mean, col. 2=mean stnd. error, col. 3=DF'
    write(5,*) sum(4),sum(8),an2
     PRINT *,'SUM4,8= ',SUM(4),SUM(8),AN2
    write(5,*)'******************************************************'
    write(5,*)'mean partial HQ for',anmal,'RANDM X PRS X PRS X COC'
    write(5,*)'col.1=mean, col. 2=mean stnd. error, col. 3=DF'
    write(5,*) sum(6),sum(9),an3
     PRINT *,'SUM6,9= ',SUM(6),SUM(9),AN3
     WRITE(5,*) 'MEAN HQ FOR ',ANMAL,'BY COC; COL.1=MEAN, COL.2'
     WRITE(5,*)' = MEAN STND. ERROR, COL.3=OBS'
    do645ll=1,lc
    VAL=0.0
    if(anc(1,ll).gt.1.0)
   1val=(sumc(1,ll)-(sumc(2,ll)**2)/anc(1,ll))/(anc(1,ll)-1.0)
```

```
      SUMC(3,LL)=0.0
      IF(ANC(1,LL).GT.1.0.and.val.ge.0.0)SUMC(3,LL)=sqrt(val)
      SUMC(4,LL)=0.0
      IF(ANC(1,LL).GT.0.0)SUMC(4,LL)=SUMC(2,LL)/ANC(1,LL)
      PRINT *,'SUMC4,3 ',SUMC(4,LL),SUMC(3,LL),ANC(1,LL),CONCC(LL)
      WRITE(5,*) SUMC(4,LL),SUMC(3,LL),ANC(1,LL),CONCC(LL),LL
  645 continue
      WRITE(5,*) 'MEAN TOTAL HQ FOR ',ANMAL,'BY COC; COL.1=MEAN, COL.2'
      WRITE(5,*)' = MEAN STND. ERROR, COL.3=OBS'
      do646 ll=1,lc
      VAL=0.0
      IF(ANC(2,LL).GT.1.0)
     1VAL=(SUMC(5,LL)-(SUMC(6,LL)**2)/ANC(2,LL))/(ANC(2,LL)-1.0)
      SUMC(7,LL)=0.0
      SUMC(8,LL)=0.0
      IF(ANC(2,LL).GT.1.0.AND.VAL.GE.0.0)SUMC(7,LL)=SQRT(VAL)
      IF(ANC(2,LL).GT.0.0)SUMC(8,LL)=SUMC(6,LL)/ANC(2,LL)
      PRINT *,'SUMC8,7 ',SUMC(8,LL),SUMC(7,LL),ANC(2,LL),CONCC(LL)
      WRITE(5,*) SUMC(8,LL),SUMC(7,LL),ANC(2,LL),CONCC(LL),LL
  646 CONTINUE
      write(5,*)'***********END OF ECORSK OUTPUT SUMMARY***************'
c  resets ecorsk for new test
c
 6356 go to 10
c
  120 stop
      end
```

Table A-3. Toxicity reference values (TRVs) used in the preliminary risk assessment of the American peregrine falcon at the Los Alamos National Laboratory.

ANALYTE Inorganics	NOAEL mg/kg/d	Reference	Test Species	Chemical Form	Endpoint, Comment and/or Test Species	Comparison NOAEL (mg/kg/d)	Reference to Comparison Value
Aluminum	109.700	Carriere et al., 1986	ringed dove	Al (SO4)	reproduction		
Antimony	0.035	LANL, 1994				0.035=rat LOAEL, whole body & blood	LANL, 1994 and EPA, 1996
Arsenic	1.160	Whitworth et al., 1991 In: Weston, 1995.	1-d mallard		Chronic NOAEL, behavioral effects	1) 0.001; 2) 0.009 mg/L = human oral NOAEL	1) LANL, 1994; 2) EPA, 1996
Barium	20.800	Johnson et al., 1960	1-day chicks	hydroxide	mortality	0.21= oral human NOAEL for BaCn, cardiovasc. target	LANL, 1994
Boron	28.800	Smith and Anders, 1989	mallard ducks	boric acid	reproduction	28.8	
Beryllium	0.540	EPA, 1993c	rat		Oral rat NOAEL (EPA, 1996)	= oral rat NOAEL (EPA, 1996)	
Cadmium	1.450	White et al., 1978	mallard ducks	chloride	reproduction	1. 0.005; 2. 19.1 = oral NOAEL in rat	1. LANL, 1994 2. EPA, 1996
Calcium	24.000	Shane and Young, 1968 In: Weston, 1995	White leghorn chick		Chronic death from renal failure	None	
Chromium III	3.810	Hill and Matrone, 1970 In: Weston, 1995	3-wk chick		Chronic weight loss and mortality	1. 1468; 2. 5% = oral NOAEL, rat	1. LANL, 1994; 2. EPA, 1996
Chromium Vl	3.800	Hill and Matrone, 1970 In: Weston, 1995	3-wk chick		Chronic NOAEL, body weight	2.4 = oral NOAEL, rat	LANL, 1994 /EPA, 1996

Table A-3 (cont.)

ANALYTE Inorganics	NOAEL mg/kg/d	Reference	Test Species	ChemicalForm	Endpoint, Comment and/or Test Species	Comparison NOAEL (mg/kg/d)	Reference to Comparison Value
Cobalt							
Copper	46.970	Mehring et al., 1960	1 day chicks	oxide	growth, mortality	5.3 mg = single dose NOAEL, human	
Cyanide	10.800	EPA,1993b	rat		oral NOAEL		
Fluorides	4.500	LANL, 1994				0.06 = oral NOAEL, human	
Hydrogen Fluoride							
Iron							
Lead	1.130	Edens et al., 1976	Japanese quail	acetate	reproduction	0.9	LANL, 1994
Lithium	480.000	Opresko et al., 1994	red-winged blackbird	$LiCl_2$	NOAEL = [15,000 ppm (feeding dose) x bw]/bw; no endpoint stated		
Magnesium	32.000	Opresko et al., 1994	Japanese quail		NOAEL = [1,000 ppm (feeding dose) x bw]/bw; endpoint=physiology	no EPA, 1996 value	
Manganese	9.140	Vohra and Kratzer, 1968 In: Weston, 1995	turkey poults		Acute NOAEL	1) 0.14=oral human NOAEL; 2) 0.005	1) EPA, 1996; 2) LANL, 1994
Mercury	0.064	Opresko et al., 1994	Japanese quail	HgCl	NOAEL = [2 ppm (feeding dose) x bw]/bw; endpoint=physiology	1) 0.32; 2) 0.0064	1) LANL, 1994; 2) ORNL, CH_3Hg NOAEL for mallard
Molybdenum	0.280	Lepore and Miller, 1964 In: Weston, 1995	7-mo hen		50% embryo mortality [LD_{50}] x 0.01		

Table A-3 (cont.)

Analyte	NOAEL mg/kg/d	Reference	Test Species	Chemical Form	Endpoint, Comment and/or Test Species	Comparison NOAEL (mg/kg/d)	Reference to Comparison Value
Nickel	0.676	Weber and Reid, 1968 In: Weston, 1995	1-d chick		wt. gain	1) 5.0; 2)100 ppm = rat diet NOAEL	1) LANL, 1994; 2) EPA, 1996
Nitrate	1.600	LANL, 1994					
Nitrite	1.000	LANL, 1994				10 ppm = oral human NOAEL, methemoglobinemia	EPA 1993b
Potassium		LANL, 1994					
Selenium	0.400	Heinz et al., 1989	mallard duck		reproduction	1. 0.015; 2. 0.853 mg/d = human NOAEL, whole body	1. LANL, 1994; 2. EPA, 1996
Silver	0.344	Peterson and Jensen, 1975 In: Weston, 1995	1-d chick		Chronic growth and mortality	0.0014	LANL, 1994
Sodium	124.000	Scott et al., 1960 In: Weston, 1995	1-d quail		Chronic NOAEL, "no effects"	20.4=oral NOAEL in rat, CNS	EPA, 1996
Thallium	1.200	Opresko et al., 1994	golden eagle	$TlSO_4$	LD_{50} x 0.01	1) 0.22=oral NOAEL, rat (ThO_2); 2) 0.192=LC_{50} pheasant.	1) Hudson et al., 1984 In: Weston, 1995.
Vanadium	0.320	Opresko et al., 1994	mallard duck	$VaSO_4$	NOAEL = [10 ppm (feeding dose) x bw]/bw; endpoint=blood chemistry	5 ppm=rat oral diet NOAEL	EPA, 1996
Zinc	1.935	Stahl et al., 1990	white leghorn hens		reproduction	1) 10.1=chronic "no effects" NOAEL in 1-d chicks; 2) 0.2231="acute dose" x 0.01 in great horned owl; 3) 0.1	1) Oh et al., 1979 In: Weston, 1995; 2) Opresko et al., 1994 ; 3) LANL, 1994

Table A-3 (cont.)

Volatile Organic Compounds	NOAEL (mg/kg/d)	Reference	Test Species	Chemical Form	Endpoint, Comment and/or Test Species	Comparison NOAEL (mg/kg/d)	Reference to Comparison Value
1,1,1,2-Tetrachloroethane						89.300	LANL, 1994
1,1,1-Trichloroethane	1000.0	Lane et al., 1982 In: Opresko et al., 1994	mouse		reproduction, chronic NOAEL		
1,1,2,2-Tetrachloroethane							
1,1,2-trichloro-1,2,2-trifluoroethane						273.000	LANL, 1994
1,1,2-Trichloroethane						3.900	LANL, 1994
1,1-Dichloroethane							
1,1-Dichloroethene						9.000	LANL, 1994
1,2,3-Trimethyl benzene(d)							
1,2,4-Trimethylbenzene							
1,2-di bromo-3-Chloropropane							
1,2-Dichloroethane	17.2	Alumot et al., 1976b In: Opresko et al., 1994	chicken		reproduction, chronic NOAEL		
1,2-Dichloropropane							
1,3,5-Trimethylbenzene							
1,3- Dichloropropene	3.0	LANL, 1994					
2-Butanone (Methyl ethyl ketone)	1771.0	LANL, 1994					
2-Hexanone(g)							
3-carene(d)							
4-hydroxy-4-methyl-2-pentanone(d)							
4-isopropytoluene							
4-Methyl-2-pentanone (MIK)							
Acetone	565.0	Hill and Camardese, 1986	Japanese quail		acute toxicity		

Table A-3 (cont.)

