Using Arc Marine in ArcGIS 10

Tutorial for Beginners

Introduction

Arc Marine (or the ArcGIS Marine Data Model - MDM), is a geodatabase model tailored specifically for the marine GIS community. Created by researchers from Oregon State University, Duke University, NOAA, the Danish Hydrologic Institute and ESRI, work on the data model began in 2001 in response to three major needs by the marine GIS community: (1) provide an application-specific geodatabase structure for assembling, managing, storing and querying marine data in ArcGIS 8/9, (2) provide a standardized geodatabase template upon which develop and maintain marine applications, and (3) provide a better understanding of ESRI's new geodatabase data structure.

Arc Marine was designed to be used as a geodatabase template for marine GIS users. This template, like all geodatabases, is an organized hierarchy of data objects. These data objects are a collection of feature data sets, feature classes, object classes and relationship classes. Specifically, a feature data set is a collection of feature classes that share a common spatial reference. The spatial reference is part of the definition of the geometry field in the database. Accordingly, a set of transect survey points stored in the coordinate system NAD83 UTM Zone 4 could not be in the same feature data set as geographic latitude/longitude coordinates. In the geodatabase, all objects represent a real world object such as a marker buoy or lighthouse, and are stored in a row in a relational database table. Object classes are not represented geographically; however, they can be related to spatial information through a relationship class. Conversely, all of the features in a geodatabase are geographic objects that have a defined spatial location. Basically, a feature is just like an object but it also has a geometry or shape column in its relational database table. The Arc Marine geodatabase can store a range of data sets, from the small to medium data sets of personal geodatabases, to the very large geodatabases managed with the help of ArcSDE (Arc Spatial Database Engine).

Arc Marine was generated in a series of steps, beginning with the definition of feature datasets, classes, attributes, and relationships in a Unified Modeling Language (UML) diagram created in Visio 2000. The UML diagram was then converted into an XMI (XML Metadata Interchange) format, which is an equivalent tabular structure, or schema, so that it could be loaded into Microsoft Access or other relational data servers. In this tutorial, this schema will be applied to the Arc Marine personal geodatabase to create the sets of classes and attributes that were defined originally in the UML.

To make use of the newly created Arc Marine geodatabase, data must be loaded into the appropriate feature classes and tables. What follows is a tutorial on how to load sample data into Arc Marine, as well as some trouble-shooting tips.

In addition to the Arc Marine tutorial here, you may also be interested in the **2005 ESRI Virtual Campus Training Seminar**, <u>Introduction to ArcGIS Data Models</u>. This presentation by Joe Breman of ESRI can be viewed with Windows Media Player (best in Internet Explorer on the PC) and is about an hour long with Q&A at the end. To see the creation of a geodatabase using parts of both Arc Marine and Arc Hydro, slide the slider bar to about minute 43, 3/4 of the way through the presentation. Joe gives a nice example of how the synergy between data model groups can steer their implementation.

Tutorial Objectives

The purpose of this tutorial is to introduce you to the ESRI geodatabase data model in general and the Arc Marine Data Model in particular. The tutorial is designed to be a do-it-yourself exercise in geodatabase building. Although the exercise is step-by-step, it is assumed that the user has a working knowledge of ArcGIS. Hopefully, through the exploration of Arc Marine, you will see its utility for your own applications, while grasping the basics of the geodatabase.

By the end of this tutorial, you will be able to do the following specific activities:

- List the basic elements of a geodatabase
- Import an existing schema into an empty geodatabase
- Compare your data structure to that of an existing geodatabase schema
- Load data
- Create new relationships between tables
- Import tables with data already in them
- Create and load a raster catalog
- Display your data using dynamic segmentation
- Query data linked through relationships in ArcMap

As with any database, the schema design is a very time consuming part. Schema is table structure and it is critical that you understand your data and how to normalize it before you design your database. There are 4 ways to build geodatabase schemas in ArcCatalog 10.x.

- 1. Create with ArcCatalog wizards
 - a. Build tables in ArcCatalog>>right click>>new object
- 2. Import existing data (and the existing schema)
- a. Right click the database and import an object. You can also export from the object to the database
- Create Schema with CASE tools

 Use Microsoft Visio or like software for development of UML
- Create Schema in the geoprocessing framework
 - a. Use ArcToolbox geoprocessing to create objects

In this tutorial, you will use the Schema Wizard in ArcGIS to load the Arc Marine data model schema and then modify it to suit your needs.

