The California Wildlife Biology, Exposure Factor, and Toxicity Database (Cal/Ecotox) is a compilation of physiological and ecological parameters and toxicity data for a number of California fish and wildlife.

Introduction

Ecological risk assessment is the process by which exposure and effects data are systematically evaluated to assess the likelihood that adverse ecological effects may occur as a result of exposure to stressors. In California, technical data needs for ecological risk assessment are diverse and include both chemical- and species-specific exposure and effects information. These data needs are often met by data retrieval from the scientific literature or by collection of new data. In order to facilitate access to existing information that may be utilized in ecological risk assessments conducted or reviewed by member boards, departments, and offices within the California Environmental Protection Agency (Cal/EPA), the Office of Environmental Health Hazard Assessment (OEHHAA), in collaboration with the University of California at Davis, Information Center for the Environment, has developed Cal/Ecotox. Cal/Ecotox is a relational database which contains California Wildlife Biology, Exposure Factor, and toxicity information.

The database collates species-specific information for 28 exposure factors (e.g., body weights, ingestion rates, seasonal activities and population dynamics) commonly used to estimate exposure to contaminants. The exposure factors in Cal/Ecotox were patterned after the United States Environmental Protection Agency (USEPA) Wildlife Exposure Factor Handbook (USEPA, 1993) but augment USEPA's efforts by including information for 62 California mammal, bird, reptile and amphibian species. In addition to exposure factors, toxicological data for population-level to individual-level effects have been included for these species, when available.

Cal/Ecotox is a unique database in that it combines exposure and effects information for a wide variety of California terrestrial species. It will continue to expand as data for additional terrestrial, and eventually aquatic, species are added and as data for the current species are updated. By providing convenient access to this scientific information, it is hoped that regulators, the regulated community and the public may benefit due to the improved quality of ecological risk assessments that are produced using Cal/Ecotox.

Content of Cal/Ecotox

Literature searches were conducted to identify available exposure factor and toxicological information for each wildlife species in Cal/Ecotox. Relevant data from the primary literature were entered into Cal/Ecotox as datasets. Each dataset contains value(s) for the particular exposure factor or toxicological endpoint, along with a set of dataset descriptors that provide additional information about the study design. Linked to each dataset is the citation information to identify the primary literature source. Additional information about the content of Cal/Ecotox is provided below.

Species in Cal/Ecotox

Species coverage in Cal/Ecotox focuses exclusively on those known to occur in California. Most common California species also occur outside of the state, and data from studies conducted in other states may be included in the database, depending on the availability of California-specific information. Currently, Cal/Ecotox includes only vertebrate species, and, since a number of aquatic toxicity databases exist already, the focus of the initial phase of data entry was on terrestrial or semi-terrestrial organisms. Ongoing updates of the database are anticipated to include aquatic taxa and other terrestrial species.

Many of the wildlife species covered by Cal/Ecotox were selected based on the potential utility of the species
to serve as an indicator or surrogate species in ecological risk assessments. These species were judged to be potentially useful as representative species for modeling or extrapolating effects for other species based on four specific criteria: 1) distribution and occurrence, 2) habitat type, 3) trophic level and 4) taxonomic group.

Accordingly, the initial group of species entered into Cal/Ecotox contains common California species that represent a breadth of taxonomic families, trophic groupings, habitats, and distribution within the state. An important source of range and habitat information for species selection was the California Department of Fish and Game "California's Wildlife" series (Zeiner et al., 1988; 1990a; 1990b). Several of the species selected have been previously reviewed for exposure factors in the Wildlife Exposure Factors Handbook (USEPA, 1993), and were included for comparative purposes with respect to USEPA and Cal/Ecotox databases. These species were also selected because they were associated with large datasets of existing exposure factor and/or toxicological information, which permitted testing of Cal/Ecotox querying capabilities. Other "California" species covered in the Wildlife Exposure Factors Handbook were specifically not included to avoid duplication of effort. It is anticipated that this preliminary list will provide information for a number of appropriate indicator and/or surrogate species for ecological risk assessment. Use of the data for surrogate species development, however, would require incorporation of appropriate species extrapolation methods by the user.