Volatile Organic Compounds	NOAEL (mg/kg/d)	Reference	Test Species	Chemical Form	Endpoint, Comment and/or Test Species	Comparison NOAEL (mg/kg/d)	Comparison Value Reference
Benzene	26.36	Nawrot and Staples, 1979 In: Opresko et al., 1994	mouse		reproduction		
Benzoic acid	4.46	LANL, 1994					
Bromobenzene(d)							
Bromochloromethane(d)							
Bromodichloromethane	17.9	EPA, 1993c	mouse		kidney		
Bromoform	17.9	EPA, 1993c	rat		liver, NOEL		
Bromomethane	1.4	LANL, 1994					
Carbon disulfide	11.0	EPA, 1993c	rabbit		fetus, NOAEL		
Carbon tetrachloride	16	Alumot et al., 1976a In: Opresko et al., 1994	rat		reproduction, chronic NOAEL	0.71	LANL,1994
Chlorobenzene	19.0	LANL, 1994					
Chloroethane							
Chloroethane							
Chloroform	15.0	Palmer et al., 1979 In: Opresko et al., 1994	rat		liver, kidney, gonad condition, chronic NOAEL	12.9	LANL, 1994
Chloromethane							
cis-1 ,2-Dichloroethene							
cis-1,3-Dichloropropene							
Dibromodichloromethane	21.4	EPA, 1993c	rat		liver		
Dibromoethane							
dibromomethane(d)							
Dichlorodifluoromethane (1,2)-(1,3)-(2,2)	15.0	LANL, 1994					
Dichloropropane (1,2)							

Table A-3 (cont.)

Volatile Organic Compounds	NOAEL (mg/kg/d)	Reference	Test Species	Chemical Form	Endpoint, Comment and/or Test Species	Comparison NOAEL (mg/kg/d)	Comparison Value Reference
Ethyl benzene	97.1	LANL, 1994					
hexanone (methyl butyl ketone)(d)							
Isopropyl benzene							
Limonene(d)							
Methanol	50.0	EPA 1982 In: Opresko et al., 1994	rat		mortality, blood chemisrty, NOEL	500.0	LANL, 1994
Methyl Iodide(d)							
Methylene Chloride	5.85	NCA 1986 In: Opresko et al., 1994	rat		liver histology, chronic NOAEL	5.85	LANL,1994
n-butylbenzene(d)							
n-Hexane							
Nitrotoluenes							
o-Chlorotoluene	20.0	EPA, 1993c			whole body		
p-Chlorotoluene(d)							
propyl benzene(d)							
Styrene	200.0	LANL, 1994					
Tetrachloroethylene	14.0	EPA, 1993c	mouse		liver, hepatotoxicity		
Toluene	25.98	Nawrot and Staples 1979 In: Opresko et al., 1994	mouse		reproduction	223.0	LANL, 1994
trans-1,2-Dichloroethene	17.0	LANL, 1994					
Vinyl Chloride	0.17	Feron et al. 1981 In: Opresko et al., 1994	rat		longevity, morality		
Xylene (Total)	7.77	Hill and Camardese, 1986 In: Weston, 1995	Japanese quail		acute NOAEL	179.0	LANL, 1994
Trichloropropane (1,2,3)	8	EPA, 1993c	rat		whole body	5.71	LANL, 1994

Table A-3 (cont.)

Volatile Organic Compounds	NOAEL (mg/kg/d)	Reference	Test Species	Chemical Form	Endpoint, Comment and/or Test Species	Comparison NOAEL (mg/kg/d)	Comparison Value Reference
(2,4-Dichlorophenoxy) propionic acid (dichloroprop)(d)							
1,2,4-Trichlorobenzene	100.0	EPA, 1993c	rat		adrenal	14.8	LANL, 1994
1,2-Dichlorobenzene	85.7	LANL, 1994					
1,3-Dichlorobenzene							
1,4-Dichlorobenzene							
1,4-methan Azulene, decahydro-4,4,8(d)							
2,2-Oxybis(1-chloropropane) (bis[2-chloroisopropyl]ether)							
2,4,5 -Trichlorophenoxyacetic acid	10.0	EPA, 1993c	rat		kidney, liver NOEL	3.0	LANL, 1994
2,4,5-Trichlorophenoxy Propionic Acid	0.75	EPA, 1993c	dog		liver, NOEL		
2,4,5-Trichlorophenol	100.0	EPA, 1993c	rat		liver, kidney NOEL		
2,4,6-Trichlorophenol							
2,4-D	0.8	Hudson et al., 1984	chuckar		mortality		
2,4-DB	8.0	LANL, 1994					
2,4-Dichlorophenol	0.3	EPA, 1993c	rat		immune system, NOEL		
2,4-Dimethylphenol	50.0	EPA, 1993c	mouse		nervous system, blood		
2,4-Dinitrophenol	2.0	EPA, 1993c	human		eye, LOAEL		
2- Nitrophenol(d)							
2-Chloronaphthalene							
2-Chlorophenol	5.0	EPA, 1993c	rat		reproduction		
2-Methyl-4,6-dimitrophenol(d)							
2-Methylnaphthalene(d)							
trans-1,3-Dichloropropene							
Trichloroethene							
Trichlorofluoromethane	1000	EPA, 1993c	rat		whole body, LOAEL	349.0	LANL, 1994
2-Methylnaphthalene(g)							

Table A-3 (cont.)

Volatile Organic Compounds	NOAEL (mg/kg/d)	Reference	Test Species	Chemical Form	Endpoint, Comment and/or Test Species	Comparison NOAEL (mg/kg/d)	Comparison Value Reference
2-Methylphenol (o-cresol)	50.0	EPA, 1993c	rat		whole body		
2-Nitroaniline, (o-Nitroaniline)							
2-Nitroaniline							
2-Nitrophenol(g)							
2-Nitrophenol)(g)							
2H-1-benzo-pyran-2-one(d)							
3,3'-Dichlorobenzidine							
3-Nitroaniline(m-nitroaniline)(g)							
3-Nitroaniline							
4 -Chloro-3-methylphenol (p-chloro-m-cresol)							
4,6-Dinitro-2-methylphenol(g) (4,6-dinitro-o-creso)							
4- Nitrophenol							
4-Bromophenvl phenyl ether(d)							
4-Bromophenyl-phenylether(g)							
4-Chloro o-tolyoxyacetic acid(d)							
p-Chloroaniline	12.5	EPA, 1993c	rat		spleen, LOAEL		
4-Chlorophenyl phenyl ether(d)							
4-Chlorophenyl phenylether(g)							
4-Methylphenol (p-cresol)	5.0	EPA, 1993c	rabbit		whole body, NOEL		
4-Nitroaniline(p-nitroaniline)(g)							
4-Nitroaniline							
Acenaphthene	175.0	LANL, 1994					
Acenaphthvlene(d)							
Acenaphthylene(g)							
Adipic ester(d)							
Aldrin	0.0200	Tucker and Crabtree, 1970 In: Weston, 1995	mallard duck		mortality, chronic NOAEL	1) .02 rat; reproduction, chronic NOAEL 2) 0.025	1) Treon and Cleveland 1955 In: Opresko et al., 1994 2) LANL, 1994
Alpha-BHC							

Table A-3 (cont.)

Volatile Organic Compounds	NOAEL (mg/kg/d)	Reference	Test Species	Chemical Form	Endpoint, Comment and/or Test Species	Comparison NOAEL (mg/kg/d)	Comparison Value Reference
Aniline							
Anthracene	1000.0	EPA, 1993c	rat		NOEL		
Arochlors (mixed)	0.4759					0.007	LANL, 1994
Aroclor-1248	0.00272	Cecil et al., 1974	chicken		chronic reproductive		
Aroclor-1254	0.0052	Lillie et al., 1975 In: Weston, 1995	leghorn (pullets)		reproduction, noteratogensis	0.18, ring-necked pheasant, reproduction	Dahlgren et al., 1972 In: Opresko et al., 1994
Aroclor-1260	0.468	Heath et al., 1972 In: Weston, 1995	bobwhite (chick)		mortality		
Azobenzene							
Benzene acetic acid(d)							
Benzidine							
Benzo[a]anthracene							
Benzo[a]pyrene							
Benzo[b]fluoranthene							
Benzo[ghi]perylene							
Benzo[k]fluoranthene							
Benzyl alcohol(d)							
Benzyl alcohol							
Beta-BHC							
Bis(2-ethylhexyl)phthalate	1.11	Peakall, 1974 In: Opresko et al., 1994	ringed dove		reproduction	22.6, white leghorn, chronic effect dose	Wood and Bitman, 1980 In: Weston, 1994
Bis(2chloroethoxy)methane(g)							
Bis-(2-chloroethyl)ether							
Butyl benzyl phthalate	159.0	LANL, 1994					
Carbazole							
Cetyl alcohol(d)							
Chlordane	2.14	Stickel et al., 1983 In: Opresko et al., 1994	red-winged blackbird		mortality	0.055	LANL, 1994

Table A-3 (cont.)

Volatile Organic Compounds	NOAEL (mg/kg/d)	Reference	Test Species	Chemical Form	Endpoint, Comment and/or Test Species	Comparison NOAEL (mg/kg/d)	Comparison Value Reference
Chlorophenoxy acetic acid (2-methy-4)							
Chrysene							
Dalapon	8.45	LANL, 1994					
DDD	0.236	Hill et al., 1975	ring-necked pheasant		mortality	165.0	LANL, 1994
DDE	0.00224	Longcore et al., 1971	black duck		egshell thinning	42.0	LANL, 1994
DDT	0.0028	Anderson et al., 1975 In: Opresko et al., 1994	brown pelican		reproduction	1) 0.00660, mallard, reproduction 2) 0.05	1) Davison and Sell, 1974 In: Weston, 1995 2) LANL, 1994
delta-BHC(d)							
Di-n-butylphthalate	0.111	Peakall, 1974 In: Opresko et al., 1994	ringed dove		reproduction		
Di-n-octyl phthalate	175.0	LANL, 1994					
Dibenzo[a,h]anthracene							
Dibenzofuran(d)							
Dicamba	3.0	LANL, 1994					
Dieldrin	0.024	Heath et al., 1972 In: Weston, 1995	bobwhite		mortality, acute LC 50	1) 0.077, barn owl, reproduction 2) 0.005	1)Mendenhall et al., 1983 In: Weston, 1995 2)LANL, 1994
Diethylphthalate	4583.0	Lamb et al., 1987 In: Opresko et al., 1994	mouse		reproduction		
Dimethyl phthalate	1000.0	EPA, 1993c	rat		kidney, NOEL		
Dimethylformamide							
Dinoseb	1.0	EPA, 1993c	rat		fetus, LOAEL		
Endosulfan I & II	0.15	EPA, 1993c	rat		kidney, LOAEL		
Endosulfan sulfate(d)							

Table A-3 (cont.)

Volatile Organic Compounds	NOAEL (mg/kg/d)	Reference	Test Species	Chemical Form	Endpoint, Comment and/or Test Species	Comparison NOAEL (mg/kg/d)	Comparison Value Reference
Endosulfan	10	Abiola, 1992	gray partridge		reproduction		
Endrin	0.3	Spann et al., 1986 In: Opresko et al., 1994	rat		reproduction	0.025	LANL, 1994
Ethyl acetate	900.0	EPA, 1993c	rat		whole body, NOEL		
Ethylene glycol	200.0	EPA, 1993c	rat		fetus, NOEL		
Fluoranthene	125.0	EPA, 1993c	mouse		kidney, liver, blood		
Fluorine	125.0	LANL, 1994					
Heptachlor Epoxide	0.013	EPA, 1993c	dog		liver, LOAEL		
Heptachlor	0.0880	Hill and Camardese 1986 In: Weston, 1995	Japanese quail		mortality, acute LC_{50}	0.150	LANL, 1994
Hexachlorobenzene	0.080	LANL, 1994					
Hexachlorobutadiene							
Hexachlorocyclopentadiene	7.0	EPA, 1993c	rat		forestomach		
Hexachloroethane	1.0	EPA, 1993	rat		kidney		
Hexadeconoic acid(d)							
Indeno[1,2,3-cd]pyrene							
Isophorone	150.0	EPA, 1993c	dog		kidnay, NOEL		
Lindane (gamma BHC)	0.244	Hill and Camardese, 1986 In: Weston, 1995	Japanese quail		mortality	1) 2.0, mallard duck, reproduction 2) 0.33	1) Chakravarty and Lahiri, 1986 In: Opresko et al., 1994 2)LANL, 1994
Mecoprop (MCPP)	3.0	LANL, 1994					
Mecoprop(d)							

Table A-3 (cont.)

