REPORT OF THE
BIOLOGICAL COLLECTIONS DATA STANDARDS WORKSHOP
August 18-24, 1992

AN INFORMATION MODEL FOR BIOLOGICAL COLLECTIONS

Association of Systematics Collections
Committee on Computerization and Networking

DRAFT

MARCH 1993 VERSION

Version History

October 1992	**Released in printed form as an incomplete draft for comment to ASC Committee members**
February 1993	**Entity definitions completed, some entities re-defined, minor changes made to the model (Figure 2), distributed in printed form to about 50 recipients. Cover page erroneously dated October 1992.**
March 1993	**[This version] Version page added, minor copy editing, made available via anonymous FTP on the TAXACOM FTP Server located on huh.harvard.edu in: WordPerfect, Postscript and in ASCII text as files:**

/pub/standards/asc/ascmodel.ps	**Postscript document**
/pub/standards/asc/ascmodel.wp5	**WordPerfect document**
/pub/standards/asc/ascmodel.txt	**ASCII text document**
/pub/standards/asc/ascfig1.ps	**Postscript Figure 1**
/pub/standards/asc/ascfig2.ps	**Postscript Figure 2**

(Figures available only in Postscript form)

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I. INTRODUCTION: Background and Objectives

The Association of Systematics Collections Committee on Computerization and Networking met at Cornell University in Ithaca, New York, from August 18-24, 1992. Co-chairs Julian Humphries and Janet Gomon organized the meeting with assistance from Elaine Hoagland of ASC. The focus of the workshop was to initiate the process of establishing data standards for biological collection information.

The opportunity exists for natural history museums to be at the forefront of digital access to information about specimens, taxa, and organismal biology. Conservation biologists, molecular geneticists, ecologists, functional morphologists, law enforcement officials -- the list is very long of those who are potential users of natural history collection information. Traditional means of access, however, -- personal visits to collections and long diligent searches of paper records -- guarantee that most of these people will find other means of acquiring the information they need or act with insufficient information. If these researchers could have simple, rapid access to the huge amount of knowledge that our collections represent, then natural history collection institutions can be at the vanguard of information providers.

In order to support a broad audience accessing our collections, as well as ensure efficient access for traditional users, certain guidelines and rules by which we record information about collections will need to be established. Workshop participants agreed that previous standardization efforts had primarily focused on individual elements of collection information and that no interdisciplinary model of this information existed. It was decided that for a cross-disciplinary effort to succeed, a high-level description of biological collections was required. Workshop participants undertook this effort by producing a draft conceptual **information model for biological collections**, described in this report.

The draft model is being circulated to scientific societies. (An electronic version of this document may be copied via ftp from the Taxacom server "huh.harvard.edu" under the directory "/pub/standards/asc".) Comments are welcome.

The ASC Data Standards Workshop participants recognize that the information model presented in this report is not complete. The parts are neither fully fleshed out nor documented adequately. In addition, participants at the Workshop did not represent all biological collection disciplines. Nevertheless, a decision to distribute the report at this time was made so that individuals and institutions currently modeling or planning to model biological collections data will have the opportunity to derive some benefit from the work done so far, and so that the model itself can be critiqued and refined by a broader group. The August, 1992, Workshop participants will continue to expand and document the model, with full consideration given to all commentary provided to the Co-chairs, either directly as personal correspondence, or indirectly as comments posted to the Taxacom list-server ("taxacom@harvarda.harvard.edu"). It is expected that follow-on workshops will be scheduled.

The model presented describes the high-level **entities** (logical and physical objects) that comprise the domain of a biological collection, including collecting activities, specimen objects and their handling, their taxonomy, locality and collector data, other objects, and the **relationships** among them. The model should be able to accommodate an insect collection as satisfactorily as a fish collection, botanical collection, or paleontological collection. Therefore, this conceptual information model provides an opportunity for the diverse disciplines of collections-based biologists to discuss their common activities and analogous information in a mutually comprehensible frame of reference. The model also provides the framework from which more detailed models can be developed.

There is no implication in this conceptual information model as to how it should be physically implemented.

II. INFORMATION MODELS: DEFINITIONS AND CONVENTIONS

A. A Context for Information Modeling

Information modeling is a methodology for designing databases, and the product, an information model, represents a highly structured description of information in the real world. It defines the scope of relevant information and specifies, to some degree, the data structures that must be available in the database to hold that information. It also specifies the rules that must be followed to keep the information internally consistent. Information modeling has been proven effective in the development of numerous business and scientific databases, and information management professionals have come to regard modeling as the basis for designing *correct, consistent, sharable, and flexible databases* (Fleming & von Halle, 1989[1]).

Models are particularly useful when the problem domain is large, and when the desired database is intended to serve a diverse community of users. In such cases, the database design almost certainly will require input from several experts or user-groups. One of the most important reasons for building an information model is that it allows many individuals to contribute to the problem description, and allows the description to be validated or revised as necessary by additional reviewers. Once completed, the model serves as a communication tool between domain experts and database developers (programmers).

B. Components of an Information Model

1. Entity-Relationship Diagrams

Information models typically have two components, a structured textual description, and one or more illustrations that summarize the model. The illustrations are called **entity-relationship diagrams** (ERDs), and depict the principal entities of the problem domain, as well as the interrelationships among them.

Figure 1 illustrates the two basic components of an ERD: entities (boxes) and relationships (the lines between the boxes). An **entity** is a grouping of people, places, physical objects, events, actions, or even concepts that can be described by the same information categories or attributes. Example entities from biological collections might include SPECIMEN, COLLECTING-EVENT, and LOCALITY. The individuals (specific things or events, etc.) that comprise an entity are called instances (not depicted

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[1] Fleming, C.C. and B. von Halle, 1989. Handbook of Relational Database Design. xvii, 605 pp. Addison-Wesley, Reading, MA. ISBN 0-201-11434-8

Figure 1 Located here, File: ascfig1.ps

because a model focuses is on generalities). In a relational database implementation of an information model, entities and attributes translate into data tables and their associated data fields; instances translate into the rows of a table.

The attributes of an entity are the place holders for data. They are important not only because they specify the information of interest, but because restrictions on the values that attributes may or must contain ultimately determines the scope and definition of the entity. The first restriction on attributes is that they must be single-valued at any given time. If an attribute legitimately may have many values simultaneously (i.e., a list of values needs to be recorded at a given time for a given instance), the supposed attribute probably isn't an attribute in the context of an information model, but rather another entity or relationship. The convention followed in information modeling is to remove multi-valued attributes into their own entities.

Another important aspect of entity attributes, is that, for each entity, a combination of attributes must be identified or chosen that distinguishes every instance in the entity. Every instance must be uniquely identified. This rule grounds the model in reality. If information is to be recorded about a thing in the real world, the thing must be identifiable. The identifying information and descriptive information must always be associated. The identifying attributes of an entity are called its **primary key**. Any attribute that is part of the primary key must always be populated with data for every valid instance; it can never be blank.

Repeated interactions or associations among the things in the real world are represented in the model as **relationships**. Relationships are depicted as lines between entities. Note that while relationships connect entities in the diagram, they are understood to represent possible associations between instances that are contained in the connected entities. Relationships are instance-to-instance, rather than group-to-group. Example relationships from biological collections might include (expressed in words):

1) a SPECIMEN was collected in a COLLECTING-EVENT, and

2) a COLLECTING-EVENT was conducted at a LOCALITY.

Relationships between instances are not always one to one. For example, a single COLLECTING-EVENT may produce more than one SPECIMEN. The symbols on the line next to an entity (a circle, cross-hatch, or crow's foot) depict the **cardinality** of the relationship; the number of individuals in the entity that may be related to a single individual in the other entity (at the opposite end of the line), zero, one, or many, respectively. Note that relationships are directional, and the symbols at opposite ends of a line are usually different. (The words describing a relationship may also change with direction.)

The inner symbol (further from the entity) indicates the minimum number of instances (individuals) in that entity that must be related to a single instance in the other, and may be either a circle or a cross-hatch (zero or one). For example, the relationship between the COLLECTING-EVENT and SPECIMEN entities (Figure 1 A) indicates that a COLLECTING-EVENT must exist for every SPECIMEN. In other words, the existence of a SPECIMEN is predicated on the existence of a COLLECTING-EVENT. The zero by the SPECIMEN entity indicates that there may be no corresponding instance for a given COLLECTING-EVENT. This implies that there is a reason for keeping information about a COLLECTING-EVENT even though no SPECIMENs were collected. (This is just a pedagogical example and not intended to bias the reader one way or the other about the correctness of this representation.)

The outer symbol (closer to the entity) indicates the minimum number of instances in that entity that may be related to a single instance in the other, and may be either a cross-hatch or a crow's foot.   A cross-hatch indicates that, at most, one instance in that entity may be related to a single instance in the other. A crow's foot indicates that many instances may be related to a given instance in the other entity. In Figure 1 A, the relationship between the COLLECTING-EVENT and SPECIMEN entities is one-to-many; a single COLLECTING-EVENT may be produce many SPECIMENS. From the perspective of the SPECIMEN entity, the relationship is many-to-one; a SPECIMEN is collected in one and only one COLLECTING-EVENT.

The COLLECTING-EVENT to SPECIMEN relationship is one to many. Relationships may also be one-to-one and many-to-many. One-to-one relationships are relatively uncommon, except in the depiction of supertype-subtype hierarchies, discussed below. Many-to-many relationships are more common, and can be depicted in two ways, depending on whether or not additional information needs to be captured about the relationship beyond its existence. If only the existence of the relationship needs to be recorded, a many-to-many relationship can be drawn as in Figure 1 B. The relationship between the SPECIMEN and REFERENCE entities is many-to-many. Crow's feet are present at both ends of the line; a single specimen may be cited by many REFERENCEs, and a single REFERENCE can cite many SPECIMENs. If the relationship itself needs to be described, the relationship should be drawn as an associative entity (a box with a diamond in it), as in Figure 1 C, so that it can be populated with descriptive attributes. Note that all many-to-many relationships imply an associative entity, whether or not one is drawn in the ERD.

The placement of the crow's feet around the associative entity in a many-to-many relationship may seem counter intuitive at first, but can be explained as follows. An **associative entity** records each instance of a relationship. If an individual SPECIMEN is cited by many REFERENCEs, each "citation" represents an instance of a relationship and is recorded in an associative entity, CITATION. The relationship" between the SPECIMEN and CITATION is then one-to-many. The same one-to-many "relationship" exists between REFERENCE and CITATION. Note that there are no zeroes by the primary entities, SPECIMEN and REFERENCE; each and every instance of the relationship (an instance in the CITATION entity) is existence dependent on corresponding instances in each of the "target" entities. A CITATION, in this case, cannot exist without both a SPECIMEN and REFERENCE.

A **recursive relationship** is used to indicate relationships between individuals of the same entity. The TAXON entity (Figure 1 D) shows a recursive relationship. A TAXON may contain other TAXONs (also an illustration of how the entity naming convention has priority over grammar in modeling), and each TAXON may be contained in zero or one TAXON. Recursive relationships are particularly important in biology because they model hierarchies (individuals that are related to each other in a potentially large and indefinite tree or network structure).

The last kind of relationship commonly used in information modeling is that depicting a superset - subset relationship between entities known as **supertypes** and **subtypes**, respectively. The supertype-subtype concept is used to portray important commonalities and distinctions between groups of similar things in the real world. An entity (supertype) may have zero to many subtypes. A subtype inherits all of the attributes of its supertype, but also has additional attributes. The additional attributes of one subtype are different from the additional attributes of another subtype.