Computer and Data Requirements

Software and Hardware:

- ArcGIS 10.x (full license including ArcEditor and ArcInfo workstation). This tutorial was developed using ArcGIS 9.0 and 9.1 and revised for ArcGIS 10.0.
- At least Windows XP (XP Pro is best) or even a Windows 2000 machine, 800 Mhz processor or greater, 800 Mb RAM or greater, ample file storage (about 40 Mb of space needed to accommodate the files for this tutorial)

Required Data and Schema:

<u>Tutorial data</u> (right click, Save As, 39 Mb zip file) Unzipping this file will produce a folder named "E_Datamodel" within which you will find the various data sets needed in "Tutorial" and the schema in "Tutorial\ArcMDM". You will want to "connect" to these series of folders in ArcCatalog.

Highly Recommended Accompanying Files:

<u>Common Marine Data Types Diagram</u> to help you match your data to the appropriate feature classes <u>Conceptual Framework PPT</u> (28 Mb file by D. Wright, 6/15/05, important background information on initiation and development of Arc Marine)

<u>Tutorial Intro PPT</u> (540 K file by P. Serpa, 6/15/05, for introducing tutorial to classroom participants, important general background information on geodatabases)

<u>Old Tutorial PPT</u> (13 Mb PDF file by A. Aaby, D. Wright, ESRI UC 2004, info. from old tutorial based on ArcGIS 8.3 but with some important tips and tricks that are still quite useful)

Context of Activities:

Our goal will be to model the transect path of an ROV (remotely-operated vehicle) and the accompanying video observations that were made. The ROV path and the observations on that path can be located in the X, Y and Z axes at discrete time intervals during a dive.



Tutorial Activities

In the instructions below, file names and database objects are in **bold**; field names are in *italics*; menu items are <u>underlined</u>.

1.0 Loading CASE Tools

CASE Tools requires a separate installation in ArcGIS 10. This can be done by inserting the software installation CD, locating CaseTools and running the Setup Windows Installer Package.

2.0 Building a Personal Geodatabase and Applying the Schema

A. Creating the Personal Geodatabase

- Open ArcCatalog
- Right click the E_Datamodel\Tutorial\Geodatabase folder, highlight <u>New</u>, then select <u>Personal</u> <u>Geodatabase</u>
- Name it MyArcMarineTut.mdb

Catalog Tree	Ψ×	Contents Preview Description	n	
🖃 📻 Folder Connections		Name		Type
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E 🔚 C:\Documents and Settings\dickd\My Docume	nts\Downloa			
🖃 🚞 arcmarine_tutorial				
E_Datamodel				
🗆 🔚 Tutorial				
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	间 File	Geodatabase		
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	Srou	up Layer		
	📃 Shaj	pefile		
	🖅 Turr	Feature Class		
	😂 Tool	box		
	🔲 dBA	SE Table		
	🔕 Add	ress Locator		
	🗞 Com	posite Address Locator		
	X XML	Document		

B. Add the Schema Creation Wizard to ArcCatalog

The Schema Creation Wizard, which looks like 3, is provided in ArcCatalog for loading an existing scheme into a blank database. This tool requires an ArcEditor or ArcInfo license to run. To load it:

- On the header tool bar, click on Customize, select Toolbars, and then select CASE Tools
- The Scheme Wizard icon will appear, drag-and-drop it anywhere on the existing toolbar area

ArcCatalog - ArcInfo - C:\Documents and	Settings\dickd\My Docur	nent	ts\Downloads\arcmarine	e_tutorial\E_Datamodel\Tutorial\Geodatabase
File Edit View Go Geoprocessing Cus	tomize Windows Help	,		
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E Glus				1
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Li Ula Database Servers				
Connections GIS Servers				

C. Applying the Arc Marine Data Model Schema to the Geodatabase

The Schema Creation Wizard will apply existing schemas from two different sources, an XMI file or a repository database. The XMI file is created using a CASE tool (<u>Computer Aided Software Engineering</u>) application such as Microsoft Visio 2002. The database repository is a Microsoft Access database containing the desired schema. The Arc Marine Data Model is available in either an XMI or repository; you will be using the XMI format. Note, however, the XMI (XML Metadata Interchange) is a standard that specifies how to store an UML (Universal Markup Language) model in an XML (Extensible Markup Language) file; it is actually an XML file that is loaded.

- In ArcCatalog, with the **MyArcMarineTut.mdb** geodatabase selected, start the Schema Creation Wizard (click on the icon).
- Read the first info screen then click next.
- Select "Model stored in XMI file".
- Browse to "E_Datamodel\Tutorial\ArcMDM", select **ArcGISMarineDataModel.xml** then click next.
- Select "Use default values" then click next.
- Review the contents of this schema and their properties. DON'T CLICK "Next" YET!