Volatile Organic Compounds	NOAEL (mg/kg/d)	Reference	Test Species	Chemical Form	Endpoint, Comment, Test Species	Comparison NOAEL (mg/kg/d)	Comparison Value Reference
Methoxychlor	3.16	Hill and Camardese, 1986 <u>In</u>: Weston, 1995	Japanese quail		mortality, acute LC_{50}	1) 4.0, rat, reproduction 2) 5.01	1) Gray et al., 1988, <u>In</u>: Opresko et al., 1994 2) LANL, 1994
N-Nitrosodi-N-propylamine							
N-Nitrosodimethylamine							
N-Nitrosodiphenylamine							
Naphthalene	1.39	Wildlife Intn'l Ltd. 1985 <u>In</u>: Weston, 1995	bobwhite quail		acute NOAEL		
Nitrobenzene	4.6	LANL, 1994					
Octacosane(d)							
Octadeconoic acid(d)							
Octamethyleyclotetrasiloxane(d)							
PCB (aroclors)	0.007	LANL, 1994					
Pentachlorophenol	0.00038	Stedman et al., 1980 <u>In</u>: Weston, 1995	broiler chick		chronic effect dose	3.0	LANL, 1994
Phenanthrene carboxylic acid(d)							
Phenanthrene(d)							
Phenanthrene(g)							
Phenol	60.0	EPA, 1993c	rat		fetus		
Phthalate ester(d)							
Pyrene	75.0	EPA, 1993c	mouse		kidney		
Tetradecanoic acid(d)							
Toxaphene	8.0	Kennedy et al., 1973 <u>In</u>: Opresko et al., 1994	rat		reproduction, chronic NOAEL		
Vinyl Acetate	100.0	LANL, 1994					

Table A-3 (cont.)

Volatile Organic Compounds	NOAEL (mg/kg/d)	Reference	Test Species	Chemical Form	Endpoint, Comment, Test Species	Comparison NOAEL (mg/kg/d)	Comparison Value Reference
High Explosives							
1,3,5-TNB (trinitrobenzene)	0.51	EPA, 1993c	rat		spleen		
1,3-DNB (dinitrobenzene)	0.4	EPA, 1993c	rat		spleen		
2,4,6-TNT (trinitrotoluene)	0.5	EPA, 1993c	dog		liver, LOAEL		
2,4-DNT (dinitrotoluene)	0.2	EPA, 1993c	dog		CNS		
2,6-DNT (dinitrotoluene)							
2-amino-2,6-DNT (aminodinitrotoluene)(g)							
2-amino-4.6-Dimitrotoluene(d)							
4-amino-2,6-DNT (aminodinitrotoluene)(g)							
Ammonium nitrate(g)							
Barium nitrate (soluble barium)							
CEF (tri[b-chloroethyl]phosphate)(g)							
DPA (diphenylyamine)	2.5	EPA, 1993	dog		whole body, NOEL		
HMX (cyclotetramethylenete-tranitramine	50.0	LANL, 1994					
Nitrocellulose (non-toxic)(g/k)							
Nitromethane(g)							
NP (bis[2,2-dinitropropyl]acetyl/formal)(g)							
PETN (pentaerythritolletra-nitrate)							
RDX (trimethylenetri-nitramine)	0.30	LANL, 1994					
TATB (triaminotrinitrobenzene)(g)							
Tetryl (N-methyl-N,2,4,6-tetranitrobenzeneamine)							

Table A-3 (cont.)

Radionuclide	SAL (pCi/g)	Reference	Radionuclide	SAL (pCi/g)	Reference
Americium-241	17.0	FIMAD	Ruthenium-106	14.0	FIMAD
Carbon-14	41.0	FIMAD	Sodium-22	1.3	FIMAD
Cerium-144	56.0	FIMAD	Strontium-90	5.9	FIMAD
Cesium-134	1.8	FIMAD	Technetium-99	38.0	FIMAD
Cesium-137	4.0	FIMAD	Thorium-228	1.7	FIMAD
Cobalt-57	40.0	FIMAD	Thorium-230	5.0	FIMAD
Cobalt-60	0.9	FIMAD	Thorium-232	5.0	FIMAD
Gross Alpha Activity			Tritium	820.0	FIMAD
Iodine-129	41.0	FIMAD	Uranium-233	86.0	FIMAD
Manganese-54	3.4	FIMAD	Uranium-234	86.0	FIMAD
Plutonium-238	20.0	FIMAD	Uranium-235	18.0	FIMAD
Plutonium-239	18.0	FIMAD	Uranium-238	59.0	FIMAD
Potassium-40	12.0	FIMAD	Depleted Uranium	59.0	FIMAD
Radium-226	5.0	FIMAD	Uranium	66.0	FIMAD
Radium-228	5.0	FIMAD			

Table A-4. Hazard indices (cumulative HQ) for each of 100 randomly selected potential nest sites of the American Peregrine Falcon in EEU-74. The distributions are for (A) unweighted foraging in an unscaled square home range, (B) unweighted foraging in a 4:1-scaled (w:h) rectangular home range, (C) weighted foraging in an unscaled square home range, and (D) weighted foraging in a 4:1 scaled rectangular home range.

Nest Site No.	Column	Row	A	B	C	D
1	98	75	0.294090	2.68E-02	0.341039	3.23E-02
2	113	72	0.439427	3.03E-02	6.85E-03	4.86E-02
3	73	75	0.173074	2.92E-02	5.37E-02	1.37E-02
4	103	76	0.337737	1.87E-02	2.20E-03	3.15E-04
5	80	74	0.209314	2.92E-02	8.20E-04	1.61E-04
6	87	74	0.239212	2.92E-02	5.51E-04	9.97E-05
7	118	71	0.463825	3.36E-02	0.427427	5.45E-02
8	84	75	0.230315	2.67E-02	1.93E-03	2.19E-03
9	90	74	0.241519	2.67E-02	6.99E-04	8.86E-05
10	193	65	0.228268	8.44E-02	1.15E-03	3.62E-03
11	81	74	0.216402	2.92E-02	4.66E-04	2.70E-04
12	72	75	0.170782	2.92E-02	4.49E-04	2.10E-04
13	207	62	0.063377	5.86E-02	2.91E-04	3.63E-04
14	198	61	0.119156	8.08E-02	3.47E-04	2.75E-04
15	103	75	0.384206	2.73E-02	2.85E-03	5.64E-04
16	95	75	0.277161	2.63E-02	4.98E-04	6.64E-05
17	202	61	0.092891	8.08E-02	3.14E-04	2.46E-04
18	105	76	0.335514	1.87E-02	5.29E-04	4.89E-05
19	219	58	0.028415	0.222194	2.19E-04	3.42E-04
20	233	55	0.014810	0.307202	1.56E-04	2.12E-04
21	221	57	0.024549	0.236531	2.03E-04	2.14E-04
22	118	70	0.470348	3.36E-02	0.301036	6.53E-03
23	205	61	0.074875	7.80E-02	5.31E-04	2.86E-04
24	235	55	0.014810	0.299653	1.49E-04	1.54E-04
25	99	75	0.299273	2.68E-02	1.82E-03	6.05E-05
26	87	76	0.217992	2.56E-02	9.63E-04	9.16E-05
27	211	61	0.046632	8.72E-02	2.68E-04	2.42E-04
28	96	76	0.234674	2.51E-02	4.41E-04	6.16E-05
29	107	74	0.397724	2.87E-02	1.21E-03	6.22E-05
30	197	62	0.126018	7.48E-02	5.63E-04	2.40E-04
31	217	58	0.033596	0.145683	2.25E-04	2.17E-04
32	234	56	0.014810	0.28858	1.64E-04	1.69E-04
33	116	69	0.467891	3.43E-02	2.34E-03	9.20E-05
34	223	58	0.023309	0.220931	2.15E-04	2.19E-04
35	194	65	0.221514	8.44E-02	5.67E-04	0.102783
36	97	75	0.286808	2.68E-02	5.17E-04	8.51E-05
37	222	57	0.023841	0.242286	2.03E-04	2.27E-03
38	226	57	0.016091	0.230027	1.95E-04	2.07E-04
39	73	75	0.173074	2.92E-02	0.126278	2.02E-04
40	77	74	0.191293	2.92E-02	6.68E-04	1.73E-04
41	217	58	0.033596	0.145683	6.34E-04	2.42E-04
42	192	65	0.235232	8.44E-02	1.00E-03	9.53E-04
43	114	71	0.454442	3.28E-02	3.81E-03	7.84E-05
44	211	61	0.046632	8.72E-02	3.58E-04	2.42E-04
45	106	75	0.384666	2.74E-02	6.31E-04	5.86E-05
46	89	75	0.240789	2.56E-02	4.63E-04	8.56E-05
47	115	72	0.449327	3.03E-02	9.05E-04	7.19E-05

Table A-4. (Cont.)