A common example from the business world concerns employees, which may be full-time or part-time. A business typically records certain information (attributes) about all employees, and then records additional information for full-time employees that it does not for part-time employees, and vice versa. (Some authors refer to the entities in a supertype-subtype relationship as an "Is A" hierarchy; e.g., a part-time employee "is a" kind of employee.) Subtypes may or may not be mutually exclusive.

The supertype-subtype relationship places two requirements on the attributes of related entities. First, the primary key of a subtype must be exactly the same as its supertype. If EMPLOYEE-ID is the primary key of EMPLOYEE, then the primary key of PART-TIME-EMPLOYEE must also be EMPLOYEE-ID. This restriction maintains a one-to-one relationship between instances of the subtype and supertype, and therefore ensures the inheritance of attributes. Second, the supertype must contain one or more classification variables to indicate explicitly that a given instance of the supertype is also zero, one, or many of the possible subtypes. Using the business example again, an attribute called EMPLOYEE-TYPE-CODE, with the possible values 'Full-Time' and 'Part-Time', could be added to the EMPLOYEE entity to serve as the classification variable.

The diagramming conventions used here for super- and subtypes are illustrated in Figure 1 E. A single cross-hatch with the words "Is A" to the side indicate that the entity (or entities) below is a subtype of the entity above. The branching relationship line in the employee example illustrates mutually exclusive relationship, in this case, mutually exclusive subtypes. Completely separate lines would have been used if the subtypes were not mutually exclusive.

Although it is possible to build models that don't include subtypes, they are useful for indicating commonalities and distinctions between entities. This is especially important when one subtype can participate in relationships that the supertype or other subtypes cannot.

The last modeling tool that should be understood is the use of primary key attributes in the specification of a relationship. Recall two points made above: 1) attributes of the primary key uniquely identify instances in an entity, and 2) relationships exist between instances, not entities. To relate any two instances, the identifying information (primary keys) for both must be placed in the same entity (information cannot exist in the model outside an entity). Because all attributes must be single-valued, one-to-many relationships are implemented by distributing (copying) the primary key attributes of the "one" entity into the "many" entity. In the SPECIMEN and COLLECTING-EVENT example, a place-holder is created in the SPECIMEN entity for the primary key of COLLECTING-EVENT (e.g., COLLECTING-EVENT-ID). Within the SPECIMEN entity, the new attribute COLLECTING-EVENT-ID is called a **foreign key**. In the textual portion of the model foreign keys are typically listed among the attributes on an entity.

In many-to-many relationships, both foreign keys are placed in the associative entity. Even though information cannot exist in the model without being placed in an entity, modelers sometimes allow themselves the short-hand notation of not listing associative entities. In these cases, the foreign keys that specify the relationship are not shown.

2. Conventions of the Textual Description

The textual portion of a model provides the descriptions of entities, the attributes of each entity, and the descriptions of the relationships. The text should also describe briefly the outstanding issues involving a particular concept in the model. Additional sections may be added as necessary in later iterations.

As many individuals will be contributing to development of this model it is important that descriptive standards be adopted to ensure that the description is complete and consistent. We propose that the following information be recorded in descriptions of all data entities.

Entity Name
Description
Primary Key
Foreign Keys
  Target Entity
  Data Elements
Data Elements
Remarks

In addition, we propose to name all data objects, entities and data elements, according to a **naming convention**. A naming convention is a system for translating a data concept (e.g., a data element or data entity) into a name. Naming conventions are used in data administration to facilitate the development and use of a standard reference (e.g., model or data dictionary) by reducing ambiguity and redundancy among data objects. The name of a data object should suggest its definition and possible content. Armed with a knowledge of the naming convention, a person looking in a dictionary for a data object should find it easier to locate the corresponding object, or determine that the object does not exist in the dictionary. Note that the names for data objects used in a dictionary are not intended to be used as the names for corresponding tables or data elements in a database. The naming conventions used here conform to guidelines set forth by the National Institute of Standards and Technology, formerly Bureau of Standards, (Newton, 1987; Rosen & Law, 1989). All data object names are written in upper case.

Different methods are used to derive names for entities and data elements.

Entity Names. Entities are the primary subjects or concepts of interest to an enterprise. To make an entity name meaningful, it should always contain at least one noun. Adjectives or modifiers are used to clarify and restrict the meaning of the noun. The format of an entity name follows the English convention, in which modifiers are placed before the noun. Modifiers are optional, and used only to clarify the scope of the entity and eliminate ambiguity. Hyphens are used to join words in a name.

Entity Name = [Modifiers] + Noun

Examples:

Descriptive Name

SPECIMEN
DERIVED-OBJECT
TYPE-SPECIMEN-CITATION

Entities are always named in the singular, to represent a typical instance of the entity, except in cases where the instance itself is a plural concept.

Data Element Names. Data element names are composed of two parts, a prime term and a class term. The prime term is simply an existing entity name, and the class term is composed of optional modifiers plus a data class name. Note that modifiers may be nouns as well as adjectives, and again are used to clarify meaning. In some cases, an entity name and a class name are sufficient to convey the meaning of the data element, and no modifiers are required. A data class is used to describe the content of the data element. A provisional list of class names (after a document describing the naming conventions used by a federal agency) is included below. (Other documents on data administration contain similar lists of data classes.)

Data Element Name = Entity Name + [Modifiers] + Class Term

Examples:

Name

SPECIMEN-IDENTIFIER
LOCALITY-COUNTRY-NAME
COLLECTING-EVENT-EQUIPMENT-NAME

Table of Class Terms

Class Name	Abbrev	Definition
Amount	AMT	A monetary value. (May include average, balance, and other derived values).
Angle	ANGL	The rotational measurement between two lines or planes, diverging from a common point or line, respectively.
Area	AREA	The measurement of a surface.
Count	CNT	An integer value representing the number of items.
Code	CD	A combination of one or more numbers, letters, or special characters which is substituted for a specific meaning. Indicates the existence of a predetermined, finite set of values.
Coordinate	COORD	The designation of location by a line or plane. (Includes latitude and longitude.)
Date	DAT	The notation of a specific period of time.
Dimension	DMSN	A measured linear distance. (Includes: altitude, depth, diameter, distance, elevation, height, length, radius, width.)
Flag	FLG	A boolean variable for recording a yes/no, or on/off state.
Identifier	ID	A combination of one or more numbers, letters, or special characters that designate the identity of a specific object, entity, or instance, but has no other meaning.
Mass	MASS	The measure of inertia of a body.
Name	NAM	A designation of an object, entity, or instance, expressed as a word, phrase.

Quantity	QTY	A non-monetary value. (Includes, count, average, balance, deviation, factor, index, and scale.)
Rate	RT	A quantity, amount or degree of something in relation to a unit of something else. (Includes: acceleration, density, flow, speed, force, frequency, humidity, etc.)
Temperature	TP	The measure of heat in an object or ambient medium.
Text	TXT	An unformatted character string, generally in the form of words.
Time	TM	A notation of a specified chronological point within a period.
Volume	VOL	The measurement of space occupied by a three dimensional object.
Weight	WT	The force with which an object is attracted toward the earth by gravitation.

III. AN INFORMATION MODEL FOR BIOLOGICAL COLLECTIONS

Figure 2 represents a "first cut" at a high-level information model for biological collections. (It spans four pages, so we encourage readers to remove these pages and paste them together.) The textual description of the model follows the summary illustration and contains an alphabetical list of entities, a definition and description of each entity (including example data elements in some cases), an alphabetical list of relationships, and brief descriptions of the relationships.

One additional, non-standard, convention was used to simplify this entity-relationship diagram; the marking of certain entities with an asterisk. Entities marked with an asterisk indicate AGENTs as they perform a particular role in the model. Note, an "AGENT-role" entity does not indicate another subtype of AGENT, because an AGENT that plays a role isn't conceptually different from the subtypes already defined; i.e., a PERSON, PLATFORM, or ORGANIZATION. Information about the AGENT's participation in a relationship should be recorded with the relationship, rather than with the AGENT. Entities marked with an asterisk are simply replicates of the AGENT entity (or one of its subtypes), and reduce the number of long relationship lines that traverse the diagram.

A. List of Entities (Supertypes and Subtypes in Alphabetical Order):

Figure 2 located here, File: ascfig2.ps

(Pages 15, 16, 17, 18 consisted of Figure 2 in the paper distribution of this draft. The identical figure is now represented on one page. To maintain the original pagination, the next page is 19.)

B. Entity Descriptions

Entity Name: ABSOLUTE-AGE-DETERMINATION
(Subtype of GEOLOGIC-AGE-DETERMINATION)

Description:

An age determination for a PALEO-COLLECTING-EVENT derived from an "absolute" dating technique. Examples include Carbon-14, Potassium/Argon, amino acid recemization, fission-track dating, and thermoluminescence. All of these techniques yield an age in the form of a number of years before present, with an associated error term.

Primary Key:

ABSOLUTE-AGE-DETERMINATION-ID
(= GEOLOGIC-AGE-DETERMINATION-ID)

Foreign Keys:

None

Example Data Elements:

MAXIMUM-AGE-VALUE
MINIMUM-AGE-VALUE
AGE-ERROR-VALUE
AGE-DETERMINATION-METHOD

Entity Name: AGENT (Supertype)

Description:

A PERSON, ORGANIZATION, or PLATFORM that performs actions on various biological and collection entities.

Subtypes:

PERSON
ORGANIZATION
PLATFORM

Primary Key:

AGENT-ID

Foreign Keys:

Target Entity: none
Data Elements:

Example Data Elements:

AGENT-ID
AGENT-TYPE-CD

Remarks:

The subtype entities are collected into the AGENT supertype because more than one of the AGENT subtypes may play the same role in relationships with other entities. For example, any combination of PERSON, ORGANIZATION and PLATFORM may serve as a COLLECTOR in a COLLECTING-EVENT.

Entity Name: **CHRONOSTRATIC-AGE-DETERMINATION**
(a subtype of GEOLOGIC-AGE-DETERMINATION)

Description:

An age determination for a PALEO-COLLECTING-EVENT based on one or more boundaries of a GEOLOGIC-TIME-UNIT.

Primary Key:

CHRONOSTRATIC-AGE-DETERMINATION-ID
(=GEOLOGIC-AGE-DETERMINATION-ID)

Foreign Keys:

Target Entity: GEOLOGIC-TIME-UNIT
Data Elements: MAXIMUM-AGE-TIME-UNIT-NM (=TIME-UNIT-NM)

Target Entity: GEOLOGIC-TIME-UNIT
Data Elements: MINIMUM-AGE-TIME-UNIT-NM (=TIME-UNIT-NM)

Example Data Elements:

Entity Name: CITATION (Supertype)

Description:

The designation of a REFERENCE-WORK in order to associate it with a TAXON-NAME-USE, COLLECTING-EVENT, COLLECTING-UNIT or LOCALITY.

Subtypes:

COLLECTING-EVENT-CITATION
LOCALITY-CITATION
GAZETTEER-CITATION
TAXON-NAME-USE-CITATION
COLLECTING-UNIT-CITATION

Primary Key:

CITATION-ID

Foreign Keys:

Target Entity: REFERENCE-WORK
Data Elements: REFERENCE-WORK-ID

Example Data Elements:

CITATION-ID
CITATION-TYPE-CD
REFERENCE-WORK-ID

Entity Name: **CLOCK-TIME** (Subtype of TIME-EXPRESSION)

Description:

A subtype of TIME-EXPRESSION, CLOCK-TIME is an expression of TIME as instant(s) or span(s) of time as represented chronometrically, or on a calendar where such can be made unambiguously.