In the hierarchical structure of the geodatabase, you see different objects organized into groups. The objects include:

- > The workspace this is the geodatabase which is a container for geographic data objects
- > **Tables** called Object classes, store non-spatial objects like equipment specifications or personnel information.
- Feature classes collections of lines, points, or polygons. Specialized feature classes are used to store annotation, dimension, and route features.
- Feature datasets container for feature classes (never object classes) that share a common spatial reference.
- Relationship classes manage thematic relationships between object classes, feature classes, or a combination of the two. They enforce referential integrity between the origin and destination classes.

It is important to have a good understanding of your data structure prior to applying a schema. Because you will be setting parameters that cannot be changed later, should you later find that your data does not meet some of the criteria you specified, it will be necessary to rebuild part or the entire schema from the beginning! Feature datasets require that all features within them have the same spatial reference (projection and coordinate system) and are within the bounds of an applied coordinate range (also called domain extent). You will be exploring the specifics of the coordinate range in the next few steps.

- Highlight the MarineFeatures feature dataset. Make sure the box next to Marine Features is checked.
- Click the <u>Properties</u> button; notice that there is no spatial reference.
- Click the edit button.

[™] Schema Wizard	
Select the feature datasets to create.	
Image: Workspace Image: Workspace Image: Point Image: Point	
	Properties

Feature Dat	aset Properties		×
Name:	MarineFeatures		孟
Spatial Re	eference		
Description	ι:		
Unknown	Coordinate System i		×
🔲 Show [Details		Edit
		ОК	Cancel

The Coordinate system and Domains may be set manually but it is easier to import the spatial reference from an existing layer and modify it to meet your needs. A layer has been provided that is projected to the California Teale Albers projection standard NAD 83. The x/y domain is in the correct range for your data; however, the m and z domains will need to be modified.

X and Y values are stored for all features. Z and M values are optional values that may be stored with the spatial reference of a feature. Our data contain both Z and M values. The Z and/or M values are stored in the shape field (geometry) of the feature and the option for making a feature "Z or M aware" can only be set at the time of creation and cannot be changed later. The range of values that can be stored in the X,Y,Z and M reference is set on the Spatial Reference Properties page.

- On the XY Coordinate Systems tab, Click the Import button
- Browse to E_Datamodel\Tutorial\Shapefiles\Monterey_Study_Area.shp, click Add
- On the Z Domain tab, change the Min value to -20000 and Max value to 20000

The Z values in your data are stored in meters. Setting this range of values for the Z Domain will allow your data to store the greatest anticipated values (and then some).

Spatial Refere	nce Properties			? ×
XY Coordinate	System 🛛 🛛 X/Y Domain	Z Domain	1 Domain	
The coordi dependent Precision is specifies th	nate range, or domain e upon the minimum Z, m the number of system u e degree of resolution.	xtent of the fea aximum Z, and inits per unit of	ture class, is Precision values. Th measure, and theref	ne ore
Min:	-20000	Max:	20000	
Precision:	225179981368.525			

Did you notice how the precision changed when you set your range values? Precision is a scale factor that is required to convert storage units to map units. If you set a precision = 1000 and your data units are meters, then map units are 1mm or 1/1000 of your data unit. Because the geodatabase stores coordinates as a positive 4-byte integer, the maximum value is approximately 2.14 billion map units. The default precision from our imported spatial reference has a false precision of 100,000 for the M Domain. The maximum range for storage units that can be stored with this precision is approximately 21,400 (21,400 * 100,000 = 2.14 billion). Because the M value units in your data (representing a serial time code) have a range of values between 0 and 80,000, the default precision will not hold those values, and thus a precision of 1000 is more appropriate (max value = 2.14 million). In many cases the default precision is fine; however, this is a case to demonstrate the importance of knowing your data before proceeding.

• On the M Domain tab, change the value in the precision field to 1000.