Nest Site No.	Column	Row	A	B	C	D
48	116	69	0.467891	3.43E-02	3.35E-03	9.47E-05
49	195	63	0.149784	9.07E-02	4.70E-02	2.46E-04
50	231	57	0.014810	0.245122	2.20E-04	2.10E-04
51	208	61	0.058792	8.70E-02	2.87E-04	2.38E-04
52	233	56	0.014810	0.291196	1.68E-04	2.09E-04
53	88	76	0.219771	2.56E-02	1.41E-03	8.68E-05
54	191	67	0.239443	3.91E-02	5.38E-04	2.20E-04
55	227	57	0.014810	0.22755	1.92E-04	2.01E-04
56	210	62	0.048750	7.48E-02	2.76E-04	2.57E-04
57	231	56	0.014810	0.286785	1.73E-04	1.82E-04
58	96	74	0.288159	2.70E-02	9.00E-04	6.69E-05
59	118	70	0.470348	3.36E-02	1.23E-03	8.25E-05
60	104	76	0.336169	1.87E-02	5.23E-04	4.94E-05
61	92	74	0.245309	2.67E-02	5.07E-04	7.69E-05
62	207	62	0.063377	5.86E-02	2.87E-04	3.78E-04
63	216	59	0.036407	0.107184	2.56E-04	2.24E-04
64	235	57	0.014810	0.242291	1.72E-04	1.75E-04
65	203	60	0.088143	9.40E-02	3.00E-04	2.32E-04
66	212	62	0.043721	7.48E-02	2.75E-04	2.59E-04
67	98	76	0.248269	2.47E-02	4.59E-04	5.86E-05
68	110	72	0.440540	2.94E-02	8.57E-04	7.18E-05
69	118	71	0.463825	3.36E-02	1.01E-03	7.87E-05
70	89	74	0.245403	2.68E-02	4.92E-04	8.91E-05
71	231	55	0.014810	0.3018	1.61E-04	2.57E-04
72	194	63	0.223851	8.98E-02	4.37E-04	2.41E-04
73	75	74	0.184009	2.92E-02	2.19E-02	1.90E-04
74	231	56	0.014810	0.286785	1.83E-04	1.81E-04
75	88	76	0.219771	2.56E-02	4.25E-04	8.69E-05
76	206	62	0.070065	5.75E-02	3.00E-04	2.54E-04
77	88	73	0.242650	2.92E-02	5.22E-04	9.73E-05
78	203	62	0.087525	6.00E-02	3.11E-04	2.45E-04
79	195	64	0.149784	8.78E-02	3.67E-04	2.46E-04
80	223	56	0.023309	0.271195	1.89E-04	1.97E-04
81	211	60	0.046823	0.10562	2.55E-04	2.33E-04
82	82	74	0.222800	2.92E-02	4.67E-04	1.33E-04
83	87	75	0.235193	2.67E-02	4.46E-04	9.55E-05
84	192	67	0.232381	3.91E-02	4.06E-04	2.25E-04
85	224	57	0.021581	0.236835	2.00E-04	2.06E-04
86	74	76	0.162407	2.67E-02	4.02E-04	1.81E-04
87	234	56	0.014810	0.28858	1.64E-04	1.69E-04
88	95	76	0.231530	2.54E-02	4.35E-04	6.35E-05
89	73	75	0.173074	2.92E-02	4.44E-04	2.00E-04
90	118	70	0.470348	3.36E-02	1.10E-03	8.26E-05
91	202	61	0.092891	8.08E-02	3.12E-04	2.39E-04
92	88	74	0.241940	2.68E-02	4.87E-04	9.40E-05
93	192	64	0.235128	8.77E-02	4.42E-04	2.39E-04
94	93	76	0.232880	2.58E-02	4.24E-04	6.82E-05
95	231	55	0.014810	0.3018	1.61E-04	1.69E-04
96	92	74	0.245309	2.67E-02	5.07E-04	7.69E-05
97	230	57	0.014810	0.24915	1.88E-04	1.95E-04
98	116	69	0.467891	3.43E-02	0.32728	8.61E-05
99	79	74	0.201071	2.92E-02	6.88E-04	1.56E-04
100	108	74	0.399993	2.82E-02	9.04E-04	6.24E-05

Table A-5. Hazard indices (cumulative HQ) for each of 100 randomly selected potential nest sites of the American peregrine falcon in EEU-33. The distributions are for (A) unweighted foraging in an unscaled square home range, (B) unweighted foraging in a 4:1-scaled (w:h) rectangular home range, (C) weighted foraging in an unscaled square home range, and (D) weighted foraging in a 4:1 scaled rectangular home range.

Nest Site No.	Column	Row	A	B	C	D
1	78	77	1.32E-02	3.08E-02	1.28E-02	1.83E-02
2	283	163	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3	70	81	1.07E-02	3.22E-02	1.72E-03	1.96E-02
4	84	66	1.32E-02	1.35E-02	1.12E-02	1.05E-04
5	80	70	1.32E-02	2.76E-02	4.34E-04	2.27E-04
6	71	79	1.07E-02	3.20E-02	1.06E-02	1.77E-03
7	79	77	1.32E-02	3.08E-02	8.24E-03	9.21E-05
8	75	81	1.29E-02	3.22E-02	1.05E-02	1.96E-02
9	69	76	1.05E-02	3.08E-02	1.71E-04	2.25E-03
10	278	164	0.00E+00	0.00E+00	0.00E+00	0.00E+00
11	62	76	1.05E-02	3.08E-02	2.15E-05	2.46E-05
12	296	162	0.00E+00	0.00E+00	0.00E+00	0.00E+00
13	245	104	0.00E+00	1.90E-02	0.00E+00	1.35E-06
14	72	79	1.13E-02	3.20E-02	5.56E-05	3.39E-04
15	71	79	1.07E-02	3.20E-02	4.86E-05	5.11E-05
16	280	162	0.00E+00	0.00E+00	0.00E+00	0.00E+00
17	71	64	1.05E-02	4.99E-03	2.36E-05	1.25E-05
18	76	71	1.32E-02	2.92E-02	1.29E-02	4.84E-05
19	247	104	0.00E+00	1.90E-02	0.00E+00	1.14E-06
20	75	73	1.27E-02	2.94E-02	4.90E-03	5.07E-05
21	71	78	1.05E-02	3.14E-02	7.37E-05	4.82E-05
22	69	81	1.07E-02	3.22E-02	1.32E-04	1.96E-02
23	73	65	1.17E-02	1.35E-02	2.99E-05	5.17E-05
24	295	163	0.00E+00	0.00E+00	0.00E+00	0.00E+00
25	239	99	0.00E+00	1.90E-02	0.00E+00	2.39E-06
26	74	74	1.22E-02	2.94E-02	5.10E-05	4.89E-04
27	79	70	1.32E-02	2.84E-02	1.28E-02	5.39E-05
28	246	103	0.00E+00	1.90E-02	0.00E+00	1.25E-06
29	72	67	1.11E-02	2.06E-02	9.41E-04	2.37E-05
30	70	75	1.05E-02	2.95E-02	4.13E-05	5.68E-05
31	83	68	1.32E-02	2.06E-02	1.41E-04	4.96E-05
32	80	73	1.32E-02	2.94E-02	7.39E-05	7.13E-05
33	72	75	1.11E-02	2.95E-02	4.52E-05	4.52E-05
34	248	100	0.00E+00	1.90E-02	0.00E+00	1.08E-06
35	240	99	0.00E+00	1.90E-02	0.00E+00	2.18E-06
36	74	63	1.22E-02	4.18E-03	2.74E-05	1.23E-05
37	248	102	0.00E+00	1.90E-02	0.00E+00	1.06E-06
38	238	102	0.00E+00	1.90E-02	0.00E+00	2.53E-06
39	71	70	1.05E-02	2.84E-02	3.28E-05	3.08E-05
40	240	99	0.00E+00	1.90E-02	0.00E+00	2.18E-06
41	80	73	1.32E-02	2.94E-02	7.33E-05	7.12E-05
42	81	67	1.32E-02	1.71E-02	5.37E-05	3.81E-05
43	245	101	0.00E+00	1.90E-02	0.00E+00	1.39E-06
44	75	79	1.29E-02	3.20E-02	1.30E-02	6.98E-04
45	248	98	0.00E+00	1.90E-02	0.00E+00	1.09E-06
46	81	74	1.32E-02	2.94E-02	8.32E-03	8.31E-05
47	298	161	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table A-5 (Cont.)

Nest Site No.	Column	Row	A	B	C	D
48	75	78	1.27E-02	3.14E-02	1.79E-04	6.59E-05
49	68	81	1.07E-02	3.22E-02	5.60E-03	1.96E-02
50	238	100	0.00E+00	1.90E-02	0.00E+00	2.58E-06
51	246	97	0.00E+00	1.90E-02	0.00E+00	1.31E-06
52	292	164	0.00E+00	0.00E+00	0.00E+00	0.00E+00
53	70	73	1.05E-02	2.94E-02	6.16E-05	8.97E-04
54	75	81	1.29E-02	3.22E-02	7.99E-05	1.96E-02
55	71	67	1.05E-02	2.06E-02	2.81E-05	8.85E-05
56	245	101	0.00E+00	1.90E-02	0.00E+00	1.40E-06
57	76	80	1.33E-02	3.22E-02	1.30E-02	1.96E-02
58	72	66	1.11E-02	1.71E-02	1.28E-03	6.10E-05
59	73	74	1.17E-02	2.94E-02	8.22E-05	4.24E-04
60	62	78	1.05E-02	3.20E-02	2.28E-05	3.60E-04
61	85	70	1.32E-02	2.68E-02	2.84E-04	7.15E-05
62	77	71	1.32E-02	2.92E-02	5.49E-05	5.19E-05
63	68	81	1.07E-02	3.22E-02	1.25E-02	1.96E-02
64	66	76	1.05E-02	3.08E-02	7.32E-04	1.78E-03
65	77	61	1.32E-02	1.64E-03	1.95E-04	5.45E-06
66	281	163	0.00E+00	0.00E+00	0.00E+00	0.00E+00
67	73	74	1.17E-02	2.94E-02	4.73E-05	4.98E-05
68	77	65	1.32E-02	1.35E-02	3.75E-05	2.52E-05
69	241	102	0.00E+00	1.90E-02	0.00E+00	1.95E-06
70	76	72	1.32E-02	2.92E-02	5.32E-05	5.11E-05
71	75	74	1.27E-02	2.94E-02	5.47E-05	5.33E-05
72	77	66	1.32E-02	1.71E-02	4.00E-05	2.82E-05
73	69	81	1.07E-02	3.22E-02	1.26E-02	1.96E-02
74	63	76	1.05E-02	3.08E-02	7.84E-04	1.43E-03
75	77	74	1.32E-02	2.94E-02	3.27E-04	6.60E-05
76	238	98	0.00E+00	1.90E-02	0.00E+00	2.61E-06
77	293	165	0.00E+00	0.00E+00	0.00E+00	0.00E+00
78	74	64	1.22E-02	4.99E-03	2.98E-05	1.52E-05
79	79	74	1.32E-02	2.94E-02	7.25E-05	7.05E-05
80	73	80	1.18E-02	3.22E-02	1.28E-02	1.96E-02
81	76	69	1.32E-02	2.68E-02	5.86E-03	2.63E-04
82	237	102	0.00E+00	1.90E-02	0.00E+00	2.76E-06
83	70	81	1.07E-02	3.22E-02	3.23E-03	1.96E-02
84	246	100	0.00E+00	1.90E-02	0.00E+00	1.29E-06
85	294	164	0.00E+00	0.00E+00	0.00E+00	0.00E+00
86	79	63	1.32E-02	4.18E-03	8.78E-03	2.53E-05
87	240	102	0.00E+00	1.90E-02	0.00E+00	2.13E-06
88	63	75	1.05E-02	2.95E-02	6.53E-05	5.58E-04
89	63	77	1.05E-02	3.14E-02	2.39E-05	6.41E-05
90	248	98	0.00E+00	1.90E-02	0.00E+00	1.09E-06
91	70	78	1.05E-02	3.14E-02	4.31E-05	4.46E-05
92	243	105	0.00E+00	1.90E-02	0.00E+00	1.59E-06
93	281	163	0.00E+00	0.00E+00	0.00E+00	0.00E+00
94	69	67	1.05E-02	2.08E-02	2.45E-05	1.95E-05
95	74	68	1.22E-02	2.52E-02	3.85E-05	2.91E-05
96	69	72	1.05E-02	2.94E-02	3.13E-05	3.13E-05
97	78	63	1.32E-02	4.18E-03	3.51E-05	1.56E-05
98	73	82	1.24E-02	3.22E-02	1.31E-02	1.96E-02
99	80	71	1.32E-02	2.92E-02	5.24E-03	1.18E-03
100	73	77	1.17E-02	3.08E-02	8.74E-05	1.86E-04

Table A-6. Partial HQs for Nest Site No. 22 (X/Y location: 118,70) of EEU-74.