Primary Key:

CLOCK-TIME-ID

Foreign Keys:

None

Example Data Elements:

CLOCK-TIME-ID
CLOCK-TIME-QTY (a recorded point in calendar time)
START-CLOCK-TIME-QTY
END-CLOCK-TIME-QTY
CLOCK-TIME-QUALIFIER-CD
TIME-ZONE-CD (determined from location and date)
DATE
START-DAT
END-DAT
DATE-QUALIFIER-CD

Entity Name: COLLECTING-EVENT (Supertype)

Description:

The act of collecting zero or more COLLECTING-UNITs at a particular LOCALITY and TIME.

Subtypes:

PALEO-COLLECTING-EVENT

Primary Key:

COLLECTING-EVENT-ID

A unique tag (surrogate key) to allow other entities to connect to COLLECTING-EVENT.

Foreign Keys:

Target Entity: LOCALITY
Data Elements: LOCALITY-ID

Example Data Elements:

COLLECTING-EVENT-ID

A unique tag to allow other entities to connect to COLLECTING-EVENT.

COLLECTING-EVENT-TYPE-CD

A classification attribute, indicating the type (kind) of COLLECTING-EVENT.

STATED-TIME-TXT

Specification of points and/or intervals of time in absolute or indefinite units, or relative to each other.
Examples: evening; late 1980s; spring; March or June; 17:56:01, 12 JUN 1992; three hours after second dredge haul.

STATED-LOCALITY-TXT

Original statement (literal quotation) of the location of the COLLECTING-EVENT.

COLLECTING-EVENT-COMMENTS-TXT

(Unstructured text.)
Examples: Nothing was collected at this station; dredge not adequately cleaned between hauls.

Entity Name: COLLECTING-EVENT-ASSOCIATION

Description:

Establishes and describes a (recursive) relationship between two COLLECTING-EVENTs.

Primary Key:

COLLECTING-EVENT-ID
ASSOCIATED-COLLECTING-EVENT-ID

Foreign Keys:

Target Entity: COLLECTING-EVENT
Data Elements: COLLECTING-EVENT-ID

Target Entity: COLLECTING-EVENT
Data Elements: ASSOCIATED-COLLECTING-EVENT-ID

Example Data Elements:

ASSOCIATED-COLLECTING-EVENT-ID

COLLECTING-EVENT-ID

ASSOCIATION-DESCRIPTION-TXT

Describes how COLLECTING-EVENTs are related.
Examples: "COLLECTING-EVENT 123 occurred before COLLECTING-EVENT 124, although the exact times are unknown for both."

Entity Name: **COLLECTING-EVENT-CITATION**
(a subtype of CITATION)

Description:

An explicit mention of a COLLECTING-EVENT, typically in a published work but possibly in an unpublished archival document.

Primary Key:

COLLECTING-EVENT-CITATION-ID (=CITATION-ID)

Foreign Keys:

Target Entity: COLLECTING-EVENT
Data Elements: COLLECTING-EVENT-ID

Target Entity: CITATION
Data Elements: COLLECTING-EVENT-CITATION-ID (=CITATION-ID)

Example Data Elements:

COLLECTING-EVENT-CITATION-ID (=CITATION-ID)
COLLECTING-EVENT-ID
FIELD-NUMBER-CD

Entity Name: COLLECTING-METHOD

Description:

A description of the method used during a COLLECTING-EVENT. This may involve a specific technique, process, or use of equipment to make the collection.

Primary Key:

COLLECTING-METHOD-ID

Foreign Keys:

None (The ERD specifies a many to many relationship between COLLECTING-METHOD and COLLECTING-EVENT, which implies an associative entity not shown or described in the text.)

Example Data Elements:

COLLECTING-METHOD-ID
COLLECTING-METHOD-DESCRIPTION-TXT

Entity Name: COLLECTING-UNIT (Supertype)

Description:

An operational sample resulting from a single COLLECTING-EVENT. A COLLECTING-UNIT may be an UNSORTED-LOT, LOT, SPECIMEN, SPECIMEN-COMPONENT, or DERIVED-OBJECT. It is important to note that these subtypes are mutually exclusive. This means, for example, that a SPECIMEN removed from a LOT will bear a different identifier (COLLECTING-UNIT-ID) than the original LOT. Similarly, a SPECIMEN-COMPONENT removed from a SPECIMEN will bear a different identifier than the original SPECIMEN. The derivation history of successively smaller COLLECTING-UNITs is maintained by data fields (foreign keys) in the appropriate subtypes. For example, a data field is available in the SPECIMEN-COMPONENT subtype to identify the original SPECIMEN.)

Although the concept varies among disciplines, this entity is the fundamental ingredient of every collection. Therefore it represents the core of the model and participates in many relationships with other entities in the model.

A COLLECTING-UNIT results from a single COLLECTING-EVENT, but many COLLECTING-UNITs may result from the same COLLECTING-EVENT.

A PREPARATOR performs one or more PREPARATION-ACTIONs on the COLLECTING-UNIT and one or more DERIVED-OBJECTS may be made from a COLLECTING-UNIT.

References to a COLLECTING-UNIT may also come through one or more COLLECTING-UNIT-ASSOCIATIONs, which describe noteworthy relationships among individuals obtained in the same COLLECTING-EVENT, such as a host-parasite relationship.

One or more COLLECTING-UNITs may have the same STORAGE-REGIME. In many disciplines, there may be only one STORAGE-REGIME at a time for each COLLECTING-UNIT. However, there are common examples in Recent vertebrate collections where one COLLECTING-UNIT has more than one STORAGE-REGIME, resulting in more than one STORAGE-LOCATION and more than one STORAGE-MEDIUM. (E.g., a bat skull removed from a fluid-preserved skin, is cleaned and no longer stored in fluid, but each remains a component of the same SPECIMEN.) A COLLECTING-UNIT may also be moved from one STORAGE-LOCATION to another, or transferred to another suite of STORAGE-MEDIUMs, either of which would also result in another STORAGE-REGIME for that COLLECTING-UNIT.

A COLLECTING-UNIT is involved in one or more TRANSACTIONs, such as an acquisition or a loan.

One or more taxonomic DETERMINATIONs are made upon each COLLECTING-UNIT. Whereas each COLLECTING-UNIT can have one or more TAXON-NAMEs, each TAXON-NAME can be applied to one or more COLLECTING-UNITs.

Reference to each COLLECTING-UNIT may be contained in one or more COLLECTING-UNIT-CITATIONs. These may include field notes, catalogs, or formal publications.

Subtypes:

UNSORTED-LOT
LOT
SPECIMEN
SPECIMEN-COMPONENT
DERIVED-OBJECT

Primary Key:

COLLECTING-UNIT-ID

Foreign Keys:

Target Entity: COLLECTING-EVENT
Data Elements: COLLECTING-EVENT-ID

Example Data Elements:

COLLECTING-UNIT-ID
COLLECTING-UNIT-TYPE-CD
NUMBER-OF-ITEMS-CNT

Entity Name: COLLECTING-UNIT-ASSOCIATION

Description:

An association of COLLECTION-UNITs, either SPECIMENs, LOTs, UNSORTED-LOTs or DERIVED-OBJECTs, with one or more other COLLECTING-UNITs.

Each COLLECTING-UNIT-ASSOCIATION is of a defined COLLECTING-UNIT-ASSOCIATION-TYPE.

Primary Key:

COLLECTING-UNIT-ID
ASSOCIATED-COLLECTING-UNIT-ID

Foreign Keys:

Target Entity:	ASSOCIATED-COLLECTING-UNIT (=COLLECTING-UNIT)
Data Elements:	ASSOCIATED-COLLECTING-UNIT-ID (=COLLECTING-UNIT-ID)
Target Entity:	COLLECTING-UNIT
Data Elements:	COLLECTING-UNIT-ID
Target Entity:	COLLECTING-UNIT-ASSOCIATION-TYPE
Data Elements:	COLLECTING-UNIT-ASSOCIATION-TYPE-ID

Example Data Elements:

COLLECTING-UNIT-ID
ASSOCIATED-COLLECTING-UNIT-ID
COLLECTING-UNIT-ASSOCIATION-TYPE-ID
COLLECTING-UNIT-ASSOCIATION-COMMENTS-TXT

Entity Name: **COLLECTING-UNIT-CITATION**
(Subtype of CITATION)

Description:

An explicit mention to a COLLECTING-UNIT (a lot, specimen, etc.) in a REFERENCE-WORK. A COLLECTING-UNIT may be cited for several reasons; to establish the identity of a type specimen, to document the existence of a voucher, to point to an exemplary specimen, to document a biological form.

Primary Key:

COLLECTING-UNIT-CITATION-ID

Foreign Keys:

Target Entity: COLLECTING-UNIT
Data Element: COLLECTING-UNIT-ID

Target Entity: CITATION
Data Element: COLLECTING-UNIT-CITATION-ID (=CITATION-ID)

Example Data Elements:

COLLECTING-UNIT-CITATION-KIND-CODE
COLLECTING-UNIT-CITATION-PAGE-ID
COLLECTING-UNIT-CITATION-PLATE-ID
COLLECTING-UNIT-CITATION-FIGURE-ID
COLLECTING-UNIT-CITATION-REMARKS-TXT

Entity Name: COLLECTION

Description:

An assemblage of biological specimens maintained by an educational or research institution to be used as a research resource in biological systematics and/or ecology.

Primary Key:

COLLECTION-ID

Foreign Keys:

None

Example Data Elements:

COLLECTION-ID
COLLECTION-NAM
ORGANIZATION-ID

Entity Name: COLLECTOR*

Description:

A PERSON, PLATFORM (e.g., research vessel), or ORGANIZATION (i.e., an AGENT) that collects biological COLLECTING-UNITs.

Primary Key:

COLLECTOR-ID (=AGENT-ID)

Foreign Keys:

None

Entity Name: **DERIVED-OBJECT** (a subtype of COLLECTING-UNIT)

Description:

A COLLECTING-UNIT of one or more observations, images, or representations of an UNSORTED-LOT, LOT, SPECIMEN, or SPECIMEN-COMPONENT.

Primary Key:

DERIVED-OBJECT-ID (=COLLECTING-UNIT-ID)

Foreign Keys:

Target Entity: COLLECTING-UNIT
Data Elements: ORIGINAL-COLLECTING-UNIT-ID

Target Entity: DERIVED-OBJECT-TYPE
Data Elements: DERIVED-OBJECT-TYPE-ID

Example Data Elements:

DERIVED-OBJECT-ID (=COLLECTING-UNIT-ID)
DERIVED-OBJECT-TYPE-ID
ORIGINAL-COLLECTING-UNIT-ID (=COLLECTING-UNIT-ID)

Entity Name: DERIVED-OBJECT-TYPE

Description:

The class of DERIVED-OBJECTs obtained from a COLLECTING-UNIT.

Primary Key:

DERIVED-OBJECT-TYPE-ID

Foreign Keys:

None

Example Data Elements:

DERIVED-OBJECT-TYPE-ID
DERIVED-OBJECT-TYPE-NAM
DERIVED-OBJECT-TYPE-DESCRIPTION-TXT

Entity Name: DETERMINATION

Description:

An action performed by a determiner (=AGENT) in which an association is made between a COLLECTING-UNIT and a TAXON-NAME.