9	Spatial Referen	ce Properties			? ×
	XY Coordinate	System 🛛 🛛 X/Y Domain	Z Domain	M Domain	
	The coordin dependent (Precision is specifies the	ate range, or domain a upon the minimum M, r the number of system a e degree of resolution.	extent of the f naximum M, a units per unit	eature class, is ind Precision values. of measure, and there	The fore
	Min:	-100000	Max:	900719825474.0	099
	Precision:	1000			

- Click OK twice.
- Highlight the feature class named Track and click Properties
- On the M/Z tab, confirm that both boxes are checked Click OK
- Set the Spatial Reference for the **Mesh Features** feature dataset to match that of **Marine Features** (Make sure the box next to **Mesh Features** is checked).
- NOW you can click Next
- Click Finish
- You may review the log file if you wish

Your ArcCatalog session should now look like:

Catalog Tree + ×	Contents Preview Description	
E Folder Connections	Name	Туре
E 🔤 C:\Documents and Settings\dickd\My Documents\Downloa	MarineFeatures	Personal Geodatabase Feature Data
		Personal Geodatabase Feature Data
	Cruise	Personal Geodatabase Table
	CruiseHasTracks	Personal Geodatabase Relationship
	🗄 DataLineHasSurveyKeys	Personal Geodatabase Relationship
	MarineEvent	Personal Geodatabase Table
🛨 🛄 Arcimiarine Lut. mab	MeasuredData	Personal Geodatabase Table
	Measurement	Personal Geodatabase Table
E Grios	🖶 MeasurementHasData	Personal Geodatabase Relationship
I I Snapenies	MeasuringDevice	Personal Geodatabase Table
TabularData	🖶 MeasuringDeviceHasData	Personal Geodatabase Relationship
Utonaisb.sxu	Mesh	Personal Geodatabase Table
E Colloxes	HeshHasPoints	Personal Geodatabase Relationship
Connections	HeshPointHasScalarQuantities	Personal Geodatabase Relationship
	HeshPointHasVectorQuantities	Personal Geodatabase Relationship
	MeshVolume	Personal Geodatabase Table
	Parameter	Personal Geodatabase Table
	ParameterTypeHasData	Personal Geodatabase Relationship
	ParameterTypeHasScalars	Personal Geodatabase Relationship
	+ ParameterTypeHasVectors	Personal Geodatabase Relationship
	ScalarQuantity	Personal Geodatabase Table
	Series	Personal Geodatabase Table
	SurveyHasSurveyKeys	Personal Geodatabase Relationship
	SurveyInfo	Personal Geodatabase Table
	SurveyInfoHasPoints	Personal Geodatabase Relationship
	SurveyKey	Personal Geodatabase Table
	TimeSeries	Personal Geodatabase Table
	TSType	Personal Geodatabase Table
	TSTypeHasTimeSeries	Personal Geodatabase Relationship
	VectorQuantity	Personal Geodatabase Table
	Vehicle	Personal Geodatabase Table

3.0 Loading Data into the Geodatabase

A. Comparing Schemas

Now that the basic schema template has been created, you can compare your data and geodatabase schema for compatibility.

- Open a second instance of ArcCatalog
- Arrange both ArcCatalog windows side by side so that they may both be used.
- In the left ArcCatalog directory, right click E_Datamodel\Tutorial\Shapefiles\TracksMZ.shp
- Select <u>Properties</u>
- Select the Fields tab
- In the right ArcCatalog directory, right click
 E_Datamodel\Tutorial\Geodatabase\MyArcMarineTut.mdb\MarineFeatures\Track
- Select <u>Properties</u>
- Select the <u>Fields</u> tab
- Compare all the fields noting the Data Types and Field Properties.

TracksMZ shapefile field properties:

	Field Name	Data Type	_ ^
FID		Object ID	
Shape		Geometry	_
FEATURE	D	Long Integer	_
FEATURE	COD	Text	
OBJECTID		Long Integer	
VehicleID		Long Integer	
date_		Date	
location		Text	_
cruiselD		Long Integer	_
Operator		Text	
			_
l			

Track feature class field properties:

ieneral 🔰 XY Coordina	ite System	Z Coordinate S	ystem	Toleran	ce	Resolutio
Domain Fields	Indexes	Subtypes	Relation	iships	Rep	resentation
Fi	ield Name			Data Typ	е	
Shape			Geomet	ry		
OBJECTID			Object I	D.		
FeatureID			Long Int	eger		
FeatureCode			Text			
StartDate			Date			
EndDate			Date			
VehicleID			Long Int	eger		
CruiseID		Long Int	eger			
TrackID		Long Int	eger			
Name			Text			
Method			Text			
Description			Text			
LocalDesc			Text			-
lick any field to see its pro Field Properties	operties.					
Alias	Shap	e				
Allow NULL values	Yes					
Geometry Type	Line					
	0.045	74004000040				

Notice that the geodatabase has an appropriate field to hold all the data from the **TracksMZ** shapefile except for the operator field. There are some additional fields in the geodatabase that we will not be using.