ID	Contaminant Source Column	Row	HQp	% of total
1	130	24	2.59E-04	0.05%
2	131	24	1.92E-04	0.04%
3	132	24	1.77E-04	0.04%
4	134	24	2.81E-04	0.06%
5	135	24	1.76E-04	0.04%
6	136	24	2.59E-04	0.06%
7	137	24	1.72E-04	0.04%
8	154	24	3.48E-04	0.07%
9	155	24	3.97E-04	0.08%
10	156	24	4.02E-04	0.09%
11	157	24	3.69E-04	0.08%
12	158	24	1.03E-03	0.22%
13	159	24	4.11E-05	0.00%
14	160	24	9.25E-04	0.20%
15	161	24	2.48E-04	0.05%
16	162	24	3.51E-04	0.07%
17	164	24	2.67E-04	0.06%
18	165	24	3.55E-04	0.08%
19	166	24	2.72E-04	0.06%
20	112	25	4.09E-04	0.09%
21	148	25	3.73E-04	0.08%
22	149	25	3.26E-04	0.07%
23	150	25	1.23E-03	0.26%
24	151	25	1.43E-03	0.30%
25	152	25	2.96E-03	0.63%
26	153	25	1.20E-03	0.26%
27	155	25	1.29E-03	0.27%
28	159	25	1.67E-03	0.35%
29	165	25	3.61E-04	0.08%
30	112	26	3.99E-04	0.08%
31	113	26	1.10E-03	0.23%
32	139	26	4.37E-04	0.09%
33	143	26	5.09E-03	1.08%
34	144	26	3.51E-03	0.75%
35	147	26	5.70E-04	0.12%
36	148	26	8.05E-04	0.17%
37	149	26	5.16E-04	0.11%
38	150	26	1.12E-03	0.24%
39	151	26	1.33E-03	0.28%
40	152	26	1.16E-03	0.25%
41	153	26	1.13E-03	0.24%
42	155	26	5.25E-04	0.11%
43	156	26	1.43E-04	0.03%
44	159	26	2.35E-04	0.05%
45	161	26	3.29E-04	0.07%
46	162	26	2.53E-04	0.05%
47	163	26	1.06E-03	0.23%
48	164	26	3.47E-04	0.07%
49	165	26	2.84E-04	0.06%
50	166	26	3.53E-04	0.08%

Table A-6. (Cont.)

	Contaminant Source			%
ID	Column	Row	HQp	of total
51	104	27	1.65E-04	0.04%
52	105	27	5.46E-04	0.12%
53	137	27	5.27E-04	0.11%
54	139	27	1.63E-03	0.35%
55	140	27	1.21E-03	0.26%
56	143	27	2.88E-03	0.61%
57	147	27	1.57E-04	0.03%
58	149	27	10.00E-04	0.21%
59	150	27	1.15E-03	0.25%
60	151	27	1.09E-03	0.23%
61	152	27	3.83E-04	0.08%
62	153	27	4.00E-04	0.08%
63	154	27	3.94E-04	0.08%
64	155	27	1.11E-03	0.24%
65	162	27	1.26E-03	0.27%
66	163	27	1.83E-03	0.39%
67	164	27	2.66E-04	0.06%
68	165	27	4.50E-04	0.10%
69	166	27	2.51E-04	0.05%
70	100	28	1.83E-04	0.04%
71	101	28	1.68E-04	0.04%
72	103	28	1.78E-04	0.04%
73	104	28	8.91E-04	0.19%
74	105	28	4.70E-04	0.10%
75	127	28	2.69E-04	0.06%
76	128	28	2.49E-04	0.05%
77	135	28	4.54E-04	0.10%
78	136	28	5.94E-04	0.13%
79	138	28	2.68E-04	0.06%
80	139	28	4.88E-04	0.10%
81	140	28	1.49E-03	0.32%
82	141	28	8.36E-04	0.18%
83	143	28	1.61E-04	0.03%
84	146	28	2.49E-04	0.05%
85	149	28	9.45E-04	0.20%
86	150	28	1.19E-03	0.25%
87	151	28	5.41E-04	0.12%
88	152	28	3.92E-04	0.08%
89	158	28	1.12E-03	0.24%
90	161	28	1.03E-03	0.22%
91	162	28	1.49E-03	0.32%
92	163	28	1.23E-03	0.26%
93	164	28	3.48E-04	0.07%
94	165	28	2.47E-04	0.05%
95	166	28	6.44E-04	0.14%
96	87	28	1.70E-04	0.04%
97	90	28	4.10E-04	0.09%
98	95	28	4.05E-04	0.09%
99	98	28	1.75E-04	0.04%
100	100	29	6.69E-04	0.14%
101	101	29	1.22E-03	0.26%
102	102	29	1.14E-03	0.24%
103	103	29	1.15E-03	0.24%
104	104	29	1.04E-03	0.22%
105	105	29	1.24E-03	0.26%
106	106	29	1.29E-03	0.28%
107	122	29	2.61E-04	0.06%

Table A-6. (Cont.)

	Contaminant Source			%
ID	Column	Row	HQp	of total
108	123	29	2.30E-04	0.05%
109	124	29	3.41E-04	0.07%
110	127	29	2.66E-04	0.06%
111	128	29	3.41E-04	0.07%
112	129	29	7.17E-04	0.15%
113	130	29	2.51E-04	0.05%
114	131	29	6.59E-04	0.14%
115	132	29	2.56E-04	0.05%
116	134	29	3.49E-04	0.07%
117	135	29	2.45E-04	0.05%
118	136	29	3.55E-04	0.08%
119	137	29	9.73E-04	0.21%
120	138	29	1.01E-03	0.21%
121	139	29	1.67E-04	0.04%
122	140	29	1.08E-03	0.23%
123	141	29	2.48E-02	5.28%
124	146	29	1.89E-04	0.04%
125	149	29	6.49E-04	0.14%
126	153	29	6.93E-04	0.15%
127	154	29	6.82E-04	0.14%
128	155	29	6.76E-04	0.14%
129	157	29	1.39E-03	0.30%
130	158	29	9.25E-04	0.20%
131	159	29	3.88E-04	0.08%
132	160	29	5.80E-04	0.12%
133	161	29	1.06E-03	0.22%
134	162	29	3.22E-04	0.07%
135	164	29	2.19E-04	0.05%
136	75	29	4.02E-04	0.09%
137	87	29	1.08E-03	0.23%
138	91	29	4.07E-04	0.09%
139	95	29	5.44E-04	0.12%
140	96	29	1.11E-03	0.24%
141	98	29	7.83E-04	0.17%
142	99	29	1.20E-03	0.26%
143	102	30	1.12E-03	0.24%
144	103	30	9.82E-04	0.21%
145	104	30	1.16E-03	0.25%
146	124	30	3.33E-04	0.07%
147	128	30	6.62E-04	0.14%
148	129	30	6.91E-04	0.15%
149	130	30	5.28E-04	0.11%
150	131	30	4.08E-04	0.09%
151	136	30	5.77E-04	0.12%
152	141	30	1.56E-02	3.31%
153	146	30	7.21E-04	0.15%
154	147	30	7.27E-04	0.15%
155	149	30	5.84E-04	0.12%
156	150	30	6.63E-04	0.14%
157	151	30	6.63E-04	0.14%
158	152	30	6.71E-04	0.14%
159	153	30	7.33E-04	0.16%
160	154	30	7.17E-04	0.15%
161	155	30	1.17E-03	0.25%
162	156	30	1.38E-03	0.29%
163	157	30	1.13E-03	0.24%
164	158	30	8.79E-04	0.19%
165	159	30	1.17E-03	0.25%
166	160	30	8.53E-04	0.18%

Table A-6. (Cont.)

	Contaminant Source			%
ID	Column	Row	HQp	of total
167	165	30	3.30E-04	0.07%
168	166	30	2.40E-04	0.05%
169	83	30	1.46E-04	0.03%
170	84	30	7.15E-04	0.15%
171	85	30	7.01E-04	0.15%
172	86	30	4.17E-04	0.09%
173	88	30	3.93E-04	0.08%
174	91	30	4.01E-04	0.09%
175	96	30	4.03E-04	0.09%
176	99	30	1.67E-04	0.04%
177	101	31	1.65E-04	0.04%
178	103	31	1.78E-04	0.04%
179	118	31	1.94E-04	0.04%
180	119	31	1.67E-04	0.04%
181	120	31	2.02E-04	0.04%
182	122	31	3.48E-04	0.07%
183	123	31	2.52E-04	0.05%
184	127	31	7.28E-04	0.15%
185	128	31	1.17E-03	0.25%
186	129	31	6.41E-04	0.14%
187	130	31	4.70E-04	0.10%
188	131	31	7.57E-04	0.16%
189	132	31	8.36E-04	0.18%
190	133	31	1.02E-03	0.22%
191	134	31	4.97E-04	0.11%
192	144	31	3.21E-04	0.07%
193	145	31	1.28E-03	0.27%
194	146	31	6.73E-04	0.14%
195	147	31	1.29E-03	0.27%
196	149	31	6.05E-04	0.13%
197	150	31	6.61E-04	0.14%
198	151	31	8.92E-04	0.19%
199	152	31	5.97E-04	0.13%
200	153	31	6.13E-04	0.13%
201	155	31	7.25E-04	0.15%
202	156	31	5.33E-04	0.11%
203	157	31	3.93E-04	0.08%
204	158	31	1.27E-03	0.27%
205	159	31	8.84E-04	0.19%
206	160	31	8.48E-04	0.18%
207	161	31	3.49E-04	0.07%
208	162	31	2.42E-04	0.05%
209	76	31	4.08E-04	0.09%
210	83	31	3.33E-04	0.07%
211	84	31	6.69E-04	0.14%
212	85	31	6.27E-04	0.13%
213	89	31	4.06E-04	0.09%
214	98	31	1.69E-04	0.04%
215	100	32	1.87E-04	0.04%
216	103	32	1.78E-04	0.04%
217	111	32	1.67E-04	0.04%
218	113	32	1.67E-04	0.04%
219	114	32	9.77E-04	0.21%
220	115	32	1.82E-04	0.04%
221	116	32	7.02E-04	0.15%
222	118	32	1.66E-04	0.04%
223	119	32	6.77E-04	0.14%
224	124	32	2.83E-04	0.06%
225	125	32	7.09E-04	0.15%

Table A-6. (Cont.)