Only one DETERMINATION should be considered valid at a time if the COLLECTING-UNIT is a SPECIMEN or SPECIMEN-COMPONENT. More than one valid DETERMINATION may exist for a COLLECTING-UNIT containing multiple individuals (UNSORTED-LOT).

The fact that four attributes make up the primary key enables the DETERMINATION entity to accommodate a wide variety of scenarios involving re-determinations, and COLLECTING-UNITs containing multiple taxa.

Primary Key:

COLLECTING-UNIT-ID
TAXON-NAME-ID
DETERMINER-ID (=AGENT-ID)
DETERMINATION-DAT

Foreign Keys:

Target Entity: COLLECTING-UNIT
Data Elements: COLLECTING-UNIT-ID

Target Entity: TAXON-NAME
Data Elements: TAXON-NAME-ID

Target Entity: AGENT
Data Elements: DETERMINER-ID (=AGENT-ID)

Example Data Elements:

COLLECTING-UNIT-ID
TAXON-NAME-ID
DETERMINER-ID (=AGENT-ID)
DETERMINATION-DAT
DETERMINATION-STATUS-CD

Entity Name: DETERMINER*

Description:

An PERSON who creates an association between a TAXON-NAME and a COLLECTING-UNIT; e.g., a PERSON who identifies a SPECIMEN.

Primary Key:

DETERMINER-ID (=AGENT-ID)

Foreign Keys:

None

Entity Name: ESTUARINE-HABITAT-DESCRIPTION

Description:

Primary Key:

HABITAT-DESCRIPTION-ID

Foreign Keys: none

Example Data Elements:

Entity Name: FRESHWATER-HABITAT-DESCRIPTION

Description:

Primary Key:

HABITAT-DESCRIPTION-ID

Foreign Keys: none

Example Data Elements:

Entity Name: **GEOLOGIC-AGE-DETERMINATION** (Supertype)

Description:

The assignment of a geologic age or age-range to a PALEO-COLLECTING-EVENT (and thus to the COLLECTING-UNITS deriving from it). Either a maximum age, minimum age, or both may be specified in a single GEOLOGIC-AGE-DETERMINATION. An age is expressed either in absolute units of time (millions of years before present) in the case of an ABSOLUTE-AGE-DETERMINATION or in the form of the name of a GEOLOGIC-TIME-UNIT for a CHRONOSTRATIC-AGE-DETERMINATION. For example, a radiometric date on a rock below the sampled deposit may yield a maximum age but no minimum age. In contrast, assignment of the deposit to a time-unit (e.g., "Cretaceous") can provide both an upper and lower bound for age via calibration with the geologic time scale.

Subtypes:

ABSOLUTE-AGE-DETERMINATION
CHRONOSTRATIC-AGE-DETERMINATION

Primary Key:

GEOLOGIC-AGE-DETERMINATION-ID

Foreign Keys:

Target Entity: PALEO-COLLECTING-EVENT
Data Elements: PALEO-COLLECTING-EVENT-ID (=COLLECTING-EVENT-ID)

Target Entity: AGE-DETERMINER (= AGENT)
Data Elements: AGE-DETERMINER-ID (= AGENT-ID)

Example Data Elements:

AGE-DETERMINATION-TYPE
AGE-DETERMINATION-DATE
AGE-DETERMINATION-REMARKS-TXT

Entity Name: GEOLOGIC-TIME-UNIT

Description:

A formally named unit belonging to any one of the chronostratic sequences of a geologic time scale. This includes both geochronologic entities such as epochs, ages, chrons, biozones, etc. and the chrons of the magnetic polarity timescale. It includes both global and regional entities if formally named and in general use.

Primary Key:

GEOLOGIC-TIME-UNIT-NAME

Foreign Keys:

Target Entity: TIME-UNIT-BOUNDARY
Data Elements: UPPER-BOUND (= TIME-UNIT-BOUNDARY-ID)

Target Entity: TIME-UNIT-BOUNDARY
Data Elements: LOWER-BOUND (= TIME-UNIT-BOUNDARY-ID)

Example Data Elements:

TIME-UNIT-NAME
TIME-UNIT-RANK-NM
TIME-UNIT-SEQUENCE-NAME

Remarks:

A geologic time scale is a sequence of rock strata whose boundaries are calibrated in a linear numerical scale representing "absolute" time (Harland, et al. 1990). The sequence of strata allows rocks and their contained fossils to be assigned to particular, widely recognizable intervals of continuous time without requiring knowledge of absolute dates. This is a necessity in geological and paleontological work because absolute dates are not available for the majority of rocks and fossils that need to be placed in a temporal context. In recent decades considerable progress has been made on international agreement about both the particular rock units and the specific boundary points that will be components of a universal, standard scale. Also, modern dating techniques allow high levels of precision in temporal calibration for many parts of the geologic record. However, not all periods of earth history have agreed definitions for a standard scale, and the hierarchical level (see below) of standardization also varies. Thus, currently there is no single geologic time scale in general use, and even should one be agreed upon it will still change over time as a result of refinements in isotopic dating and other means of calibration.

What is generally presented as a Geologic Time Scale is actually a set of several parallel, overlapping stratigraphically-ordered sequences of named time-units that represent unequal intervals of geologic time. These different "chronostratic" sequences may be based on different criteria and may be in use globally or may have primarily regional significance. For example, the sequence of magnetic polarity chrons is global in scope and based on the polarity of the earth's magnetic field; the sequence of North American land mammal ages is based on biostratigraphic criteria involving continental mammal faunas, and applies only to North America. In principle all of these time units can be related to each other through calibration in units of absolute time (years). The units of any of these sequences may be used, then, to indicate (with varying levels of precision) specific intervals of time.

Geologic time units have traditionally been presented in a hierarchical scheme with ranks: Eon, Era, Period, Epoch, Stage (or Age), Chron. This hierarchy has a long and complex history. The higher-ranked units usually form a neat, nested hierarchy, with lower-ranked entities lying entirely within the boundaries of their parent units. For example, the latest epoch within a period is generally considered to end at the same point as the period (it is "conterminous" with the period). However, Ages/Stages and --- especially --- Chrons are not universally regarded as conterminous with higher-ranked entities, though in formal standardization schemes they are intended to be so. The result is that many of the most useful regional time units based on biostratigraphic criteria, as well as the crucial paleomagnetic polarity chrons, will not be adopted as formal divisions of the major geologic time units. Nevertheless, they may frequently be more meaningful for researchers, and will continue to be used in geologic age assignments. The qualifiers "Early," "Middle," and "Late" are also frequently applied to subdivisions of named time-units and increasingly are being given formal definitions as well.

Any two adjacent time units of the same rank in a particular chronostratic sequence necessarily share a boundary (upper boundary for one and lower boundary for the other). Geochronological entities at different ranks can share boundaries as well. For example, the Mesozoic Era, the Cretaceous Period, and the Maastrichtian Age (or Stage) all share the same upper boundary. Incorporating a geologic time scale into the present information model thus requires at least two entities, GEOLOGIC-TIME-UNIT and TIME-UNIT-BOUNDARY.

Usually, time is expressed in years (ka, Ma, Ga = one thousand years, one million years, one billion years, respectively) before present. The "present" is defined as the year 1950, if such precision is relevant.

Reference:

Harland, W. B., R. L. Armstrong, A. V. Cox, L. E. Craig, A. G. Smith, and D. G. Smith. 1990. A Geologic Time Scale 1989. Cambridge University Press, Cambridge.

Entity Name: GEOMETRIC-LOCALITY

Description:

A GEOMETRIC-LOCALITY is a LOCALITY whose spatial position on earth can be characterized (described, defined) by a set of geometric data. Because an individual COLLECTING-EVENT can occur at a point or over an area, and because of inaccuracy of description, we have several categories of geometric locality depending on nature of the COLLECTING-EVENT.

It should be noted that whether a COLLECTING-EVENT is a point or a polygon is a practical, rather than geometric distinction, depending on the accuracy of spatial locating equipment and the importance of microlocality to collections.

Subtypes:

POINT
LINE
POLYGON

Primary Key:

LOCALITY-ID

Foreign Keys:

None

Example Data Elements:

LOCALITY-ID
GEOMETRIC-LOCALITY-SUBTYPE-CD

Entity Name: HABITAT-DESCRIPTION (Supertype)

Description:

A description of the physical and biotic environment at the time and place of a COLLECTING-EVENT.

Subtypes:

TERRESTRIAL-HABITAT-DESCRIPTION
FRESHWATER-HABITAT-DESCRIPTION
MARINE-HABITAT-DESCRIPTION
ESTUARINE-HABITAT-DESCRIPTION
ETC.

Primary Key:

HABITAT-DESCRIPTION-ID

Foreign Keys:

None

Example Data Element Groups:

Geomorphic Features
Physical/Chemical Measurements
Sampling Scale
Meteorological Data
Life Zone
Vegetation Type
Soil Type

Entity Name: **LINE** (Subtype of GEOMETRIC-LOCALITY)

Description:

A subtype of GEOMETRIC-LOCALITY. Collections defined by a line are those occurring along a line, such as a transect. Definition of this kind of collection would be a point, direction and distance, or a connected series (chain) of two or more points.

Primary Key:

LOCALITY-ID

Foreign Keys:

None

Example Data Elements:

LOCALITY-ID
(others as represented in a GIS)

Entity Name: LOCALITY (Supertype)

Description:

A geographical, mappable location that is the site of a COLLECTING-EVENT. LOCALITYs are usually expressed verbally with relation to geographically stable points of reference (i.e., towns, mountains, roads, etc.) and

Ideally, a LOCALITY should be expressible in terms of GEO coordinates (either as a point, with an attributed level of precision, or line, or polygon.)

Subtypes:

GEOMETRIC-LOCALITY

Primary Key:

LOCALITY-ID

Foreign Keys:

Target Entity: NAMED-PLACE
Data Elements: NAMED-PLACE-ID

Example Data Elements:

LOCALITY-ID
LOCALITY-NAM
GEOMETRIC-LOCALITY-FLG
NAMED-PLACE-ID
ELEVATION-DMSN

(Note: ELEVATION and DEPTH may be synonymous as "deviation from sea-level", but may not be used the same way by marine and terrestrial collectors. As used by terrestrial collectors, ELEVATION is commonly perceived as an attribute of the LOCALITY. As used by marine collectors, DEPTH may be perceived as an attribute of COLLECTING-EVENT. E.g., two trawls can be made precisely between the same coordinates, but at different depths -- two LOCALITYs or two COLLECTING-EVENTs?)

Entity Name: LOCALITY-CITATION (Subtype of CITATION)

Description:

An explicit mention of a LOCALITY in a REFERENCE-WORK, typically a reference in a published work to a named LOCALITY.

Primary Key:

LOCALITY-CITATION-ID (=CITATION-ID)

Foreign Keys:

Target Entity: CITATION
Data Elements: LOCALITY-CITATION-ID (=CITATION-ID)

Target Entity: LOCALITY
Data Elements: LOCALITY-ID

Example Data Elements:

Entity Name: **LOT** (Subtype of COLLECTING-UNIT)

Description:

A COLLECTING-UNIT of one ore more individuals of the same taxon from a single COLLECTING-EVENT. Subsequent study or future knowledge may demonstrate that what had been considered a LOT is still a grouping of mixed taxa that would then be subdivided into appropriate single taxon groupings to form new LOTs. These new LOTs would become new and separate COLLECTING-UNITs (with new COLLECTING-UNIT-IDs, and the former LOT would become an UNSORTED-LOT. Thus, the status of any LOT that contains more than one individual is somewhat plastic.