Make sure that the database is not being used by any other applications, including the second session of ArcCatalog. You will have to close and reopen ArcCatalog if the database is write protected.

- Scroll down to the bottom of the fields list in the Track feature class
- Click in the first empty row and type Operator
- For data type, select text
- Leave the default values
- Click OK

General XY Coordinate System Domain Fields Indexes TrackID Name Method Description LocalDesc Shape_Length Operator	Z Coordinate System Tolerance Resolution Subtypes Relationships Representations Data Type Long Integer Text Text Text Text Double
Domain Fields Indexes Field Name TrackID Name Method Description LocalDesc Shape_Length Operator	Subtypes Relationships Representations Data Type Long Integer Text Text Text Data Type
Field Name TrackID Name Method Description LocalDesc Shape_Length Operator	Data Type Long Integer Text Text Text Text Double
TrackID TrackID Name Method Description LocalDesc Shape_Length Operator	Long Integer Text Text Text Text Double
IrrackiD Name Method Description LocalDesc Shape_Length Operator	Text Text Text Text Double
Method Description LocalDesc Shape_Length Operator	Text Text Text Text Double
Description LocalDesc Shape_Length Operator	Text Text Double
LocalDesc Shape_Length Operator	Text Double
Shape_Length Operator	Double
Operator	
	Text
-	
lick any field to see its properties.	
Field Properties	
Alias	
Allow NULL values Yes	
Default Value	
Length 50	
	Terrent

Compare the schema of:

E_Datamodel\Tutorial\TabularData\Monterey2002ROV**Cruise**

Catalog Tree	able Properties	<u>?</u> ×
Folder Connections G:\Documents and Settings\dickd\My Documer	General Fields Indexes	1
	Field Name	Data Type
	CruiselD	Long Integer
	projectName	Text
	vessel	Text
	ves_operator	Text
	DateStart	Date
	DateEnd	Date
	Code	Text
E Monterey2002ROV.mdb		
Cruise		
HabitatSegments		
ProccessedXYZ		
ROVdiveInfo	Click any field to see its properties.	
ROVLog ROVLogObservations	Field Properties	
	Alias CruiselD	
SpeciesObservation	Allow NULL values Yes	
	Default Value	
Uehicle		

Catalog Tree	Table Properties	<u>?</u> ×
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Carcmarine_tutorial	Field Name	Data Type
E E_Datamodel	OBJECTID	Object ID
	CruiseID	Long Integer
	Code	Text
🖃 🧰 Geodatabase	Name	Text
🕀 🛄 ArcMarineTut.mdb	Purpose	Text
🖃 🛄 MyArcMarineTut.mdb	Status	Text
🕀 📅 MarineFeatures	Description	Text
🕀 🔂 Mesh Features	StartDate	Date
Cruise	EndDate	Date
🔁 CruiseHasTracks	ShipName	Text
🔁 DataLineHasSurveyKeys		
MarineEvent		
MeasuredData		_
Measurement	Click any field to see its properties.	
🔁 MeasurementHasData		
MeasuringDevice		
🔁 MeasuringDeviceHasData	Alias OBJECTID	
🛄 Mesh		
🖶 MeshHasPoints		
Handreit MeshPointHasScalarQuanti		

Compare the scheme of:

E_Datamodel\Tutorial\TabularData\Monterey2002ROV**Vehicle**

Catalog Tree	Tab	e Properties			<u>?</u> ×
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E E Datamodel	[VehicleID		Long Integer	
🖃 🚞 Tutorial		Name		Text	
🕀 🧮 ArcMDM		Category		Text	
🖽 🛅 Geodatabase					
🕀 🛅 Grids					
🕀 🚞 Shapefiles					
🖂 🧰 TabularData					
🖂 🧊 Monterey2002ROV.mdb					
Cruise					
HabitatSegments					
ProccessedXYZ					_
ROVdiveInfo					
ROVLog					-
ROVLogObservations	0	lick any field to see its prop	erties.		
SpeciesCodes		-Field Properties			
SpeciesObservation					
SPECIESprocessed		Alias	VehicleID		
E Vehicle		Allow NULL values	Yes		
Tutorial3D.sxd		Detault Value			
🛨 🚳 Toolboxes					