ID	Contaminant Source Column	Row	HQp	% of total
226	126	32	3.65E-04	0.08%
227	128	32	3.53E-04	0.08%
228	129	32	6.60E-04	0.14%
229	130	32	6.72E-04	0.14%
230	131	32	9.64E-04	0.20%
231	132	32	6.80E-04	0.14%
232	137	32	1.21E-03	0.26%
233	140	32	1.78E-04	0.04%
234	141	32	1.68E-04	0.04%
235	143	32	4.79E-04	0.10%
236	144	32	6.90E-04	0.15%
237	145	32	6.67E-04	0.14%
238	146	32	6.67E-04	0.14%
239	147	32	7.76E-04	0.17%
240	148	32	5.92E-02	12.58%
241	149	32	7.55E-04	0.16%
242	150	32	5.10E-04	0.11%
243	151	32	7.83E-04	0.17%
244	152	32	1.92E-04	0.04%
245	153	32	1.83E-04	0.04%
246	155	32	2.83E-04	0.06%
247	156	32	9.08E-04	0.19%
248	157	32	2.00E-04	0.04%
249	158	32	1.98E-04	0.04%
250	160	32	1.88E-04	0.04%
251	161	32	7.10E-04	0.15%
252	162	32	1.88E-04	0.04%
253	164	32	9.14E-04	0.19%
254	165	32	1.88E-04	0.04%
255	166	32	6.04E-04	0.13%
256	99	32	1.86E-04	0.04%
257	107	33	1.66E-04	0.04%
258	110	33	1.66E-04	0.04%
259	111	33	1.67E-04	0.04%
260	113	33	6.44E-04	0.14%
261	114	33	1.84E-04	0.04%
262	115	33	2.12E-04	0.05%
263	120	33	1.83E-04	0.04%
264	121	33	3.74E-04	0.08%
265	123	33	2.62E-04	0.06%
266	124	33	3.64E-04	0.08%
267	126	33	2.63E-04	0.06%
268	127	33	5.79E-04	0.12%
269	128	33	1.64E-03	0.35%
270	129	33	1.89E-03	0.40%
271	130	33	8.50E-04	0.18%
272	132	33	1.25E-03	0.27%
273	137	33	1.15E-03	0.24%
274	138	33	1.17E-03	0.25%
275	141	33	6.07E-04	0.13%
276	142	33	2.44E-04	0.05%
277	144	33	7.76E-04	0.16%
278	145	33	6.96E-04	0.15%
279	146	33	7.74E-04	0.16%
280	147	33	7.06E-04	0.15%
281	148	33	1.21E-02	2.58%
282	149	33	9.28E-04	0.20%
283	150	33	6.64E-03	1.41%
284	151	33	1.92E-04	0.04%

Table A-6. (Cont.)

	Contaminant Source			%
ID	Column	Row	HQp	of total
285	152	33	8.83E-04	0.19%
286	153	33	1.95E-04	0.04%
287	154	33	8.41E-04	0.18%
288	155	33	7.46E-04	0.16%
289	156	33	1.38E-03	0.29%
290	157	33	8.85E-04	0.19%
291	158	33	7.51E-04	0.16%
292	160	33	7.59E-04	0.16%
293	86	33	3.73E-04	0.08%
294	88	33	8.63E-04	0.18%
295	89	33	1.00E-03	0.21%
296	105	34	2.63E-04	0.06%
297	119	34	7.09E-04	0.15%
298	120	34	1.03E-03	0.22%
299	128	34	8.54E-04	0.18%
300	129	34	7.74E-04	0.16%
301	130	34	8.57E-04	0.18%
302	131	34	8.72E-04	0.19%
303	140	34	6.39E-04	0.14%
304	141	34	4.35E-04	0.09%
305	142	34	1.94E-04	0.04%
306	144	34	8.07E-04	0.17%
307	145	34	6.79E-04	0.14%
308	146	34	7.82E-04	0.17%
309	147	34	7.67E-04	0.16%
310	154	34	8.69E-04	0.18%
311	158	34	1.89E-03	0.40%
312	86	34	4.00E-04	0.09%
313	88	34	2.75E-04	0.06%
314	89	34	1.18E-03	0.25%
315	100	35	5.88E-04	0.12%
316	107	35	8.95E-04	0.19%
317	109	35	6.89E-04	0.15%
318	111	35	7.27E-04	0.15%
319	113	35	1.73E-04	0.04%
320	115	35	6.68E-04	0.14%
321	119	35	8.85E-04	0.19%
322	120	35	1.85E-04	0.04%
323	122	35	2.60E-04	0.06%
324	123	35	1.07E-03	0.23%
325	124	35	9.58E-04	0.20%
326	125	35	1.05E-03	0.22%
327	126	35	7.06E-04	0.15%
328	127	35	7.81E-04	0.17%
329	128	35	1.01E-03	0.22%
330	130	35	4.48E-04	0.10%
331	131	35	6.45E-04	0.14%
332	137	35	9.21E-04	0.20%
333	144	35	3.56E-04	0.08%
334	145	35	7.20E-04	0.15%
335	148	35	1.06E-03	0.23%
336	149	35	4.29E-03	0.91%
337	151	35	1.90E-04	0.04%
338	152	35	1.32E-03	0.28%
339	86	35	1.23E-03	0.26%
340	88	35	1.38E-03	0.29%
341	89	35	1.28E-03	0.27%
342	98	35	6.92E-04	0.15%
343	99	35	5.87E-04	0.12%

Table A-6. (Cont.)

ID	Contaminant Source Column	Row	HQp	% of total
344	107	36	2.67E-04	0.06%
345	111	36	7.01E-04	0.15%
346	112	36	1.06E-03	0.23%
347	113	36	7.03E-04	0.15%
348	114	36	3.89E-04	0.08%
349	115	36	7.19E-04	0.15%
350	116	36	7.11E-04	0.15%
351	120	36	8.68E-04	0.18%
352	121	36	1.04E-03	0.22%
353	122	36	9.16E-04	0.19%
354	123	36	1.21E-03	0.26%
355	124	36	1.62E-03	0.35%
356	131	36	2.30E-04	0.05%
357	132	36	2.63E-04	0.06%
358	134	36	2.55E-04	0.05%
359	135	36	4.35E-04	0.09%
360	136	36	2.43E-04	0.05%
361	137	36	1.35E-03	0.29%
362	147	36	2.07E-04	0.04%
363	89	36	1.05E-03	0.22%
364	99	36	5.19E-04	0.11%
365	100	37	2.43E-04	0.05%
366	107	37	6.73E-04	0.14%
367	111	37	7.42E-04	0.16%
368	112	37	6.80E-04	0.14%
369	113	37	6.88E-04	0.15%
370	114	37	7.32E-04	0.16%
371	115	37	7.48E-04	0.16%
372	116	37	7.19E-04	0.15%
373	117	37	7.14E-04	0.15%
374	118	37	9.39E-04	0.20%
375	119	37	7.36E-04	0.16%
376	120	37	8.98E-04	0.19%
377	121	37	8.81E-04	0.19%
378	122	37	8.93E-04	0.19%
379	123	37	1.29E-03	0.28%
380	127	37	2.41E-04	0.05%
381	128	37	6.84E-04	0.15%
382	129	37	6.91E-04	0.15%
383	130	37	6.68E-04	0.14%
384	131	37	8.28E-04	0.18%
385	132	37	3.51E-04	0.07%
386	133	37	1.28E-03	0.27%
387	134	37	3.61E-04	0.08%
388	135	37	2.46E-04	0.05%
389	136	37	7.75E-04	0.16%
390	137	37	6.64E-04	0.14%
391	140	37	8.87E-04	0.19%
392	141	37	2.06E-04	0.04%
393	143	37	6.77E-04	0.14%
394	144	37	1.95E-04	0.04%
395	145	37	6.99E-04	0.15%
396	126	38	5.51E-04	0.12%
397	127	38	7.00E-04	0.15%
398	128	38	6.97E-04	0.15%
399	131	38	7.08E-04	0.15%
400	133	38	9.44E-04	0.20%
401	107	39	1.72E-04	0.04%
402	124	39	3.30E-04	0.07%

Table A-6. (Cont.)

ID	Contaminant Source Column	Row	HQp	% of total
403	125	39	8.54E-04	0.18%
404	126	39	1.16E-03	0.25%
405	127	39	8.59E-04	0.18%
406	128	39	3.94E-04	0.08%
407	129	39	7.35E-04	0.16%
408	130	39	7.05E-04	0.15%
409	131	39	2.91E-04	0.06%
410	135	39	7.15E-04	0.15%
411	136	39	1.84E-04	0.04%
412	137	39	6.75E-04	0.14%
413	139	39	2.09E-04	0.04%
414	149	39	3.90E-04	0.08%
415	99	39	1.04E-03	0.22%
416	107	40	6.48E-04	0.14%
417	109	40	1.66E-04	0.04%
418	124	40	2.40E-04	0.05%
419	126	40	1.15E-03	0.24%
420	127	40	2.56E-04	0.05%
421	134	40	1.96E-04	0.04%
422	148	40	3.73E-04	0.08%
423	107	41	1.67E-04	0.04%
424	128	41	1.87E-04	0.04%
425	130	41	6.76E-04	0.14%
426	131	41	1.77E-04	0.04%
427	132	41	9.08E-04	0.19%
428	145	41	1.27E-03	0.27%
429	103	42	2.56E-02	5.45%
430	105	42	1.48E-02	3.14%
431	137	42	3.85E-04	0.08%
432	82	42	9.71E-05	0.02%
433	83	42	9.71E-05	0.02%
434	107	43	1.13E-03	0.24%
435	110	43	1.10E-03	0.23%
436	124	43	1.97E-04	0.04%
437	126	43	7.39E-04	0.16%
438	127	43	1.63E-04	0.03%
439	82	43	9.71E-05	0.02%
440	83	43	9.71E-05	0.02%
441	99	43	9.56E-04	0.20%
442	109	44	8.20E-04	0.17%
443	110	44	7.35E-04	0.16%
444	111	44	2.07E-04	0.04%
445	113	44	7.51E-04	0.16%
446	114	44	1.67E-04	0.04%
447	115	44	7.41E-04	0.16%
448	116	44	1.64E-04	0.03%
449	118	44	7.64E-04	0.16%
450	119	44	2.14E-04	0.05%
451	120	44	1.15E-03	0.24%
452	122	44	2.03E-04	0.04%
453	123	44	6.96E-04	0.15%
454	82	45	9.71E-05	0.02%
455	84	45	1.24E-05	0.00%
456	160	48	1.20E-03	0.25%
457	156	49	1.10E-03	0.23%
458	145	51	4.94E-04	0.10%
459	146	51	2.44E-03	0.52%
460	147	51	1.59E-03	0.34%
461	162	51	1.11E-03	0.24%

Table A-6. (Cont.)

ID	Contaminant Source Column	Row	HQp	% of total
462	146	52	6.44E-04	0.14%
463	148	53	3.77E-04	0.08%
464	129	54	2.86E-04	0.06%
465	130	54	2.72E-04	0.06%
466	146	54	3.90E-04	0.08%
467	147	54	4.41E-04	0.09%
468	163	55	1.12E-03	0.24%
469	161	56	1.07E-03	0.23%
470	109	63	9.46E-04	0.20%
471	79	67	8.86E-04	0.19%
			4.70E-01	100.00%

Table A-7. Ranked mean partial HQ by contaminant for EEU-74 for the American Peregrine Falcon. The scenario included unweighted foraging in an unscaled square home range.