A LOT may be sorted into one or more SPECIMENs, should any contained individual acquire a special status and consequently need to be referenced as distinct from other individuals in the LOT.

See COLLECTING-UNIT for more detailed description of relationships to other entities. (Not all disciplines will utilize this subtype of COLLECTING-UNIT.)

Primary Key:

LOT-ID (=COLLECTING-UNIT-ID)

Foreign Keys:

Target Entity: UNSORTED-LOT

Data Elements: UNSORTED-LOT-ID (=COLLECTING-UNIT-ID)

Example Data Elements:

COLLECTING-UNIT-ID
AGE-RANGE
SIZE-RANGE
DISTRIBUTION-OF-DUPLICATES
STAGES
SEXES

Entity Name: MARINE-HABITAT-DESCRIPTION
(Subtype of HABITAT-DESCRIPTION)

Description:

Primary Key:

MARINE-HABITAT-DESCRIPTION-ID (=HABITAT-DESCRIPTION-ID)

Foreign Keys:

None

Example Data Elements:

Entity Name: NAMED-PLACE

Description:

A geographic entity (location or place) whose name is in common use. Preferably, the name should appear on one or more published maps.

Primary Key:

NAMED-PLACE-ID

Foreign Keys:

Target Entity: NAMED-PLACE
Data Elements: CONTAINING-NAMED-PLACE-ID

Example Data Elements:

NAMED-PLACE-ID
CONTAINING-NAMED-PLACE-ID
PLACE-NAM
PLACE-TYPE-CD

Entity Name: ORGANIZATION (Subtype of AGENT)

Description:

Primary Key:

ORGANIZATION-ID (=AGENT-ID)

Foreign Keys:

None

Example Data Elements:

ORGANIZATION-ID (=AGENT-ID)
ACRONYM-CD
DEPARTMENT-NAM
INSTITUTION-NAM

Entity Name: PALEO-COLLECTING-EVENT (Subtype of COLLECTING-EVENT)

Description:

This entity is a subtype of COLLECTING-EVENT used for collections of paleontological, archaeological, or historical biological materials. The present-day habitat(s) observed at the locality at the time of collection are presumed to have no particular correspondence to the conditions experienced by the organisms in life, and a PALEO-COLLECTING-EVENT has no habitat description. Paleohabitats that might be inferred from biological or physical evidence are inferential data rather than primary observational data recorded at the time of collection, and are beyond the scope of this information model.

Paleontologists usually refer to the source of their samples as "localities," and archaeologists usually call their equivalent entities "sites." Localities and sites are traditionally associated with the kinds of information represented in the present model by the contents of two separate entities: LOCALITY and COLLECTING-EVENT. In this model, LOCALITY contains only the information about geographic location, present elevation, and extent.[**] Just as it is the RECENT-COLLECTING-EVENT (not the LOCALITY) that contains or references detailed habitat descriptions, the PALEO-COLLECTING-EVENT contains or references information on stratigraphy, lithology, and geologic age.

Geologic age is best considered as an age range, regardless of whether dating is on the basis of absolute determinations (which always have an error associated with them) or on the basis of assignment to a calibrated geologic time unit. Thus, a PALEO-COLLECTING-EVENT can be characterized by a maximum and a minimum age, in years before present, either directly or by implication. Since ages are assigned to the collecting event and not individual specimens, all COLLECTING-UNITs from a given PALEO-COLLECTING-EVENT share the same age (range).

[**]A previous draft of the model showed both LOCALITY and COLLECTING-EVENT as bounded by the "Geologic Time Scale." This model advances the proposition that LOCALITY refers to a geographic point (line, area) with an elevation above sea level --- a place in the modern world --- and not a particular volume of rock at that place. A "place" has no age. It is always "there," at those coordinates. In fact, the things currently at that place (rock units, fossils) may have been in other places (geographic coordinates) when they were originally formed in the geologic past. It is the act of collecting from a particular rock unit at that place that creates a set of things to which a geologic age-range can be meaningfully applied. So, in this view geologic age(s) relate only to COLLECTING-EVENTs and not LOCALITYs.

Specimens of different geologic ages (e.g., deriving from different beds or excavation planes) should be assigned to different COLLECTING-EVENTs.

Primary Key:

PALEO-COLLECTING-EVENT-ID (= COLLECTING-EVENT-ID)

Foreign Keys:

None

Example Data Elements:

STRATIGRAPHIC-GROUP-NM
STRATIGRAPHIC-FORMATION-NM
STRATIGRAPHIC-MEMBER-NM
STRATIGRAPHIC-BED-NM
SECTION-REFERENCE-POINT-DESCRIPTION-TXT
SECTION-TOP-DMSN
SECTION-BOTTOM-DMSN
LITHOLOGY-DESCRIPTION-TXT
STATED-AGE-TXT
CONSENSUS-CHRONOSTRATIC-UNIT-NM
CONSENSUS-MAXIMUM-AGE-TM
CONSENSUS-MINIMUM-AGE-TM

Remarks:

The COLLECTING-EVENT may have occurred at a position within the recorded strata that is known (has been measured) relative to a particular reference point (such as a datum plane, bottom of a bed or a contact between two formations). In addition, the COLLECTING-EVENT may have occurred throughout a known thickness of sediment, the top and bottom of which can be separately related to the reference point. The data elements SECTION-REFERENCE-POINT-DESCRIPTION-TXT, SECTION-TOP-DMSN, and SECTION-BOTTOM-DMSN allow this information to be recorded.

The description of lithology may have to be expanded.

STATED-AGE-TXT is primarily to accommodate original statements of age for older collecting events that we may not be able to relate directly to current schemes for representing geologic time. Since there may be many GEOLOGIC-AGE-DETERMINATIONs for a given collecting event it may be important to record synthetic determinations of locality ages based on all available information. This is what the "CONSENSUS" fields allow, and they may require a CONSENSUS-DETERMINER (=AGENT) as well. In many paleontological collections samples are stored at least partly according to age, and for such a COLLECTION at least one of these age fields should be consistent with the information in STORAGE-LOCATION.

Entity Name: **PERIOD** (Subtype of TIME-EXPRESSION)

Description:

A subtype of TIME-EXPRESSION, PERIOD is an expression of time as instant(s) or span(s) of time as represented by season, time of day or other such designation, where such can be made unambiguously.

This entity includes more imprecise data that involves a period of time without pin-pointing the moment of collection chronometrically. These data can be seasonal, such as "spring", or deal with a span of time during a day, such as "morning", "pm", or in some cases, statements such as "around midnight", or "as the dawn broke".

Primary Key:

PERIOD-ID

Foreign Keys:

None

Example Data Elements:

PERIOD-ID

Entity Name: **PERSON** (Subtype of AGENT)

Description:

A human being that performs one or more actions or participates in one or more events related to the generation or maintenance of biological collections. The PERSON entity, as presently conceived, is not intended to include groups of PERSONs; i.e., each instance of a PERSON represents only a single individual. (Discussion at the workshop did not include the concept of an informal group of people, distinct from an ORGANIZATION.)

Primary Key:

PERSON-ID (=AGENT-ID)

Foreign Keys: none

Example Data Elements:

PERSON-ID (=AGENT-ID)
LAST-NAM
FIRST-NAM
TITLE-TXT

Entity Name: PLATFORM (Subtype of AGENT)

Description:

A named inanimate object that is employed to conduct COLLECTING-EVENTs, either in the collection of actual COLLECTING-UNITs (e.g., SPECIMENs) or DERIVED-OBJECTs such as video tapes or photographs. A typical use for the PLATFORM entity would be to hold information about research vessels, but the concept is expanded here to include "sensor platforms" that might be used in the acquisition of visual records.

Primary Key:

PLATFORM-ID (=AGENT-ID)

Foreign Keys:

None. *(We may wish to record a relationship between PLATFORM and ORGANIZATION.)*

Example Data Elements:

PLATFORM-ID (=AGENT-ID)
PLATFORM-NAM

Entity Name: **POINT** (Subtype of GEOMETRIC-LOCALITY)

Description:

A subtype of GEOMETRIC-LOCALITY. Collections defined by a point are those occurring at a single place describable by latitude-longitude (or other coordinate system). Such coordinates could be derived from maps or GPS systems (clearly, an attribute of this subtype would be a source of coordinates). Most collections would be of this type.

Primary Key:

LOCALITY-ID

Foreign Keys:

None

Example Data Elements:

LOCALITY-ID
LATITUDE-DEGREES-QTY
LATITUDE-MINUTES-QTY
LATITUDE-SECONDS-QTY
LATITUDE-DIRECTION-CD
LONGITUDE-DEGREES-QTY
LONGITUDE-MINUTES-QTY
LONGITUDE-SECONDS-QTY
LONGITUDE-DIRECTION-CD
ACCURACY-QTY
ELEVATION-DMSN
(or as represented in a GIS)

Entity Name: POLYGON (Subtype of GEOMETRIC-LOCALITY)

Description:

A subtype of GEOMETRIC-LOCALITY. Polygons include two kinds of collections: those truly occurring over a broad two (or three) dimensional area such as a reef census or poison station (that is, a "bay" was sampled), or the definition is a polygon because point data are not available and the only information about locality is a geographic area (e.g. Florida). Certainly, an accuracy attribute would be used to separate these two categories.

Primary Key:

LOCALITY-ID

Foreign Keys:

None

Example Data Elements:

LOCALITY-ID
(others as represented in a GIS)

Entity Name: PREPARATION-ACTION

Description:

An action taken by an AGENT (the PREPARATOR), usually a PERSON (s), to develop or preserve a COLLECTING-UNIT, that departs from, or goes beyond the standard processing of a COLLECTING-UNIT.

A PREPARATION-ACTION may produce a DERIVED-OBJECT that may be either SPECIMENs, LOTs, UNSORTED-LOTs or it may simply enhance an existing COLLECTING-UNIT.

A PREPARATION-ACTION involves a defined PREPARATION-METHOD.

The PREPARATION-ACTION should not be confused with the STORAGE-REGIME and its associated STORAGE-MEDIUM and STORAGE-LOCATION.

Primary Key:

COLLECTING-UNIT-ID
PREPARATION-METHOD-ID

Foreign Keys:

Target Entity: COLLECTING-UNIT
Data Elements: COLLECTING-UNIT-ID

Target Entity: PREPARATOR (=AGENT)
Data Elements: PREPARATOR-ID (=AGENT-ID)

Example Data Elements:

COLLECTING-UNIT-ID
PREPARATION-METHOD-ID
PREPARATOR-ID
PREPARATION-ACTION-DATE
PREPARATION-ACTION-NOTES

Entity Name: PREPARATION-METHOD

Description:

A defined or standard procedure employed by an AGENT (the PREPARATOR), as part of a particular PREPARATION-ACTION.

A PREPARATION-METHOD may be a simple single step procedure or may involve a number of PREPARATION-STEPs.

The same PREPARATION-METHOD may be used in many PREPARATION-ACTIONs

Primary Key:

PREPARATION-METHOD-ID

Foreign Keys:

Target Entity: REFERENCE-WORK
Data Elements: REFERENCE-WORK-ID

Target Entity: PREPARATION-ACTION
Data Elements: PREPARATION-ACTION-ID

Example Data Elements:

PREPARATION-METHOD-ID
PREPARATION-ACTION-ID
PREPARATION-METHOD-DESCRIPTION-TXT
PREPARATION-METHOD-ABBREVIATION-CD
PREPARATION-METHOD-REFERENCE-WORK-ID
PREPARATION-METHOD-NOTES-TXT

Entity Name: PREPARATION-STEP

Description:

A discrete, defined or standard step in the performance of a PREPARATION-METHOD.