Additionally, some species covered by Cal/Ecotox were selected based on their status as a legally rare species requiring special or priority consideration in ecological risk assessments in California. These special status species were included on the initial species list because they are often the target species of ecological risk assessments, and because identification and recovery of data for these species can be difficult. As with common species, it was not practical to include all special status species, and subjective selection criteria were developed primarily based on type of protected status. Highest priority in the initial selection of special status species was given to federally endangered species, followed by state endangered, federally threatened, and state threatened species. Several California Species of Special Concern were also included in this list.

**Literature Sources for Cal/Ecotox**

Biological, exposure factor, and toxicological information in Cal/Ecotox was obtained from scientific articles in peer-reviewed journals, theses or government reports. In order to identify these sources of data, extensive literature searches have been conducted for each species. The searches follow a two-tiered approach which consisted of electronic database searches for more recent articles, and reviews of primary and secondary sources for older articles. Once citations are identified, a standard procedure is followed to identify, document and retrieve citations with potentially useful information. Literature searches for the current version of Cal/Ecotox were completed in February 1999.

In order to complete comprehensive searches regarding biological and toxicological data for each species, citations are gathered from one or more of the following databases:

- *Aquatic Sciences and Fisheries Abstracts*, produced by Cambridge Scientific Abstracts, contains aquatic science citation information from journals, conference proceedings and gray literature.
- *Biosis Preview*, a Biological Abstracts, Inc. database, contains citations from Biological Abstracts which scans 7,500 journals reporting original research and Biological Abstracts/Reports, Reviews, and Meetings which indexes research reports, reviews, conference reports, monographs and books.
- *Current Contents*, from the Institute for Scientific Information, provides citations from over 7,000 journals and meeting abstracts in the sciences, social sciences, arts and humanities.
- *Ecological Abstracts*, produced by Cambridge Scientific Abstracts, contains papers that focus on how organisms of all kinds interact with their environment and with other organisms.
• **J-Store-Ecology**, provides access to back issues rather than recent issues of important scholarly journals in ecology.

• **Medline**, a part of the National Library of Medicine’s electronic citations database, covers approximately 4,000 medical and health sciences journals.

• **Toxicology Abstracts**, produced by Cambridge Scientific Abstracts, covers issues ranging from legislation and recommended standards to environmental issues.

• **Toxline**, produced by Cambridge Scientific Abstracts, offers access to information in all areas of toxicology, including chemicals and pharmaceuticals, pesticides, environmental pollutants, mutagens, and teratogens.

• **Walker's Mammals of the World**, contains descriptions of living mammals of the world, organized by broad taxonomic groups.

• **Wildlife Worldwide**, available from the National Information Service Corporation, consists of six separate databases that cover wildlife biology.

• **Zoological Record**, produced by Biological Abstracts, Inc., covers references from 6,500 journals, reviews, monographs, meeting proceedings, books, and reports in the field of zoology.

These databases were searched for each species (with the exception of Aquatic Sciences and Fisheries Abstracts, which was used for selected species only) to identify citations containing either the common or scientific (genus and species) species name in the title, subject or abstract fields.

For each species, the literature cited in reviewed citations was examined to identify additional sources of data. Additionally, a number of secondary sources were examined to identify older citations. A list of the most commonly used secondary sources is presented in the References section below.

**Biological and Exposure Factors**

Biological exposure factors include a variety of physiological and ecological parameters that are used in ecological risk assessments for calculating or predicting the exposure of animals to chemical toxicants. Selection of exposure factors to include in Cal/Ecotox was largely based on the Wildlife Exposure Factors Handbook (USEPA, 1993). Unlike the latter document, however, Cal/Ecotox does not provide estimates, via allometric equations, of exposure factors for selected species. Only species-specific empirical data captured from the literature are included in Cal/Ecotox. Parameters for which no information has been published remain as data gaps for a given species. A list of the different exposure factors included in the database is provided below.