to E_Datamodel\Tutorial\Geodatabase\MyArcMarineTut.mdb**Vehicle**

Catalog Tree	able Properties	<u>? ×</u>
Folder Connections Sim C:\Documents and Settings\dickd\My Documents\Dow	General Fields Indexes Subtypes Relationships	
🖃 🚞 arcmarine_tutorial	Field Name	Data Type
E_Datamodel		Object ID
🗆 🔚 Tutorial	VehicleID	Long Integer
🕀 🧮 ArcMDM	Name	Text
🖃 🧮 Geodatabase	Category	Text
🕀 🛄 ArcMarineTut.mdb		
🗆 🛄 MyArcMarineTut.mdb		
⊞ ☐ MarineFeatures ☐		
🕀 📴 Mesh Features		
Cruise		
CruiseHasTracks		
TataLineHasSurveyKeys		
MarineEvent		
MeasuredData	<u> </u>	· · · · · · · · · · · · · · · · · · ·
Measurement	Click any field to see its properties.	
🔁 MeasurementHasData	Field Properties	
MeasuringDevice	Alias OBJECTID	
HeasuringDeviceHasData		
Mesh		
년 MeshHasPoints		

The schemas match, though not in exactly the same order. When using an existing data model, you will want to collect your data with the model in mind or condition your existing data for the model. A lot of your time will be spent conditioning data.

Close the second instance of ArcCatalog.

B. Loading data

- Right click the Track feature class located in
 E_Datamodel\Tutorial\Geodatabase\MyArcMarineTut.mdb\MarineFeatures
- Highlight Load then select Load data

Catalog Tree	Ŧ×	Contents Previe	ew Description
🖃 💼 Folder Connections	_		
C:\Documents and Settings\dickd\My E	Name: Trac	k anal Condatabase Feature Class	
🖃 🚞 arcmarine_tutorial	Type: Pers	onal Geodatabase reature class	
E_Datamodel			
🗆 🧮 Tutorial			
🕀 🧮 ArcMDM			
🖃 🔚 Geodatabase			—
🗄 🛄 ArcMarineTut.mdb			
🖃 🛄 MyArcMarineTut.m	db		
🗆 👘 MarineFeature	s		
📇 DataLine			Track
E FeatureAre	ea 🔰		
FeatureLin	e		
FeaturePoi	nt		
Instantane	ousPoint		
	riesPoint		
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	Delete		
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Measurem 💙	Create Layer		
t Measurem	Attachments	+	
Measuring			-
🔁 Measuring	Export	•	
Mesh	Load		Load Data
🔁 MeshHasP 🐑	Review/Rematch A	Addresses	Load XML Recordset Document
ter MeshPoint	Add Global IDc		
t MeshPoint			-
📃 MeshVolun 😭	Properties		
Parameter			-

- The Simple Data Loader Wizard opens, read the first screen, then click on Next
- For Input Data, browse to E_Datamodel\Tutorial\Shapefiles\TracksMZ.shp
- Click Add, then Next (to skip the subtype loading)
- Click Next

In this window you will be matching the fields from your source data to the fields in your database. Match the following fields:

FeatureCode [string]	FEATURECOD [string]
StartDate [DATE]	date_[DATE]
EndDate [DATE]	date_[DATE]
TrackID [int]	FEATUREID [int]
Name [string]	None
Method [string]	None
Description [string]	None
LocalDesc [string]	location [string]

Example:

Target Field	Matching Source Field		
FeatureID [int]	FEATUREID [int]		
FeatureCode [string]	<none></none>		
StartDate [DATE]	<none></none>		
EndDate [DATE]	<none></none>		
VehicleID [int]	VehicleID [int]		
CruiselD [int]	cruiseID [int]		
TrackID [int]	<none></none>		
Name [string]	<none></none>		
Method [string]	<none></none>		
Description [string]	<none></none>		
	Reset		

Simple Data Loader

For each target field, select the source field that should be loaded into it.

Target Field	Matching Source Field	•
FeatureID [int]	FEATUREID [int]	
FeatureCode [string]	<none></none>	
StartDate [DATE]	<none></none>	
EndDate [DATE]	FEATUREID [int]	
VehicleID [int]	FEATURECOD [string]	
CruiseID [int]	OBJECTID [int]	
TrackID [int]	VehicleID [int]	
Name [string]	location (string)	
Method [string]	Operator [stripg]	
Description [string]	<none></none>	•
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ple Data Loader	< Back Next > Cance	:

Target Field	Matching Source Field	-				
FeatureID [int]	FEATUREID (int)	FEATUREID (int)				
FeatureCode [string]	FEATURECOD [string]					
StartDate [DATE]	date_[DATE]					
EndDate [DATE]	date_[DATE]	date_[DATE]				
VehicleID [int]	VehicleID [int]	VehicleID [int]				
CruiseID [int]	cruiselD [int]					
TrackID [int]	FEATUREID (int)					
Name [string]	<none></none>					
Method [string]	<none></none>					
Description [string]	<none></none>					
	Reset					
	< Back Next > 0	Cancel				

- Click Next
- Confirm that "Load all of the source data" is selected, click Next
- Click Finish
- Preview the Track feature class geography and table in ArcCatalog

X

Notice the shape records indicate Polyline ZM, showing that this layer is both Z and M aware.