A PREPARATION-METHOD may consist of a single PREPARATION-STEP.

Primary Key:

PREPARATION-METHOD-ID
PREPARATION-STEP-ID

Foreign Keys:

Target Entity: REFERENCE-WORK
Data Elements: REFERENCE-WORK-ID

Example Data Elements:

PREPARATION-METHOD-ID
PREPARATION-STEP-ID
PREPARATION-STEP-DESCRIPTION-TXT
PREPARATION-STEP-ABBREVIATION-CD
PREPARATION-STEP-REFERENCE-WORK-ID
PREPARATION-STEP-NOTES-TXT

Entity Name: PREPARATOR*

Description:

An AGENT, usually a PERSON(s), that performs a PREPARATION-ACTION on a particular COLLECTING-UNIT.

Primary Key:

PREPARATOR-ID (=AGENT-ID)

Foreign Keys:

None

Example Data Elements:

PREPARATOR-ID (=AGENT-ID)

See fuller list of data elements under PERSON entity

Entity Name: REFERENCE-WORK

Description:

The source document of a TAXON-NAME-USE, COLLECTING-EVENT, COLLECTING-UNIT, or LOCALITY. REFERENCE-WORK will frequently be a published work, but may be an unpublished authoritative text in physical or electronic media.

Examples: an article, book, occasional report, field notes, map, catalog, etc.

Primary Key:

REFERENCE-WORK-ID

Foreign Keys:

None

Example Data Elements:

REFERENCE-WORK-KIND-CODE
REFERENCE-WORK-DESCRIPTION-TEXT
REFERENCE-WORK-AUTHOR-NAME
REFERENCE-WORK-PUBLISHED-DATE
REFERENCE-WORK-TITLE-TEXT
REFERENCE-WORK-JOURNAL-NAME
REFERENCE-WORK-VOLUME-IDENTIFIER
REFERENCE-WORK-ISSUE-IDENTIFIER
REFERENCE-WORK-PAGES-IDENTIFIER
REFERENCE-WORK-PUBLISHER-NAME
REFERENCE-WORK-PUBLISHER-CITY-NAME

Entity Name: RELEVANT-TIME

Description:

A subtype of TIME-EXPRESSION, RELEVANT-TIME is an expression of time as instant(s) or span(s) of time of relevance to the object(s) collected in a COLLECTING-EVENT.

This entity includes data that record information about a specific time not necessarily relatable to a specific chronological or periodic scale. Therefore, it can record times such as "mating season", or "while spawning", without requiring precise records of the time of the COLLECTING-EVENT itself.

Primary Key:

RELEVANT-TIME-ID

Foreign Keys:

None

Example Data Elements:

RELEVANT-TIME-ID

Entity Name: SPECIMEN (Subtype of COLLECTING-UNIT)

Description:

A COLLECTING-UNIT composed of one individual or multiple parts of one individual. This subtype is perhaps the most broadly defined of the COLLECTING-UNIT subtypes because many widely-varying disciplines use this term to designate their basic COLLECTING-UNIT. Whereas a single bird, mammal or snake is considered a SPECIMEN, so is a grouping of multiple "individuals" of a colonial species or marine invertebrate, or the teeth or a single vertebra of a fossil rodent. In botanical collections, part of a plant may be obtained during one COLLECTING-EVENT, while the rest of the individual remains intact at the collecting site (LOCALITY). Subsequent collecting from the same individual plant may take place in later COLLECTING-EVENTs and may even involve other COLLECTORs. The many variations on the SPECIMEN concept have been taken into account in the development of this model.

See COLLECTING-UNIT for more detailed description of relationships to other entities.

Primary Key:

SPECIMEN-ID (=COLLECTING-UNIT-ID)

Foreign Keys:

Target Entity: LOT
Data Elements: LOT-ID (=COLLECTING-UNIT-ID)

Example Data Elements:

SPECIMEN-ID
SPECIMEN-SEX-CD
SPECIMEN-PHENOLOGY-CD
SPECIMEN-LIFE-STAGE-CD
SPECIMEN-STANDARD-LENGTH-DMSN
SPECIMEN-AGE-QTY

Entity Name: SPECIMEN-COMPONENT (Subtype of COLLECTING-UNIT)

Description:

A sub-type of COLLECTING-UNIT, a SPECIMEN-COMPONENT is a COLLECTING-UNIT of parts of individual organisms from a single COLLECTING-EVENT.

SPECIMEN-COMPONENTs are logically *a posteriori* to the SPECIMEN itself in that they are derived from a SPECIMEN or COLLECTING-UNIT (as indicated by the relationship in the ERD) in a manner analogous to that of the DERIVED-OBJECT, or in some cases, LOTs from UNSORTED-LOTS. SPECIMEN-COMPONENTs exclude DERIVED-OBJECTs.

Example: A COLLECTING-UNIT consists of the results of a dredge haul (the results for a single COLLECTING-EVENT). This UNSORTED-LOT can then be separated into LOTs or individual SPECIMENs, one of which is a colony of coral polyps. A subset of this colony (that is, a few polyps), is later segregated for special curation (possibly even as types). If we wish to record this action so that we can trace the origin of the individual polyps back to the colony, and thereby through the entire history of the dredge haul, the polyps can be recorded as a SPECIMEN-COMPONENT distinct from a simultaneously existing SPECIMEN (the colony).

Primary Key:

SPECIMEN-COMPONENT-ID (=COLLECTING-UNIT-ID)

Foreign Keys:

Target Entity: SPECIMEN (=COLLECTING-UNIT)
Data Elements: SPECIMEN-ID (=COLLECTING-UNIT-ID)

Target Entity: SPECIMEN-COMPONENT-TYPE
Data Elements: SPECIMEN-COMPONENT-TYPE-ID

Example Data Elements:

SPECIMEN-COMPONENT-ID (=COLLECTING-UNIT-ID)
SPECIMEN-ID (=COLLECTING-UNIT-ID)
SPECIMEN-COMPONENT-TYPE-ID

Entity Name: SPECIMEN-COMPONENT-TYPE

Description:

A class or kind of SPECIMEN-COMPONENT obtained from a COLLECTING-UNIT.

This is a descriptor of the condition, method of obtaining, or in some cases, even the name of a specific organismal type or part (see polyp example above for SPECIMEN-COMPONENT).

Primary Key:

SPECIMEN-COMPONENT-TYPE-ID

Foreign Keys:

None

Example Data Elements:

SPECIMEN-COMPONENT-TYPE-ID
SPECIMEN-COMPONENT-TYPE-NAM
SPECIMEN-COMPONENT-TYPE-DESCRIPTION-TXT

Entity Name: STORAGE-LOCATION

Description:

The physical location of a COLLECTING-UNIT within a COLLECTION.

Primary Key:

STORAGE-LOCATION-ID

Foreign Keys: None

Example Data Elements:

STORAGE-LOCATION-ID
STORAGE-LOCATION-CD

Description of STORAGE LOCATION is a local issue, and may require several attributes, rather than one.

Entity Name: STORAGE-MEDIUM

Description:

The physical medium, container, or mount used as part of the STORAGE-REGIME of a COLLECTING-UNIT.

Primary Key:

STORAGE-MEDIUM-ID

Foreign Keys:

None (Note: the many to many relationship between STORAGE-MEDIUM and STORAGE-REGIME implies in associative entity; not shown or defined.)

Example Data Elements:

STORAGE-MEDIUM-ID

STORAGE-MEDIUM-CD
A code that describes objects used in housing COLLECTING-UNITs, e.g., sheet, box, jar, case, shelf, vial, packet.

STORAGE-MEDIUM-DESCRIPTION-TXT
A description of the materials that compose the STORAGE-MEDIUM of a COLLECTING-UNIT. This description can be important in the conservation of a collection, identifying, for example, acidic vs acid-free materials, and allowing the effects of storage conditions on specimens to be tracked.

A COLLECTING-UNIT can have more than one STORAGE-MEDIUM, for example, a glass vial with polystyrene lid in a cardboard tray in a wooden drawer in a metal cabinet with dust-tight, gaskets. A particular COLLECTION can have many different types of vials (various types of glass and plastic), cabinets, wooden, metal, gasketed, or not), etc.

STORAGE-REGIME uses one to many STORAGE-MEDIUMs.
STORAGE-MEDIUM is used by zero to many STORAGE-REGIMEs.

Entity Name: STORAGE-REGIME

Description:

The physical location, kind of storage and availability of a COLLECTING-UNIT in relation to a COLLECTION.

Primary Key:

STORAGE-REGIME-ID

Foreign Keys:

Target Entity: STORAGE-LOCATION
Data elements: STORAGE-LOCATION-ID

(Note: the many to many relationship between STORAGE-MEDIUM and STORAGE-REGIME implies in associative entity; not shown or defined.)

Example Data Elements:

STORAGE-REGIME-ID
STORAGE-LOCATION-ID
STORAGE-MEDIUM-ID
START-DAT
END-DAT
AUTHORITY-NAM
COMMENTS-TXT

START-DAT and END-DAT define the time period that a COLLECTING-UNIT spent in a specific STORAGE-REGIME.

Entity Name: TAXON-NAME

Description:

An appellation used for a TAXONOMIC-CONCEPT in a published (or manuscript?) REFERENCE-WORK. A name is typically a latinized scientific name (under a code of taxonomic nomenclature), but need not be; the model doesn't require that a name be either scientific or published. Other possible "kinds" of names might be: manuscript names, name surrogates (e.g., Species A), and published non-latin "names" (e.g., Node 14 [in Fig. 2, Reference 999]).

Note, the TAXON-NAME entity should eventually be subdivided into subtypes to accommodate the different structures of unomials, multinomials, hybrid names, and non-latin names.

A TAXON-NAME has an original author that may or may not be the same as the author of the source REFERENCE-WORK.

A new TAXON-NAME may be required without a change in the position or content of the TAXONOMIC-CONCEPT (e.g., a TAXON-NAME may be previously occupied, or composed incorrectly).

A change in position or rank of the TAXONOMIC-CONCEPT may require that a different TAXON-NAME be used for it even though the TAXONOMIC-CONCEPT itself does not change (e.g., when a species is moved to a different genus, or a family is made a subfamily under a broader family concept).

Primary key:

TAXON-NAME-ID

Foreign Keys:

None

Example Data Elements:

TAXON-NAME-ID
TAXON-NAME-TXT
ORIGINAL-AUTHOR

Entity Name: TAXON-NAME-USE

Description:

A TAXON-NAME-USE is the application of a TAXON-NAME to a TAXONOMIC-CONCEPT. The TAXON-NAME-USE entity implements a many to many relationship between TAXON-NAME and TAXONOMIC-CONCEPT.

A TAXON-NAME must be applied to at least one TAXONOMIC-CONCEPT. Subsequently, a TAXON-NAME may be applied to a different TAXONOMIC-CONCEPT in a new TAXON-NAME-USE.

Each TAXONOMIC-CONCEPT must have at least one TAXON-NAME.

Each TAXON-NAME-USE has an origin in a source REFERENCE-WORK.

Only one TAXON-NAME is correct, as determined by rules of nomenclature, for a TAXONOMIC-CONCEPT at a given time, whether or not the concept is considered valid by a particular worker.

A TAXON-NAME-USE may have a rank.

