

Appendix A

Database used by the Herbicide Exposure program

The herbicide exposure assessment software package contains an extensive database of herbicide application and exposure calculations that it needs to carry out its function. The software package includes a copy of this database in an unprotected form that can be used by anyone familiar with Microsoft Access or the SQL database programming language, independently of this software package.

This Appendix describes the database in detail. It describes the table layouts, including a description of every column in every table.

The name of the database is **HEA.mdb**. It consists of four tables:

Name of Table	Purpose	Number of records
HERBS	HERBS file: detail for all herbicide missions	24,604
GridPoints	Map coordinates of all grid points	263,353
DATES	Consecutively numbered days of the war	5,478
Exposure_Master	Exposure data	1,454,956

Taken together, the four tables and the software make up a Geographic Information System (GIS) that enables a user to compute exposures for individuals, military units, or places. The overall GIS concept and the way in which the tables relate to each other and to the GIS as a whole are described in the publication:

A geographic information system for characterizing exposure to Agent Orange and other herbicides in Vietnam. JM Stellman, SD Stellman, T Weber, C Tomasallo, A Stellman, and R Christian Jr. Environ. Health Persp., 111: 321-328, 2003.

HERBS table

Description

The HERBS table describes all known herbicide applications that were carried out by the US military during the Vietnam War. The history and method by which this file was created are described in the publication:

The extent and patterns of usage of Agent Orange and other herbicides in Vietnam. JM Stellman, SD Stellman, R Christian, T Weber, and C. Tomasallo. Nature, 422: 681-687, 2003.

The version of the HERBS file provided with this software is the most current one as of the release date of the software package.

The HERBS file is organized by mission. A mission is a sequence of records that describes a single application of a given quantity of a specific type of herbicide along a specified route on a single day. The HERBS table includes data on herbicide spraying by the Air Force (Operation Ranch Hand) as well as other branches of the Armed Forces. The great majority of missions were flown by the Air Force as part of Operation Ranch Hand. A Ranch Hand mission consisted of one or more aircraft (each known as a *sortie*) dispersing a specified amount of herbicide along a specified route on a specified day. The HERBS table also contains non-Ranch Hand data that are derived from the so-called "Services HERBS file," and includes missions that describe ground applications carried out by truck or backpack spraying. The same format is used in this table for missions from both sources.

The HERBS table provides the actual flight paths taken by Ranch Hand aircraft as they carried out their spray missions. Alphanumeric indicators show the locations at which the aircraft switched directions or turned off and on their spray nozzles. The data are thus structured in a way that emphasizes the continuity of flight of the fixed-wing aircraft that carried out most of the Operation Ranch Hand missions. (Connectivity may not apply to ground perimeter spraying which generally went from guard post to guard post around the base camp). To convey this information, each mission within the HERBS file is organized as a sequence of "vertices" which were the starting, turning, and stopping points of spray aircraft as they carried out a mission. Figure 1 illustrates defoliation along a roadway. The flight path consists of four connected segments in which the plane begins spraying at point 1A and continues spraying until it reaches point 1E. Points 1B, 1C, and 1D are intermediate "turning" points at which the plane changes direction, while continuing to spray. The dotted line represents a 1 km envelope about the spray path. Planes frequently flew multiple paths in a single mission; additional vertices would be designated by 2A, 2B, 3A, 3B, etc. Spray nozzles would be turned off between ending one path and beginning another.

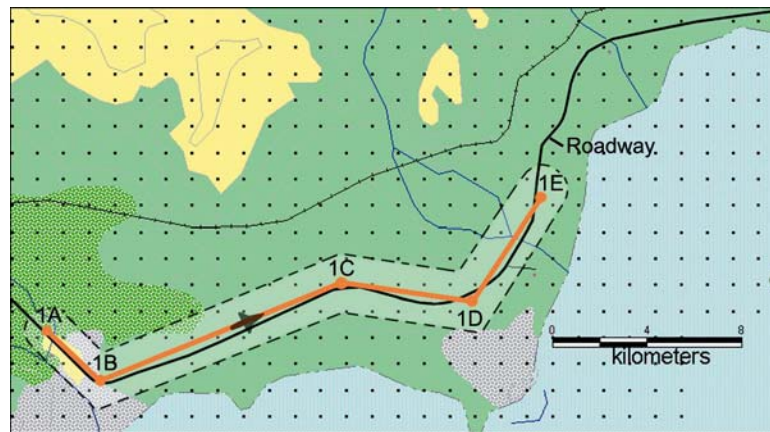


Figure 1: Typical Ranch Hand Flight Path (orange line) as represented in the HERBS file

Aircraft sprayed Agent Orange defoliant continuously along roadway from 1A → 1B → 1C → 1D → 1E. Dashed line is 1 km envelope around spray path. Dots are grid points spaced at 0.01° in longitude and latitude.