Rank	COPEC	HQ	Std Err	HQ % of Total	No. Obs.	BAF-Adjusted HQ	BMF-Adjusted HQ
1	Pentachlorophenol	7.66E-02	5.96E-02	38.3%	100		
2	Potassium-40	1.99E-02	1.31E-02	10.0%	87		
3	Cesium-137	1.56E-02	2.09E-02	7.8%	100		
4	Plutonium-239	1.50E-02	1.46E-02	7.5%	87		
5	Aluminum	1.44E-02	6.80E-03	7.2%	100		
6	Calcium	9.63E-03	4.42E-03	4.8%	100		
7	Radium-226	6.92E-03	4.22E-03	3.5%	87		
8	Strontium-90	5.81E-03	6.69E-03	2.9%	100		
9	Manganese	5.47E-03	2.46E-03	2.7%	100		
10	Thorium-228	5.01E-03	3.50E-03	2.5%	81		
11	Uranium-234	3.36E-03	5.19E-03	1.7%	81		
12	Selenium	2.49E-03	2.89E-03	1.2%	100		
13	Lead	2.40E-03	1.75E-03	1.2%	100		
14	Zinc	1.86E-03	1.21E-03	0.93%	100		
15	Nickel	1.81E-03	2.38E-03	0.91%	100		
16	Americium-241	1.59E-03	1.99E-03	0.80%	100		
17	Sodium	1.51E-03	9.91E-04	0.76%	100		
18	Uranium-235	1.36E-03	2.20E-03	0.68%	87		
19	Thorium-232	1.30E-03	1.03E-03	0.65%	81		
20	Arsenic	1.22E-03	1.17E-03	0.61%	100		
21	Barium	7.53E-04	3.43E-04	0.38%	100		
22	Thorium-230	7.52E-04	5.86E-04	0.38%	81		
23	Plutonium-238	5.71E-04	7.60E-04	0.29%	87		
24	Aroclor [Mixed-]	5.38E-04	2.39E-04	0.27%	63		1.58E-02
25	Uranium-238	4.68E-04	3.05E-04	0.23%	81		
26	Thallium	3.36E-04	1.74E-04	0.17%	100		4.37E-03
27	Chromium	3.06E-04	1.42E-04	0.15%	100		
28	Aroclor 1260	2.84E-04	9.65E-05	0.14%	63		8.52E-03
29	Molybdenum	2.64E-04	1.30E-04	0.13%	87		
30	Silver	2.59E-04	2.24E-04	0.13%	100		
31	Vanadium	2.18E-04	9.68E-05	0.11%	100		
32	Antimony	2.02E-04	1.01E-04	0.10%	100		
33	Cobalt-60	1.95E-04	1.74E-04	0.10%	100		
34	Magnesium	1.77E-04	7.89E-05	0.089%	100		
35	Beryllium	1.74E-04	8.08E-05	0.087%	100		
36	Cesium-134	1.40E-04	1.43E-04	0.070%	80		1.40E-04
37	Hexachlorobenzene	1.31E-04	1.02E-04	0.065%	100		
38	Ruthenium-106	1.17E-04	1.14E-04	0.058%	100		
39	Di-n-butyl phthalate	9.92E-05	7.94E-05	0.050%	100		
40	Aroclor 1254	9.87E-05	7.58E-05	0.049%	87		0.36
41	Sodium-22	7.09E-05	5.26E-05	0.035%	100		
42	Manganese-54	6.83E-05	8.91E-05	0.034%	80		
43	DDE	6.22E-05	5.07E-05	0.031%	87	4.78E-03	0.15
44	Cadmium	5.96E-05	2.87E-05	0.030%	100		
45	Dinitrotoluene [2,4-]	5.37E-05	4.12E-05	0.027%	100		
46	Copper	4.05E-05	2.56E-05	0.020%	100		
47	DDT [p,p']	4.03E-05	3.19E-05	0.020%	87	3.10E-03	0.30
48	Aroclor 1248	3.56E-05	1.64E-05	0.018%	63		7.01E-02
49	Dichlorophenol [2,4-]	3.50E-05	2.73E-05	0.017%	100		
50	Radium-228	3.26E-05	0.00E+00	0.016%	27		
51	Mercury	2.24E-05	2.14E-05	0.011%	100		1.24E-02
52	Dinitrophenol [2,4-]	1.45E-05	1.13E-05	0.007%	100		

Table A-7. (Cont.)

Rank	COPEC	HQ	Std Err	HQ % of Total	No. Obs.	BAF-Adjusted HQ	BMF-Adjusted HQ
53	DDE [p,p']	1.37E-05	5.13E-06	0.007%	52	6.29E-04	1.91E-02
54	Bis(2-ethylhexyl)phthalate	1.12E-05	8.55E-06	0.006%	100		
55	Hexachloroethane	1.05E-05	8.18E-06	0.005%	100		
56	Benzoic Acid	7.92E-06	6.19E-06	0.004%	100		
57	Naphthalene	7.69E-06	6.01E-06	0.004%	100		
58	Cerium-144	5.92E-06	3.17E-06	0.003%	100		
59	DDT [p,p']	5.30E-06	2.00E-06	0.003%	52	2.43E-04	2.32E-02
60	Uranium	4.44E-06	3.00E-06	0.002%	100		
61	Iodine-129	4.18E-06	1.93E-06	0.002%	68		
62	Cobalt-57	4.14E-06	5.89E-06	0.002%	87		
63	Vinyl Chloride	3.24E-06	3.05E-06	0.002%	100		
64	Lithium	2.84E-06	1.42E-06	0.001%	87		
65	Nitrobenzene	2.31E-06	1.78E-06	0.001%	100		
66	Chlorophenol [o-]	2.12E-06	1.66E-06	0.001%	100		
67	Methylphenol [4-]	2.10E-06	1.64E-06	0.001%	100		
68	Hexachlorocyclopentadiene	1.50E-06	1.17E-06	0.000%	100		
69	RDX	1.41E-06	1.69E-07	0.000%	91		
70	Xylenes (o + m + p)	1.26E-06	1.20E-06	0.000%	100		
71	Dieldrin	9.86E-07	5.28E-07	0.0005%	87	1.54E-04	1.23E-03
72	Heptachlor epoxide	9.26E-07	6.22E-07	0.0005%	87		
73	Trichlorobenzene [1,2,4-]	7.06E-07	5.52E-07	0.0004%	100		
74	Aldrin	5.77E-07	3.31E-07	0.0003%	87	1.80E-04	1.44E-03
75	DDD [p,p']	5.37E-07	6.92E-07	0.0003%	87		
76	Boron	4.98E-07	9.95E-08	0.0002%	52		
77	Carbon tetrachloride	3.94E-07	3.71E-07	0.0002%	100		
78	Bromomethane	3.93E-07	3.70E-07	0.0002%	100		
79	Azobenzene	3.72E-07	2.98E-07	0.0002%	100		
80	Trinitrotoluene [2,4,6-]	3.25E-07	1.25E-07	0.0002%	91		
81	Dinitrobenzene [1,3-]	3.22E-07	7.97E-08	0.0002%	91		
82	Trinitrobenzene [1,3,5-]	3.18E-07	1.23E-07	0.0002%	91		
83	Pyrene	2.67E-07	2.39E-07	0.0001%	100		5.23E-04
84	Trichlorophenol [2,4,5-]	2.51E-07	2.03E-07	0.0001%	100		
85	Dimethylphenol [2,4-]	2.10E-07	1.64E-07	0.0001%	100		
86	Methylphenol [2-]	2.10E-07	1.64E-07	0.0001%	100		
87	Phenol	1.78E-07	1.39E-07	0.0000%	100		
88	Fluoranthene	1.75E-07	1.66E-07	0.0000%	100		
89	Heptachlor	1.22E-07	6.47E-08	0.0000%	87		
90	Technetium-99	1.06E-07	3.18E-08	0.0000%	52		
91	Benzidine	9.85E-08	0.00E+00	0.00005%	52		
92	Dichlorobenzene (1,2)[o-]	9.30E-08	6.99E-08	0.00005%	100		
93	Toxaphene	8.99E-08	5.84E-08	0.00004%	87		
94	Fluorene	8.70E-08	6.85E-08	0.00004%	100		
95	Endosulfan II	7.32E-08	1.23E-08	0.00004%	52		
96	Trichloroethane [1,1,2-]	7.19E-08	6.78E-08	0.00004%	100		
97	Butyl benzyl phthalate	7.03E-08	5.56E-08	0.00004%	100		
98	Isophorone	6.99E-08	5.46E-08	0.00003%	100		
99	Endrin	6.56E-08	3.52E-08	0.00003%	87	1.51E-05	
100	Acenaphthene	6.32E-08	4.96E-08	0.00003%	100		
101	Di-n-octyl phthalate	5.99E-08	4.68E-08	0.00003%	100		
102	Cyanide	5.85E-08	3.60E-08	0.00003%	100		
103	Tritium	5.34E-08	3.35E-08	0.00003%	80		
104	Methylene Chloride	5.18E-08	4.83E-08	0.00003%	100		
105	DDD [p,p']	5.17E-08	9.48E-09	0.00003%	52		
106	Endosulfan I	3.83E-08	5.64E-09	0.00002%	52		
107	Endrin aldehyde	3.73E-08	7.54E-09	0.00002%	52	5.13E-06	
108	Dichlorodifluoromethane	3.61E-08	3.40E-08	0.00002%	100		
109	Endrin ketone	3.50E-08	5.65E-09	0.00002%	52	4.81E-06	
110	Dichloroethane [1,1-]	3.14E-08	2.96E-08	0.00002%	100		
111	Carbon disulfide	2.55E-08	2.40E-08	0.00001%	100		
112	Lindane	2.39E-08	3.48E-09	0.00001%	52		3.52E-07
113	Methoxychlor	2.26E-08	1.47E-08	0.00001%	87		
114	Tetrachloroethylene	2.03E-08	1.86E-08	0.00001%	100		

Table A-7. (Cont.)