Primary Key:

TAXON-NAME-USE-ID

Foreign Keys:

Target Entity: TAXON-NAME
Data Elements: TAXON-NAME-ID

Target Entity: TAXONOMIC-CONCEPT
Data Elements: TAXONOMIC-CONCEPT-ID

Example Data Elements:

TAXON-NAME-USE-ID
TAXON-NAME-ID
TAXONOMIC-CONCEPT-ID
REFERENCE-WORK-ID
STATUS-CD (e.g., local standard, or alternative)
RANK

Entity Name: **TAXON-NAME-USE-CITATION** (Subtype of CITATION)

Description:

The specific source of a TAXON-NAME-USE within a REFERENCE-WORK. A TAXON-NAME-USE-CITATION may refer to the application of a name to a new or existing TAXON or to the application of a name as a result of a DETERMINATION to a COLLECTING-UNIT.

Primary Key:

TAXON-NAME-USE-CITATION-ID (=CITATION-ID)

Foreign Keys:

Target Entity: TAXON-NAME-USE
Data Element: TAXON-NAME-USE-ID

Example Data Elements:

TAXON-NAME-USE-CITATION-ID
TAXON-NAME-USE-ID
TAXON-NAME-USE-QUALIFIER (certainty, etc.)
TAXON-NAME-USE-TYPE (identification, new name, nomenclatural basis, etc.)

Entity Name: TAXONOMIC-CONCEPT

It should be noted that the information structures proposed in this model are intended to hold multiple classifications, rather than a single standard classification. The model doesn't preclude the creation of a local standard, but the goal is to accommodate competing treatments and to support information retrieval according to any classification contained in the system. A real collection database might begin with a local standard taxonomy, expand to include synonyms, and then incorporate multiple classifications as the local standard is revised.

Description:

A TAXONOMIC-CONCEPT is a set of one or more species-level taxa. (Ultimately, any TAXONOMIC-CONCEPT translates into a set of type specimens, as each species-level taxon is based on one or more type specimens.)

Two TAXONOMIC-CONCEPTS are distinct if they designate different sets of existing species-level taxa. The position or parent of a taxonomic concept does not contribute to its identity. The arrangement or content of non-terminal taxa within a concept also does not contribute to its identity, as long as alternative arrangements do not change the set of terminals.

A new concept is **not** implied when:

1) A new lower-level taxon is described and added to an existing (higher-level) concept.

    Example 1a: Newly described species X is placed in existing genus A. The TAXONOMIC-CONCEPT named by genus A remains unchanged.

    Example 1b) Species A and B are members of genus G, which is a member of Family F. (Species A is the type for G.) The next worker describes genus H , with type species B, as a new member of family F. The description of genus H does not require a new concept for family F because F still refers to the same set of existing species-level taxa (and type specimens). (A new concept is required, however, for genus G; see case 3 below.)

   Without this stipulation, each new discovery or description of a lower-level taxon would produce a series of new higher-level TAXONOMIC-CONCEPTs, one for every concept in the path to the root. Thus, each new species would produce a new concept of "Life".

2) An existing concept is transferred to a different higher-level concept. (Only the higher-level concepts -- potentially more than one -- are changed because they contain different sets of species-level taxa.)

A new concept **is** implied when:

3) a contained lower-level concept is removed and placed under a different concept.

4) an existing, but previously excluded, lower-level concept (or type specimen) is added.

Primary Key:

TAXONOMIC-CONCEPT-ID

Foreign Keys:

None

Example Data Elements:

TAXONOMIC-CONCEPT-ID

Note: While a TAXONOMIC-CONCEPT can be defined as a set of included terminal taxa, the human-understandable attributes used to identify it, the "handle", have not yet been defined. Candidate attributes for the handle might include attributes generally referred to as: Original-Taxon-Name, Original Author (& Date), Authority (as used in Botany), and the Authority-Reference-Work. As these attributes are defined, their inclusion in this entity may change the relationships of this entity to the entities TAXON-NAME-USE and TAXON-NAME-USE-CITATION.

Entity Name: TAXONOMIC-RELATIONSHIP

Description:

A TAXONOMIC-RELATIONSHIP is a single parent-child relationship between two TAXONOMIC-CONCEPTS, indicating that the child is a either a valid member, or a synonym, of the parent concept.

This entity implements a recursive many to many relationship (a network) among TAXONOMIC-CONCEPTS. A network is required, rather than a hierarchy, because a single concept may have different placements in different classifications, and thus may have more than one PARENT-TAXONOMIC-CONCEPT. Without the capability to handle multiple parents, alternative subtrees cannot be joined to the existing global tree; a complete and separate copy of the global tree would be required for each new subtree. Re-use of unchanged TAXONOMIC-CONCEPTS allows new subtrees to be placed in an existing context and to be composed of existing lower-level taxa.

Primary Key:

TAXONOMIC-CONCEPT-ID
PARENT-TAXONOMIC-CONCEPT-ID (=TAXONOMIC-CONCEPT-ID)

Foreign Keys:

Target Entity: TAXONOMIC-CONCEPT
Data Elements: TAXONOMIC-CONCEPT-ID

Target Entity: TAXONOMIC-CONCEPT
Data Elements: PARENT-TAXONOMIC-CONCEPT-ID

Target Entity: REFERENCE-WORK
Data Elements: REFERENCE-WORK-ID

Example Data Elements:

TAXONOMIC-CONCEPT-ID
PARENT-TAXONOMIC-CONCEPT-ID
TAXONOMIC-RELATIONSHIP-TYPE (e.g., member of, or synonym of)

Entity Name: **TERRESTRIAL-HABITAT-DESCRIPTION**
(Subtype of HABITAT-DESCRIPTION)

Description:

Primary Key:

Foreign Keys: none

Target Entity: RECENT-COLLECTING-EVENT

Data elements: RECENT-COLLECTING-EVENT-ID
(=COLLECTING-EVENT-ID)

Example Data Elements:

Entity Name: TIME-EXPRESSION (Supertype)

Description:

The time recorded for the occurrence of a COLLECTING-EVENT

This entity is introduced to facilitate use of any type of information regarding the time of a COLLECTING-EVENT. For example, a COLLECTING-EVENT could be made "on a spring morning, before 1958". The manner in which this information is recorded in the database is strictly bounded by the use to which it might be put. A query for all collections made in spring would find this entry as a part of the subtype PERIOD, without specific reference to a year. A query for period would turn up information about whether the collection was made in the morning, if precise times are not available. Likewise, the seasonal aspect of the information could be overlooked in favor of a search for collections made within a specified period of human history (for example, collections made before 1962). This avoids making entry of clock-determined calendar time or spans of time absolutely necessary for recovery of information regarding the COLLECTING-EVENT.

The designation of subtypes also permits independent relationships between individual subtypes of time and the rest of the model, should we decide to make relationships between say, DETERMINATION and some version of TIME, or between some types of TRANSACTIONs and TIME.

Subtypes:

CLOCK-TIME
PERIOD
RELEVANT-TIME

Primary Key:

TIME-EXPRESSION-ID

Foreign Keys:

Target Entity: COLLECTING-EVENT
Data Elements: COLLECTING-EVENT-ID

Example Data Elements:

TIME-EXPRESSION-ID
TIME-SUBTYPE-CD
COLLECTING-EVENT-ID

Entity Name: TIME-UNIT-BOUNDARY

Description:

A boundary belonging to one or more GEOLOGIC-TIME-UNITs, that is or potentially can be calibrated in units of absolute time in a geologic time scale.

Primary Key:

TIME-UNIT-BOUNDARY-ID

Foreign Keys:

None

Example Data Elements:

TIME-UNIT-BOUNDARY-NAME
TIME-UNIT-BOUNDARY-AGE-QTY
TIME-UNIT-BOUNDARY-REMARKS-TXT

Entity Name: TRANSACTION

Description:

An action that changes the physical custody or ownership status (meaning legal title) of a COLLECTING-UNIT.

Primary Key:

Foreign Keys: none

Example Data Elements:

Entity Name: TRANSACTOR*

Description:

An agent that performs or participates in one or more TRANSACTIONs.

Primary Key:

TRANSACTOR-ID (=AGENT-ID)

Foreign Keys:

None

Example Data Elements:

Entity Name: **UNSORTED-LOT** (Subtype of COLLECTING-UNIT)

Description:

A COLLECTING-UNIT of mixed taxa from a single COLLECTING-EVENT.

Primary Key:

UNSORTED-LOT-ID (=COLLECTING-UNIT-ID)

Foreign Keys:

Target Entity: ORIGINAL-UNSORTED-LOT (=COLLECTING-UNIT)
Data Elements: ORIGINAL-UNSORTED-LOT-ID (=COLLECTING-UNIT-ID)

Example Data Elements:

UNSORTED-LOT-ID (=COLLECTING-UNIT-ID)
ORIGINAL-UNSORTED-LOT-ID (=COLLECTING-UNIT-ID)

C. List of Relationships

ENTITY	relationship	ENTITY
AGENT	writes, edits, or publishes	REFERENCE-WORK
CHRONOSTRATIC-AGE-DETERMINATION	is based on	GEOLOGIC-TIME-UNIT
COLLECTING-EVENT	is described by	HABITAT-DESCRIPTION
COLLECTING-EVENT	takes place at	LOCALITY
COLLECTING-EVENT	occurs in	TIME-EXPRESSION
COLLECTING-EVENT-ASSOCIATION	refers to	COLLECTING-EVENT
COLLECTING-EVENT-CITATION	refers to	COLLECTING-EVENT
COLLECTING-METHOD	is used in	COLLECTING-EVENT
COLLECTING-UNIT	results from	COLLECTING-EVENT
COLLECTING-UNIT	refers to	COLLECTING-UNIT
COLLECTING-UNIT	has	STORAGE-REGIME
COLLECTING-UNIT-ASSOCIATION-TYPE	validates	COLLECTING-UNIT-ASSOCIATION
COLLECTING-UNIT-CITATION	refers to	COLLECTING-UNIT
COLLECTOR (=AGENT)	participates in	COLLECTING-EVENT
DERIVED-OBJECT	is based on	COLLECTING-UNIT
DERIVED-OBJECT-TYPE	validates	DERIVED-OBJECT
DETERMINATION	is made on	COLLECTING-UNIT
DETERMINER (=AGENT)	makes	DETERMINATION
GEOLOGIC-TIME-UNIT	has lower	TIME-UNIT-BOUNDARY
GEOLOGIC-TIME-UNIT	has upper	TIME-UNIT-BOUNDARY
LOCALITY	is closest to/contained in	NAMED-PLACE
LOCALITY-CITATION	refers to	LOCALITY
LOT	is sorted from	UNSORTED-LOT
NAMED-PLACE	is contained in	NAMED-PLACE

PALEO-COLLECTING-EVENT	has	GEOLOGIC-AGE-DETERMINATION
PREPARATION-ACTION	is applied to a	COLLECTING-UNIT
PREPARATION-ACTION	used	PREPARATION-METHOD
PREPARATION-METHOD	contains	PREPARATION-STEP
PREPARATOR (=AGENT)	performs	PREPARATION-ACTION
REFERENCE-WORK	contains	CITATION
SPECIMEN	is sorted from	LOT
SPECIMEN-COMPONENT	is removed from	SPECIMEN
SPECIMEN-COMPONENT-TYPE	validates	SPECIMEN-COMPONENT
STORAGE-REGIME	has	STORAGE-LOCATION
STORAGE-REGIME	uses	STORAGE-MEDIUM
TAXON-NAME	is applied in	DETERMINATION
TAXON-NAME	is used for	TAXON-NAME-USE
TAXON-NAME-USE-CITATION	is source of	TAXON-NAME-USE
TAXONOMIC-CONCEPT	is known as	TAXON-NAME-USE
TAXONOMIC-CONCEPT	is parent/child participant in	TAXONOMIC-RELATIONSHIP
TRANSACTION	involves	COLLECTING-UNIT
TRANSACTOR (=AGENT)	?	COLLECTION
TRANSACTOR (=AGENT)	participates in	TRANSACTION

D. Relationship Descriptions

Relationship: AGENT <> REFERENCE-WORK

Each AGENT writes, edits, or publishes zero to many REFERENCEs.