- Load both the Cruise and Vehicle tables from
 E_Datamodel\Tutorial\TabularData\Monterey2002ROV.mdb. Match all appropriate fields.
- Load E_Datamodel\Tutorial\Shapefiles\Coastline_mb.shp into the Shoreline feature class. Do not match any fields.

C. Importing Objects

Classes (object or feature) may be imported directly into the geodatabase. This is a very easy way to modify schema.

• Right click MyArcMarineTut.mdb, highlight Import, then select Table (Multiple)



- For the Input table, browse to E_Datamodel\Tutorial\TabularData\ Monterey2002ROV.mdb and select both the SpeciesObservation and HabitatSegments tables
- Click Add, then OK

• Verify that the tables are now in your database.



• Right click the MarineFeatures feature dataset, highlight Import, then select Feature Class (single)

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🖶 TSTypeHasTimeSeries	
VectorQuantity	
Vehicle	

- For "Input Features", browse to E_Datamodel\Tutorial\Shapefiles\ **Habitat_High_Res.shp**. For "Output Feature Class," type **HabClass**
- Click OK

• Verify that HabClass is now a feature class in MarineFeatures (You may have to refresh the MarineFeatures feature dataset.)

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🖂 🛄 MyArcMarineTut.mdb
🖂 📅 MarineFeatures
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🔟 FeatureArea
🛨 FeatureLine
E FeaturePoint
HabClass
i InstantaneousPoint
Shoreline
SoundingPoint
SurveyPoint
Track

D. Creating a Raster Catalog

Raster data may also be loaded into your geodatabase as a raster object or contained in a Raster Catalog. A raster catalog allows you to manage multiple rasters as if they were tiled together (mosaic). With personal geodatabases the raster is not actually stored within the .mdb file. (This is good because the .mdb is limited to 2GB!). Instead the files are converted to IMG format and stored in a directory that rides along with the geodatabase. If the rasters are "managed" then this directory will be moved anywhere the geodatabase is moved when using ArcCatalog. For this reason, it is important to *never* move personal geodatabases containing raster data using Windows Explorer.

• Right click MyArcMarineTut.mdb, highlight New, then select Raster Catalog



- For "Raster Catalog Name" type Bathymetry
- To set the "Coordinate system for the raster column", click the button
- Import the coordinate system from the Monterey_Study_Area.shp using the same method as for the feature datasets
- Set the "Coordinate system for the geometry column" field using the same method
- Click OK

🔨 Create Raster Catalog	
Output Location	^
C:\Documents and Settings\dickd\My Documents\Downloads\arcmarine_tutorial\E_Datamodel\Tutorial\Geodatabas	e*
Template Raster Catalog (optional)	
	6
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	+
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	±
Raster Catalog Name	_
Bathymetry	_
Coordinate System for Raster Column (optional)	
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Coordinate system for Geometry Column (optional)	
Confirmation Keyward Antion - N	
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) Output Spatial Grid 1 (optional)	
0	
Output Spatial Grid 2 (optional)	
0	
Output Spatial Grid 3 (optional)	_
OK Cancel Environments Show H	lelp >>

Spatial Referen	ce Properties
XY Coordinate S	System Z Coordinate System
Name:	Unknown
Details:	
	Browse for Dataset
	Look in: 🔁 Shapefiles 💽 📤 🗮 👻 😂 🐨 🚳
	Coastline_mb.shp
	Habitat_High_Res.shp UingcodZ.shp
Select	Monterey_Study_Area.shp
Import	
New	
Modify	
Clear	Name: Monterey_Study_Area.shp Add
Save As	Show of type: Geographic datasets Cancel

• Check to make sure the Raster Catalog was added



E. Loading Rasters into a Raster Catalog

- Preview the defined projection for E_Datamodel\Tutorial\Grids\c_p2mhill and E_Datamodel\Tutorial\Grids\m_c2mhill
- Right click the new Bathymetry Raster Catalog, highlight Load, then select Load Raster Datasets