- **Age at Fledging, Metamorphosis, or Weaning**: Age at which young: 1) can maintain sustained flight (fledging); 2) commence the process of metamorphosis (metamorphosis); or 3) begin to leave the nest or den to actively feed for most of their food (weaning).

- **Age at Sexual Maturity**: Earliest age at which first successful reproduction occurs.

- **Body Fat**: Amount of fat on an animal’s body, often expressed as a term relative to total body mass (e.g., percent body fat).

- **Body Weight**: Whole body weight, measured as fresh or wet weight. Body length is also used as an indicator of size.

- **Clutch or Litter Size**: The number of eggs laid per female in a single nest or clutch, or the number of live offspring born at one time to one female.

- **Clutches / Litters per year**: Number of clutches or litters produced per year per female.

- **Dietary Composition**: Food types comprising the diet, often expressed in terms of relative contribution to the total diet.

- **Duration of Incubation or Gestation**: Incubation is the period measured from the first day of incubation to the time of the first egg hatching (birds), or from the laying of the last egg to hatching (reptiles and amphibians). Gestation is measured as days of active gestation.
• **Fledging Rate or Weaning Rate**: Fledging rate is the number of young fledged per active or successful nest. Weaning rate is the proportion of young born that leave the nest or den to actively feed.

• **Food Ingestion Rate**: Daily food mass or caloric intake, often normalized to body weight (g/g-day).

• **Foraging Distance**: Distance or area covered by an individual for foraging purposes.

• **Growth Rate**: Size (mass or other measure) increase per day over a specified interval. Can be expressed as a constant associated with a specific mathematical model.

• **Hatching Success**: Number of eggs hatched per number of eggs laid.

• **Home Range**: Area occupied by an individual or family group on a daily basis.

• **Inhalation Rate**: The daily total volume of air inhaled or number of inhalations per unit time.

• **Longevity**: Longevity of adult member(s) of the population. Maximum longevity is usually measured in studies of captive or marked individuals.

• **Metabolic Rate**: Measured or estimated rate of energy expenditure (e.g., kcal/kg-day or liters O₂/kg-day), often associated with either basal or free-living conditions.

• **Population Density**: Number of individuals per unit area.

• **Surface Area**: Surface area of an organism reported as total area or area per unit body weight (cm² or cm²/g).

• **Survival/Mortality Rate**: Number of individuals in a population surviving or dying during a specified interval (e.g., annually).

• **Territory Size**: Size of an area that is occupied by an individual or family group and is defended against other individuals of the same species.

• **Time of Fledging or Metamorphosis**: Time(s) of year that young birds first maintain sustained flight (fledging), or that amphibians metamorphose or transform from the larval stage to the adult stage (metamorphosis).

• **Time of Hatching or Parturition**: Time of year that emergence from eggs (hatching) or birth of young (parturition) takes place.

• **Time of Mating / Laying**: Time of year that mating and/or egg laying take place.

• **Time of Migration, Aggregation, or Dispersal**: Times of the year associated with spring and fall migration or annual aggregation or dispersal movements.

• **Time of Molt**: Time of year that birds and mammals undergo molt of feathers and fur.

• **Time of Nesting**: Time of year at which general bird nesting activities occur (inclusive of mating, egg-laying, hatching and nestling periods).

• **Time of Torpor or Hibernation**: Time of winter hibernation or torpor.

• **Water Ingestion Rate**: Daily water intake, expressed as mass of water per unit of body weight (e.g., g/g-day).

**Toxicological Endpoints**

Toxicological information in Cal/Ecotox is intended to assist in the interpretation of exposure information during the effects assessment and risk characterization phases of an ecological risk assessment. Included in Cal/Ecotox are species-specific data relating chemical exposure to effects (dose-response data) and/or tissue concentrations (bioaccumulation/biotransfer data). Residue data are included only if there is a link to defined exposure or effects information. Standardized toxicity tests for ecological receptors are often not available, such that data reported in Cal/Ecotox for California species are extremely diverse, and originate from both field and laboratory studies.