Each REFERENCE is written, edited, or published by one to many AGENTs.

Relationship: CHRONOSTRATIC-AGE-DETERMINATION <> GEOLOGIC-TIME-UNIT

Each CHRONOSTRATIC-AGE-DETERMINATION is based on one and only one GEOLOGIC-TIME-UNIT.

Each GEOLOGIC-TIME-UNIT may form the basis for zero to many CHRONOSTRATIC-AGE-DETERMINATIONs.

Relationship: COLLECTING-EVENT <> HABITAT-DESCRIPTION

Each COLLECTING-EVENT is described by zero to one HABITAT-DESCRIPTION.

Each HABITAT-DESCRIPTION describes one and only one COLLECTING-EVENT.

Relationship: COLLECTING-EVENT <> LOCALITY

Each COLLECTING EVENT takes place at one and only one LOCALITY.
Each LOCALITY may be the subject of one or more COLLECTING EVENTs.

Relationship: COLLECTING-EVENT < > TIME-EXPRESSION

Each COLLECTING-EVENT occurs at one to many TIME-EXPRESSIONs.

Each TIME-EXPRESSION applies to one and only one COLLECTING-EVENT.

Relationship: COLLECTING-EVENT-ASSOCIATION <> COLLECTING-EVENT

Each COLLECTING-EVENT-ASSOCIATION refers to two and only two COLLECTING-EVENTS. (The COLLECTING-EVENT-ASSOCIATION entity represents a many-to-many recursive relationship between COLLECTING-EVENTs.)

Each COLLECTING-EVENT may be referred to in zero to many COLLECTING-EVENT-ASSOCIATIONs.

Relationship: COLLECTING-EVENT-CITATION <> COLLECTING-EVENT

Each COLLECTING-EVENT-CITATION refers to one and only one COLLECTING-EVENT.

Each COLLECTING-EVENT is referenced in zero to many COLLECTING-EVENT-CITATIONS.

Relationship: COLLECTING-METHOD <> COLLECTING-EVENT

Each COLLECTING-METHOD is used in zero to many COLLECTING-EVENTS.

Each COLLECTING-EVENT is conducted using one to many COLLECTING-METHODS.

Relationship: COLLECTING-UNIT <> COLLECTING-EVENT

Each COLLECTING-UNIT results from one and only one COLLECTING-EVENT.

Each COLLECTING-EVENT produces zero to many COLLECTING-UNITs.

In several disciplines there is no distinction between a "biological" individual and specimen; a single individual can be collected only once. In other disciplines (e.g., Botany, Vertebrate Paleontology, Invertebrate Zoology), it is possible to collect only part of an individual in one event, and return to collect additional parts or samples later. Whether a SPECIMEN may be collected in more than one COLLECTING-EVENT will depend on the definition (scope) of COLLECTING-UNIT.

Relationship: COLLECTING-UNIT <> COLLECTING-UNIT

Each COLLECTING-UNIT is associated with zero to many COLLECTING-UNITS (through the COLLECTING-UNIT-ASSOCIATION entity).

Relationship: COLLECTING-UNIT <> STORAGE-REGIME

Each COLLECTING-UNIT has one to many STORAGE-REGIMEs.

Each STORAGE-REGIME may involve zero to many COLLECTING-UNITS.

Relationship: COLLECTING-UNIT-ASSOCIATION-TYPE <> COLLECTING-UNIT-ASSOCIATION

Each COLLECTING-UNIT-ASSOCIATION-TYPE validates zero to many COLLECTING-UNIT-ASSOCIATIONs.

Each COLLECTING-UNIT-ASSOCIATION is validated by one and only one COLLECTING-UNIT-ASSOCIATION-TYPE.

Relationship: COLLECTING-UNIT-CITATION <> COLLECTING-UNIT

Each COLLECTING-UNIT-CITATION refers to one and only one COLLECTING-UNIT.

Each COLLECTING-UNIT may be referred to by zero to many COLLECTING-UNIT-CITATIONs.

Relationship: COLLECTOR (=AGENT) <> COLLECTING-EVENT

Each COLLECTOR participates in one or more COLLECTING-EVENTs.

Each COLLECTING-EVENT is conducted by one or more COLLECTORs.

Relationship: DERIVED-OBJECT-TYPE <> DERIVED-OBJECT

Each DERIVED-OBJECT-TYPE validates zero to many DERIVED-OBJECTs.

Each DERIVED-OBJECT is validated by one and only one DERIVED-OBJECT-TYPE.

Relationship: DETERMINATION <> COLLECTING-UNIT

Each DETERMINATION is made on one and only COLLECTING-UNIT.

Each COLLECTING-UNIT may be have one to many DETERMINATIONs.

Relationship: DETERMINER (=AGENT) <> DETERMINATION

Each DETERMINER makes zero to many DETERMINATIONs.

Each DETERMINATION is made by one and only one DETERMINER.

Relationship: GEOLOGIC-TIME-UNIT <> TIME-UNIT-BOUNDARY

Each GEOLOGIC-TIME-UNIT has one and only one upper TIME-UNIT-BOUNDARY

Each GEOLOGIC-TIME-UNIT has one and only one lower TIME-UNIT-BOUNDARY.

(The upper and lower boundaries must be different.)

Each TIME-UNIT-BOUNDARY may form the boundary of one or more GEOLOGIC-TIME-UNITs.

Relationship: LOCALITY <> NAMED-PLACE

Each LOCALITY is closest to or contained within one and only one NAMED-PLACE.

Each NAMED-PLACE is close to or contains zero to many LOCALITYs.

The "close to" and "contains" relationships are semantically distinct, not mutually exclusive, and the related objects may be different. Therefore, they should be represented in the model as two distinct relationships between the same entities (this is allowed).

Relationship: LOCALITY-CITATION <> LOCALITY

Each LOCALITY is cited in zero to many LOCALITY-CITATIONs.

Each LOCALITY-CITATION refers to one and only one LOCALITY.

Relationship: LOT <> UNSORTED-LOT

Each LOT is sorted from zero or one UNSORTED-LOT.

Each UNSORTED-LOT is sorted into zero to many LOTs.

Relationship: NAMED-PLACE <> NAMED-PLACE

Each NAMED-PLACE is contained in zero or one NAMED-PLACE.

Each NAMED-PLACE contains zero to many NAMED-PLACEs

Relationship: PALEO-COLLECTING-EVENT <> GEOLOGIC-AGE-DETERMINATION

Each PALEO-COLLECTING-EVENT is bounded in time by zero to many GEOLOGIC-AGE-DETERMINATIONS, which may provide either maximum geologic age, minimum geologic age, or both.

Each GEOLOGIC-AGE-DETERMINATION constrains the age of one and only one PALEO-COLLECTING-EVENT.

Relationship: PREPARATION-ACTION <> COLLECTING-UNIT

Each PREPARATION-ACTION is performed on one and only one COLLECTING-UNIT.

Each COLLECTING-UNIT is prepared in one to many PREPARATION-ACTIONs.

Relationship: PREPARATION-ACTION <> PREPARATION-METHOD

Each PREPARATION-ACTION uses one and only one PREPARATION-METHOD.

Each PREPARATION-METHOD is used in zero to many PREPARATION-ACTIONs.

Relationship: PREPARATION-METHOD <> PREPARATION-STEP

Each PREPARATION-METHOD contains one to many PREPARATION-STEPs.

Each PREPARATION-STEP is used in one and only one PREPARATION-METHOD.

Relationship: PREPARATOR (=AGENT) <> PREPARATION-ACTION

Each PREPARATOR (=AGENT) performs zero to many PREPARATION-ACTION.

Each PREPARATION-ACTION is performed by one and only one PREPARATOR.

Relationship: REFERENCE-WORK <> CITATION

Each REFERENCE-WORK contains one to many CITATIONs.

Each CITATION is contained in one and only one REFERENCE-WORK

Relationship: SPECIMEN <> LOT

Each SPECIMEN is sorted from zero to one LOT.

Each LOT is sorted into zero to one SPECIMENs.

Relationship: SPECIMEN-COMPONENT <> SPECIMEN

Each SPECIMEN-COMPONENT is removed from one and only one SPECIMEN.

Each SPECIMEN is represented by zero to many SPECIMEN-COMPONENTS.

Relationship: SPECIMEN-COMPONENT-TYPE < > SPECIMEN-COMPONENT

Each SPECIMEN-COMPONENT-TYPE validates zero to many SPECIMEN-COMPONENTs.

Each SPECIMEN-COMPONENT is validated by one and only one SPECIMEN-COMPONENT-TYPE.

Relationship: STORAGE-REGIME <> STORAGE-LOCATION

Each STORAGE-REGIME has one and only one STORAGE-LOCATION.

Each STORAGE-LOCATION may be involved in one to many STORAGE-REGIMES.

Relationship: STORAGE-REGIME <> STORAGE-MEDIUM

Each STORAGE-REGIME uses one to many STORAGE-MEDIUMs.

Each STORAGE-MEDIUM is used in zero to many STORAGE-REGIMEs.

Relationship: TAXON-NAME <> DETERMINATION

Each TAXON-NAME is applied in zero to many DETERMINATIONS.

Each DETERMINATION involves one and only one TAXON-NAME.

Relationship: TAXON-NAME <> TAXON-NAME-USE

Each TAXON-NAME is used in one to many TAXON-NAME-USEs.

Each TAXON-NAME-USE uses one and only one TAXON-NAME.

Relationship: TAXON-NAME-USE-CITATION <> TAXON-NAME-USE

Each TAXON-NAME-USE-CITATION is the source of one and only one TAXON-NAME-USE.

Each TAXON-NAME-USE occurs in one to many TAXON-NAME-USE-CITATIONs.

Relationship: TAXONOMIC-CONCEPT <> TAXON-NAME-USE

Each TAXONOMIC-CONCEPT has one to many TAXON-NAME-USEs.

Each TAXON-NAME-USE applies to one and only one TAXONOMIC-CONCEPT.

Relationship: TAXONOMIC-CONCEPT <> TAXONOMIC-RELATIONSHIP

Each TAXONOMIC-CONCEPT is parent participant in zero or one TAXONOMIC-RELATIONSHIPs.
Each TAXONOMIC-CONCEPT is child participant in zero or one TAXONOMIC-RELATIONSHIPs.

Each TAXONOMIC-RELATIONSHIP establishes a parent-child relationship between two and only two TAXONOMIC-CONCEPTs.

Relationship: TRANSACTION <> COLLECTING-UNIT

Each TRANSACTION involves one to many COLLECTING-UNITs.

Each COLLECTING-UNIT is involved in one to many TRANSACTIONs.

Relationship: TRANSACTOR (=AGENT) <> COLLECTION

TRANSACTOR ? COLLECTION

Relationship: TRANSACTOR (=AGENT) <> TRANSACTION

Each TRANSACTOR participates in zero to many TRANSACTIONs.

Each TRANSACTION is conducted by zero to many TRANSACTORs.

APPENDIX

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