Rank	COPEC	HQ	Std Err	HQ % of Total	No. Obs.	BAF-Adjusted HQ	BMF-Adjusted HQ
115	Dichloroethene [trans-1,2-]	1.97E-08	1.41E-08	0.00000%	80		
116	Chloroform	1.86E-08	1.76E-08	0.00000%	100		
117	HMX	1.63E-08	2.44E-09	0.00000%	91		
118	Dichloroethane [1,2-]	1.62E-08	1.53E-08	0.00000%	100		
119	Bromodichloromethane	1.56E-08	1.47E-08	0.00000%	100		
120	Bromoform	1.56E-08	1.47E-08	0.00000%	100		
121	Chlorobenzene	1.54E-08	1.46E-08	0.00000%	100		
122	Toluene	1.14E-08	1.06E-08	0.00000%	100		
123	Anthracene	1.14E-08	9.01E-09	0.00000%	100		
124	Benzene	1.12E-08	1.07E-08	0.00000%	100		
125	Dimethyl phthalate	1.05E-08	8.21E-09	0.00000%	100		
126	Chlordane	7.15E-09	1.19E-10	0.000004%	52		5.26E-06
127	Chlordane [gamma-]	5.53E-09	1.91E-09	0.000003%	52		4.07E-06
128	Chlordane [alpha-]	5.34E-09	1.95E-09	0.000003%	52		3.93E-06
129	Diethyl phthalate	3.30E-09	2.78E-09	0.000002%	100		
130	Ethylbenzene	2.88E-09	2.71E-09	0.000001%	100		
131	Acetone	2.09E-09	1.96E-09	0.000001%	100		
132	Trichloropropane [1,2,3-]	1.55E-09	7.20E-10	0.000000%	61		
133	Endosulfan sulfate	1.55E-09	1.01E-09	0.000000%	87		
134	Styrene	1.40E-09	1.32E-09	0.000000%	100		
135	Xylene (mixed)	1.00E-09	4.94E-10	0.000000%	61		
136	Trichlorofluoromethane	7.90E-10	7.39E-10	0.0000004%	100		
137	o-Chlorotoluene	4.44E-10	2.06E-10	0.0000002%	61		
138	Vinyl Acetate	1.59E-10	1.25E-10	0.0000000%	80		
139	1,1,1,2-Tetrachloroethane	9.94E-11	4.60E-11	0.00000005%	61		
140	1,1,2-Trichloro-1,2,2-trifluoroethane	2.95E-11	1.25E-11	0.00000001%	61		
	SUM	2.00E-01				2.09E-01	

Table A-8. Ranked mean partial HQ by contaminant for EEU-33 for the American Peregrine Falcon. The scenario included unweighted foraging in a 4:1- (w:h) scaled rectangular home range.

Rank	COPEC	HQ	Std Err	HQ % of Total	No. Obs.
1	Pentachlorophenol	1.00E-02	3.01E-03	40.70%	88
2	Calcium	4.00E-03	1.55E-03	16.22%	89
3	Aluminum	3.27E-03	1.43E-03	13.27%	89
4	Cobalt-60	1.84E-03	4.57E-04	7.48%	88
5	Cesium-137	1.48E-03	5.79E-04	5.99%	89
6	Manganese	1.48E-03	6.45E-04	5.99%	89
7	Zinc	4.40E-04	1.75E-04	1.79%	89
8	Lead	4.10E-04	1.60E-04	1.67%	89
9	Nickel	3.30E-04	1.14E-04	1.34%	89
10	Potassium-40	2.71E-04	5.98E-08	1.10%	73
11	Barium	1.84E-04	7.72E-05	0.75%	89
12	Radium-226	1.71E-04	2.15E-07	0.69%	73
13	Copper	1.52E-04	9.50E-05	0.62%	89
14	Arsenic	8.84E-05	3.75E-05	0.36%	89
15	Chromium	7.50E-05	3.11E-05	0.30%	89
16	Sodium	6.55E-05	2.86E-05	0.27%	89
17	Vanadium	5.77E-05	2.52E-05	0.23%	89
18	Magnesium	4.67E-05	2.04E-05	0.19%	89
19	Silver	3.94E-05	1.62E-05	0.16%	89
20	Beryllium	3.81E-05	1.60E-05	0.15%	89
21	Selenium	3.42E-05	1.75E-05	0.14%	89
22	Cadmium	2.57E-05	6.40E-06	0.10%	89
23	Antimony	2.50E-05	1.08E-05	0.10%	89
24	Mecoprop(MCPP)	1.37E-05	5.13E-06	0.06%	88
25	Hexachlorobenzene	1.24E-05	3.92E-06	0.05%	88
26	RDX	1.13E-05	4.80E-06	0.05%	89
27	Di-n-butyl phthalate	1.03E-05	3.61E-06	0.04%	88
28	Uranium	8.25E-06	4.68E-06	0.03%	89
29	Dinitrotoluene [2,4-]	6.09E-06	2.35E-06	0.02%	89
30	Uranium-238	5.03E-06	0.00E+00	0.02%	73
31	Thallium	4.93E-06	2.32E-06	0.02%	89
32	Dichlorophenol [2,4-]	3.30E-06	1.04E-06	0.01%	88
33	Uranium-234	2.73E-06	0.00E+00	0.01%	73
34	Dinitrobenzene [1,3-]	1.99E-06	8.37E-07	0.00%	89
35	Dinitrophenol [2,4-]	1.91E-06	5.73E-07	0.00%	88
36	Trinitrotoluene [2,4,6-]	1.65E-06	7.11E-07	0.00%	89
37	Trinitrobenzene [1,3,5-]	1.59E-06	6.78E-07	0.00%	89
38	Aroclor 1248	1.38E-06	5.82E-07	0.00%	88
39	Benzoic Acid	1.34E-06	3.92E-07	0.00%	88
40	Bis(2-ethylhexyl)phthalate	1.12E-06	3.46E-07	0.005%	88
41	Hexachloroethane	9.91E-07	3.13E-07	0.004%	88
42	Uranium-235	7.98E-07	0.00E+00	0.003%	73
43	Naphthalene	7.54E-07	2.40E-07	0.003%	88
44	Mercury	6.66E-07	2.91E-07	0.003%	89
45	Aroclor 1254	5.90E-07	2.50E-07	0.002%	88
46	Aroclor 1260	5.90E-07	2.50E-07	0.002%	88
47	DDE [p,p']	3.28E-07	1.42E-07	0.001%	88
48	D [2,4-]	3.14E-07	1.18E-07	0.001%	88
49	Nitrobenzene	2.69E-07	1.02E-07	0.001%	89
50	DB [2,4-]	2.36E-07	8.93E-08	0.000%	88
51	DDT [p,p']	2.16E-07	7.47E-08	0.000%	88
52	Chlorophenol [o-]	1.98E-07	6.27E-08	0.000%	88

Table A-8. (Cont.)

Rank	COPEC	HQ	Std Err	HQ % of Total	No. Obs.
53	Methylphenol [4-]	1.98E-07	6.27E-08	0.000%	88
54	(2,4-Dichlorophenoxy) proprionic acid [2-]	1.71E-07	6.38E-08	0.000%	88
55	Dalapon	1.47E-07	5.49E-08	0.000%	88
56	HMX	1.46E-07	6.14E-08	0.000%	89
57	Hexachlorocyclopentadiene	1.42E-07	4.48E-08	0.000%	88
58	Cyanide	9.44E-08	2.85E-08	0.0004%	88
59	Trichlorobenzene [1,2,4-]	6.69E-08	2.12E-08	0.0003%	88
60	Trichlorophenol [2,4,5-]	3.81E-08	1.15E-08	0.0002%	88
61	Azobenzene	3.76E-08	1.19E-08	0.0002%	88
62	Dieldrin	3.06E-08	1.32E-08	0.0001%	88
63	Heptachlor epoxide	3.01E-08	1.28E-08	0.0001%	88
64	Pyrene	2.55E-08	8.07E-09	0.0001%	88
65	Phenol	2.16E-08	7.01E-09	0.0000%	88
66	Methylphenol [2-]	1.98E-08	6.27E-09	0.0000%	88
67	Dimethylphenol [2,4-]	1.98E-08	6.27E-09	0.0000%	88
68	Aldrin	1.88E-08	8.01E-09	0.0000%	88
69	Fluoranthene	1.61E-08	5.08E-09	0.0000%	88
70	Dinoseb	1.53E-08	5.71E-09	0.0000%	88
71	Dicamba	1.48E-08	5.65E-09	0.0000%	88
72	Dichlorobenzene (1,2)[o-]	1.15E-08	3.66E-09	0.00005%	88
73	Fluorene	8.52E-09	2.71E-09	0.00003%	88
74	Isophorone	6.60E-09	2.09E-09	0.00003%	88
75	Vinyl Chloride	6.25E-09	0.00E+00	0.00003%	67
76	Butyl benzyl phthalate	6.23E-09	1.97E-09	0.00003%	88
77	Acenaphthene	6.00E-09	1.91E-09	0.00002%	88
78	Di-n-octyl phthalate	5.66E-09	1.79E-09	0.00002%	88
79	Endosulfan II	4.89E-09	2.11E-09	0.00002%	88
80	Toxaphene	4.45E-09	1.89E-09	0.00002%	88
81	Heptachlor	4.28E-09	1.82E-09	0.00002%	88
82	DDD [p,p']	3.11E-09	1.34E-09	0.00001%	88
83	Tritium	2.62E-09	3.58E-10	0.00001%	68
84	Endosulfan I	2.51E-09	1.07E-09	0.00001%	88
85	Endrin ketone	2.45E-09	1.06E-09	0.00000%	88
86	Endrin aldehyde	2.45E-09	1.06E-09	0.00000%	88
87	Endrin	2.45E-09	1.06E-09	0.00000%	88
88	Lindane	1.54E-09	6.57E-10	0.00000%	88
89	Methoxychlor	1.19E-09	5.07E-10	0.000005%	88
90	Anthracene	1.10E-09	3.50E-10	0.000004%	88
91	Methylene Chloride	1.09E-09	0.00E+00	0.000004%	67
92	Dimethyl phthalate	9.91E-10	3.13E-10	0.000004%	88
93	Bromomethane	7.60E-10	0.00E+00	0.000003%	67
94	Carbon tetrachloride	7.49E-10	0.00E+00	0.000003%	67
95	Diethyl phthalate	2.16E-10	6.84E-11	0.000000%	88
96	Chlordane [gamma-]	1.76E-10	7.49E-11	0.000000%	88
97	Chlordane [alpha-]	1.76E-10	7.49E-11	0.000000%	88
98	Trichloroethane [1,1,2-]	1.37E-10	0.00E+00	0.000000%	67
99	Endosulfan sulfate	7.34E-11	3.17E-11	0.000000%	88
100	Dichlorodifluoromethane	7.09E-11	0.00E+00	0.0000003%	67
101	Xylenes (o + m + p)	6.84E-11	3.09E-13	0.0000003%	67
102	Dichloroethane [1,1-]	5.91E-11	5.25E-13	0.0000002%	67
103	Carbon disulfide	4.83E-11	0.00E+00	0.0000002%	67
104	Tetrachloroethylene	3.80E-11	2.51E-13	0.0000002%	67
105	Chloroform	3.54E-11	0.00E+00	0.0000001%	67
106	Dichloroethene [trans-1,2-]	3.13E-11	1.01E-13	0.0000001%	67
107	Dichloroethane [1,2-]	3.09E-11	0.00E+00	0.0000001%	67
108	Bromoform	2.97E-11	0.00E+00	0.0000001%	67
109	Bromodichloromethane	2.97E-11	0.00E+00	0.0000001%	67
110	Chlorobenzene	2.80E-11	0.00E+00	0.0000001%	67

Table A-8. (Cont.)

Rank	COPEC	HQ	Std Err	HQ % of Total	No. Obs.
111	Toluene	2.05E-11	0.00E+00	0.0000000%	67
112	Benzene	2.02E-11	0.00E+00	0.0000000%	67
113	Acetone	1.51E-11	0.00E+00	0.0000000%	67
114	Ethylbenzene	5.48E-12	0.00E+00	0.00000002%	67
115	Styrene	2.66E-12	0.00E+00	0.00000001%	67
116	Trichlorofluoromethane	1.52E-12	0.00E+00	0.00000000%	67
		2.46E-03		100.00%	

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