The degree to which toxicological data are available for different species also varies considerably, with only a few species having been studied extensively. Toxicity benchmarks or reference doses for species in Cal/Ecotox are not extrapolated from data collected from other laboratory species. Since Cal/Ecotox is a species driven database, complete toxicological profiles for a particular chemical are not provided. Toxicological data are
entered if they exist for a Cal/Ecotox wildlife species (i.e., a chemical is covered only when toxicological data for a Cal/Ecotox wildlife species is available and data for species not covered by Cal/Ecotox, such as laboratory rats, are not included). Chemicals are listed by their common, or generic, name (if available) as well as Chemical Abstracts Service (CAS) Registry number. Additionally, several broad categories of chemicals, without CAS numbers (e.g., lead compounds, polycyclic aromatic hydrocarbons), have been added to accommodate studies where the exact chemical was not identified.

The list of toxicological endpoints used in Cal/Ecotox was derived from a survey of the wildlife toxicological literature, of other toxicological databases, and of veterinary and toxicological texts. In addition to the broad toxicological value types, listed below, more specific descriptions of the endpoint are included in each dataset.

**Exposure Indicators (TOX-EXP IND)**

- **Accumulation**: Tendency of a chemical to accumulate in the tissues of an organism via all exposure pathways. Includes chemical transfer rates, such as that from prey to predator or from parent to offspring. May be expressed as a factor or ratio, equation, or as tissue residues corresponding to known exposure levels.
- **Biomarkers**: Specific or general biological response (generally at the molecular level) measured in an organism that can be used to indicate whether and to what degree exposure to a given chemical has occurred.

**Mortality (TOX-MORT)**

- **Dose Response Data**: Mortality rate in a test population measured in response to increasing doses (at least three, not including a control, or zero dose, group).
- **Mortality in the Field**: Mortality measured in the field (e.g., carcass searching) associated with defined or undefined exposure to a chemical(s).
- **Toxicity Benchmarks**: Mortality expressed as an LD50, no-observed-adverse-effect level (NOAEL) or lowest-observed-adverse-effect level (LOAEL).

**Non-Reproductive Sublethal (TOX-Non-Repro-Sublethal)**

- **Behavioral Effects**: Includes measures of sensory and motor function (e.g., spontaneous activity, coordination and strength, sensory discrimination); natural, innate behaviors (e.g., social and aggressive behavior, foraging behavior, migratory behavior, etc.); and cognition, learning and memory (e.g., conditioned avoidance and preference, recognition abilities, etc.).
- **Cellular/Biochemical Effects**: Cellular includes measures of cell organelles and other components, and their associated functions, production of a particular cell type (e.g., blood cell counts). Biochemical includes, but is not limited to, measurements of enzymes (amount or activity of enzymes), immunological molecules, transport and receptor proteins, hormones (amount or activity), neurotransmitters, lipids, amino acids, and polysaccharides.
- **Genetic Effects**: Chromosomal and genome effects (e.g., mutations, carcinogenicity, multiple copies, etc.).
- **Indirect Effects**: Endpoints not associated with direct exposure to a chemical. Examples include habitat alteration or loss, change in prey numbers and species, and change in species competition.
- **Organ/System Effects**: Includes morphological endpoints (form or structure of a particular organ, or body part) and physiological endpoints (function of an organism and its parts).
- **Whole animal**: Parameters that pertain to the whole body of an animal, including body weight or condition and body temperature.
Population/Community (TOX-POP)
- **Age Distribution Effects**: Endpoints associated with the age/class structure of a population.
- **Geographic Distribution Effects**: Endpoints associated with the spatial location of a population.
- **Size Effects**: Parameters that pertain to the number of individuals of a defined population (extinction is included here).