Column	Type	Description	Range (Permissible Values)
Date	Date/Time	Date on which the spraying occurred	8/10/1961 through 12/27/1971
Mission	Integer	Collection of records describing a spray application by one or more aircraft over a prescribed route on a specified date.	1 through 13027
Leg	Text	Vertex denoting starting, stoping, or turning point	1A through 9B
CTZ	Integer	Corps Tactical Zone. One of four military regions into which the Republic of Vietnam was divided for military planning purposes. [Three additional codes have been added for convenience.]	1 = (I Corps) North to demilitarized zone 2 = (II Corps) North-Central 3 = (III Corps) South-Central including Saigon 4 = (IV Corps) South including Mekong Delta 5 = Cambodia 6 = Laos 7 = Over water
Source	Text	Type of aircraft or other equipment used to carry out the mission	R = Ranch Hand (C-123 aircraft) S = Services A = Added by NAS contractor
Incident	Text	Indicator of unplanned incident	A = Mission/Aircraft aborted E = Aircraft with herbicide load crashed L = Herbicide leak R = Wrong target sprayed Z = Emergency herbicide dump
Method	Text		F = Fixed-wing aircraft G = Ground-based spraying H = Helicopter U = Unknown
UTM	Text	Universal Transverse Mercator coordinates of the given leg; GGxxxyyy where GG is the grid, xxx is the x-coordinate, and yyy is the y-coordinate. The x and y coordinates have one decimal implied (i.e., xxx means xx.x km)	A string of two letters followed by six numbers
Agent	Text	Herbicide Agent sprayed	B = Blue D = Dinoxol K = Pink O = Orange P = Purple T = Trinoxol U = Unknown W = White
Gallons	Integer	Number of gallons dispersed over the entire mission	Appears only for 1A record for any mission
FWAC	Text	Fixed-wing aircraft designator – 3 pairs of numeric digits as a single field; 030201 means 3 aircraft were assigned to the mission, two took off, and one was productive	Any six-digit number Typical values: 030303 020201
Type	Text	Type or purpose of mission	P=perimeter spraying C=crop D=defoliation, including spraying of waterways, lines of communication, and enemy cache sites and supply routes U=unknown

GridPoints table

Description

The GridPoints table is used to translate grid points into longitude and latitude and vice versa.

Vietnam and some of the adjacent land areas are broken into a series of 0.01° x 0.01° "square" grids to facilitate exposure calculations. There are 263,353 grids in all. Each grid has a unique integer called the PointID associated with it. The PointID is the geographical link between the exposure database (**Exposure_Master** table) and the location history records for military units or other entities for which exposure is to be determined.

Exposure is always referred to the geographic center of a specific grid. The center of every grid has coordinates (Longitude + 0.005°, Latitude + 0.005°) relative to the southwest corner of the grid.

Grid points and latitude/longitude are two equivalent coordinate systems, and each has its own use. Latitude and longitude are used to describe a location in a universally accepted frame of reference. They are used to perform distance calculations and to do mapping. Grid points are used to link herbicide data with location data for entities such as military units or hamlets. An exposure score such as NT05 or E4 always pertains to a specific grid point. This table provides the means to convert between the two systems when needed.

To convert a latitude and longitude value to a grid point, truncate the longitude and latitude value to two significant figures. It is critical that the value be truncated rather than rounded, because truncating the value will always yield the southwest corner of the grid, while rounding up may yield the wrong grid (too far north or east). There will be exactly one record in the **GridPoints** table with any pair of longitude and latitude values. Its associated PointID value is used to look up records in the **Exposure_Master** table (below) that describe exposure at that grid point.

Name	Type	Duplicates Permitted	Description
PointID	Number	No	Integer between 1 and 263359 which uniquely identifies a 0.01° by 0.01° grid in South Vietnam and parts of Laos.
Longitude	Double	Yes	Longitude of the southwest corner of the grid. Two significant figures only.
Latitude	Double	Yes	Latitude of the southwest corner of the grid. Two significant figures only.