Reproduction (TOX-REPRO)
- **Behavior**: Includes male or female adult courtship, nesting or parental care behaviors, and offspring behavior, where behavioral change would be due to prenatal exposure.
- **Development**: Any aspect of prenatal or postnatal development of offspring. Adverse effects include abnormalities (terata), changed sex ratios and otherwise altered development and developmental rates.
- **Physiology**: Any aspect of adult male or female reproductive physiology, including fertility and other reproductive organ and endocrine functions.
- **Reproductive Success**: Direct measure of reproductive output, including litter or clutch size (total clutch or litter size of exposed parents), hatchability (egg-laying species), fledging/weaning rate, offspring mortality/survival rate, number of offspring produced over a given period of time (e.g., annual productivity).

Dataset Descriptors
A number of descriptors are included for each dataset to provide information on methods used to collect the data and other study conditions that facilitate interpretation of the data. Since data quality is not evaluated prior to entry into Cal/Ecotox, it is anticipated that the user will use such descriptors to determine whether data quality satisfies his/her criteria, and whether the data, as collected, are appropriate for the user’s purposes. In addition, depending on the intended use of the data, it is strongly suggested that the original citation from which the data were drawn be reviewed by the user prior to a final decision regarding use of the data.

- **Condition of Animal**: Refers to modifying factors that may influence the exposure factor value such as activity, breeding or feeding status.
- **Dose-Response Data Format**: This is used only if citation contains toxicological adverse effects data where response was measured using at least three doses in addition to controls. "Table" or "Figure" are selected depending on how the dose-response data are presented in the citation.
- **Exposure**: Includes the value indicating degree of exposure and units of exposure (includes wet or dry weight designations); includes frequency of exposures if applicable. May refer to direct dosing concentrations (e.g., feeding of toxicants in the diet) or to indirect levels of exposure (e.g., environmental/media toxicant concentrations, application rates of toxicants to habitat).
- **Exposure Duration**: Refers to amount of time over which study animals are subjected to treatments (e.g., internal exposure, or tissue residues, can continue beyond treatment period, but this period is not included as part of exposure duration).
- **Exposure Technique**: Refers to the method or route(s) by which study animals are exposed to the toxicant(s).
- **Life Cycle Stage**: Refers to stage of the animal at the time the data were collected.
- **Location – Specific**: Refers to the specific location(s) where the data (field study) or experimental animals (lab study) were collected.
- **Location**: Three types of location information may be selected for each study: 1) **County**: select California county(ies) in which a field study was located if reported in citation; 2) **State**: select state in U.S. in which field study was conducted or 3) **Laboratory**: depending on conditions under which measurements were made, report that the study was done in the laboratory.
• **Sample Size**: Refers to the number of animals from which data were collected to estimate mean or range for exposure factor value, or for a toxic effect or chemical concentration in tissue.

• **Season/Month**: Refers to time of year in which data were collected.

• **Sex**: Refers to the sex of the animals for which data were collected (males, females or both).

• **Specific-Age**: Refers to the age of the animal at the time the data were collected.

• **Statistical Significance**: Refers to whether a change in any endpoint was statistically different (as indicated in citation) from controls, pre-treatment measurements, or some other reference values.

• **Study Duration**: Refers to exposure duration and post-exposure time over which study animals are observed or measured for toxicological effects.

**Quality Assurance**: Data from citations for the selected species are entered into Cal/Ecotox if the data adheres to the exposure factor or toxicological endpoint definitions. No judgment as to data quality and soundness of the scientific approach used in generating the data in citations is made. However, quality assurance procedures are followed to ensure that the data entered into Cal/Ecotox accurately summarized citation data. Data entry personnel are individuals professionally trained in ecotoxicology and familiar with Cal/Ecotox data entry procedures. For each step of the data entry process, from citation review to entry, standard operating procedures (SOPs) are followed in order to make data entry as standardized and complete as possible. Quality control is also practiced at each phase of data entry to make sure entered data adhered to the standards detailed in the SOPs. It is highly recommended however, that the original citation be consulted by the database user prior to applying the information to an ecological risk assessment.

**References**