Exposure_Master table

This table facilitates the transformation of inputs (locations expressed as grid points) into outputs (exposure scores). **Exposure_Master** contains pre-calculated exposure scores for every grid point which was within 5 km of any herbicide spray. The software reports exposure scores for time intervals specified by the user.

Many grids were exposed to herbicide from more than one mission. Each record in this Table contains exposure values for a single, unique grid-mission combination. The design of this Table enables the software to report separately each exposure which occurred at a specific grid from individual spray missions, or to report the total exposure at a specific grid from all contributing missions. Each record in this Table also contains a copy of the variables from the HERBS Table which describe characteristics of the mission associated with that record.

Table Layout (a)

Name	Type	Description
Mission	Integer	Identifies a specific mission which was the source of exposure
Day	Integer	Day number on which the mission took place
PointID	Integer	Identifies the grid for which the exposure scores were calculated
E4_total_30	Double	Continuous E4 exposure score, based on a 30-day half-life (b)
poof	Double	"poof" factor using 3 days' residence time and 1 year half-life: to be used in calculating continuous E4 exposure score for direct hits (b)
hits05km	Integer	Number of mission legs which fell within 0.5 km of this grid point
hits1km	Integer	Number of mission legs which fell within 1 km of this grid point
hits2km	Integer	Number of mission legs which fell within 2 km of this grid point
hits5km	Integer	Number of mission legs which fell within 5 km of this grid point
TZero_30day	Integer	Parameter used by the software to convert E4 exposure score to a different residence time and/or half-life (b)

(a) This Table also contains copies of the following variables from the HERBS Table: CTZ, Source, Incident, Method, UTM, Agent, Gallons, FWAC, Type. These are described in the HERBS section of this Appendix.

(b) The table **Exposure_Master** supplied with the software contains two types of exposures: counts of direct "hits" and the continuous exposure score E4. The "hits" counts are based on geometry and are not dependent on any exposure model. The E4 score is an exposure model developed by the authors. The concepts of direct and indirect exposure are explained in the publication:

A geographic information system for characterizing exposure to Agent Orange and other herbicides in Vietnam. JM Stellman, SD Stellman, T Weber, C Tomasallo, A Stellman, and R Christian Jr. Environ. Health Persp., 111: 321-328, 2003.

The data in this table that pertain to the E4 exposure score are represented by the variables E4_total_30, TZero_30day, and "poof." E4_total_30 is the E4 score that would be experienced by an individual who remained at a specified grid point between January 1, 1961, and December 31, 1971. It assumes a decay half-life of 30 days. TZero_30day is a parameter which is used by the software to convert E4 to represent different residence times and/or different half-lives. "Poof" is an E4 adjustment factor that is applied to direct hits to take into account differential exposures for dermal and respiratory routes of entry. It is equal to an E4 score calculated at the given grid point, but using a residence interval of three days beginning with the date of spraying, using a half-life of one year. These three variables apply to the specific exposure model E4. Their use is transparent to the user. Most users will either accept the E4 model as provided or else will develop their own models which do not depend on these parameters.

DATES table

Every day of the Vietnam War period is assigned a number beginning with 1 (January 1, 1961) and ending with 5,478 (December 31, 1975). Dates and day numbers may be converted back and forth using the **DATES** table. Day numbers are found in the **Exposure_Master** table.

The **DATES** table is used to convert between day number and calendar date. This table is needed because most queries will have residence dates connected with them. The user supplies the residence dates in calendar format (e.g., 5/27/74) but calculations of E4 use day numbers. To convert calendar dates to Day values that can be used with the **Exposure_Master** table, retrieve the row where the Date column matches the date in question. Day values can be converted back to dates by looking up the row with the Day value in question. This table can convert Week values as well.

Name	Type	Description
Date	Date/Time	Calendar date. Every day between 1/1/61 and 3/31/73 is represented
Day	Integer	Day number. Every day is numbered consecutively from 1/1/61 = 1 through 12/31/75 = 5,478
Week	Integer	Week number. Consecutive from 1 through 783
Month	Integer	Month number. Consecutive from 1 through 180
Year	Integer	Year number. Consecutive from 1 through 15