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🖃 🚞 E_Datamodel					
🖂 🚞 Tutorial					
🕀 🚞 ArcMDM					
🖃 🚞 Geodatabase					
🕀 🧊 ArcMarineTut.mdb					
🖂 🔲 MyArcMarineTut.mdb					
Bathymetry					
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	Load			•	Load From Workspace
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Mesh Pai	Export				Load Raster Datasets
	Update Footprint	S		a a	Load XML Recordset Document
	Properties				

- For "Input Rasters" browse to E_Datamodel\Tutorial\Grids and select c_p2mhill and m_c2mhill
- Click Add then OK... this will take a couple minutes... shouldn't be more than a couple.
- Preview the Bathymetry Raster Catalog both rasters are shown as a mosaic



- Select the Contents tab
- Click on the handle to the far right (it has two black triangles on it)
- Next, click on the handle at the bottom left (you may have to maximize your screen)
- In the Query box type [OBJECTID] = 1 and click Selection (you should see the **c_p2mhill** grid appear)



- Click Subset... compare Selection and Subset options.
- In the query type [OBJECTID] = 1 or 2
- Click Selection
- In the window in the very lower right of ArcCatalog, change the selection from "Geography" to "Properties"



• In the Contents window, scroll down to "Spatial Reference"

Notice that the spatial reference of the raster has changed. The geodatabase will reproject data to match the raster catalog.

4.0 Creating Relationships in the Geodatabase

A. Creating Relationship Classes

Now that all of our data are in the geodatabase we can create relationship classes that link our data together.

• Right click the Track feature class, select Properties

• On the Relationships tab, highlight the relationship **CruiseHasTracks**, then click <u>Properties</u> Notice this relationship links **Cruise** and **Track** with a one-to-many (1-M) relationship. The tables are linked through the key fields *CruiseID*.

Relationship Class	Properties	? ×
General Rules		
Name:	CruiseHasTracks	
Type:	Simple	
Cardinality:	1 · M	
Notification:	None (no messages propagated)	
Origin Table/Fe	ature Class	
Name:	Cruise	
Primary Key:	CruiseID	
Foreign Key:	CruiseID	
Destination Tel	de /Easterne Olasse	
Destination Fal	Terel	
Name.	Hack	
Labels		
Forward:	Track	
Backward:	Cruise	
	ОК	Cancel Apply

- Click cancel twice
- Right click **MyArcMarineTut.mdb**, highlight <u>New</u>, then select <u>Relationship class</u>.

Catalog Tree	Ψ×	Contents Preview [Descriptio	on		
🖃 🔂 Folder Connections	Name			Type	1	
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Parameter	SurveyInfo		8	Address Locator		
ParameterTypeHasD		nts	×		hip	
ParameterTypeHasS				Composite Address Locator		
🔁 ParameterTypeHasVectors 📗 🥅 TimeSovies					Percenal Condatabase Table	

- In the "Name of the relationship class" field type VehicleHasTracks
- Select Vehicle for the origin table and Track for the destination table

New Relationship Class	? ×
Name of the relationship class: VehicleHasTracks Select the table/feature classes that will be associated Origin table/feature class:	d by this relationship class.
SurveyInfo SurveyKey TimeSeries TSType VectorQuantity Vehicle	A relationship class is a collection of relationships between objects in two tables/feature classes.
Destination table/feature class: SoundingPoint SurveyPoint TimeDurationArea TimeSeriesPoint Track ⊕ Mesh Features Bathumetru	Parcels are owned by owners. Owners own parcels.
	< Back Next > Cancel

- Click Next
- Select "Simple (peer to peer) relationship" then click Next
- Accept the default labels, click Next
- Select 1 M (one to many) then click Next
- Verify "No" is selected and click Next
- Select VehicleID for both the primary and foreign keys then click Next
- Click Finish
- Create a new Relationship Class and call it **TrackHasObservations**, using **Track** and **SpeciesObservations** as your origin and destination tables.
- Continue with the same parameters as above except the primary key is *FeatureID* and the foreign key is *SegmentID*.... Pay close attention to the order of cardinality (which is the one and which is the many?)

Your geodatabase is done!

Your ArcCatalog session should look like:



We will now explore the data and how they relate. Part of your exploration will cover a brief overview of dynamic segmentation. Dynamic Segmentation will link the habitat and species observations to their proper geography using the M values stored in the **Track** geometry.

5.0 Adding Geodatabase Features to your ArcMap Project

A. Adding and exploring the data

- Open ArcMap, and add the following data from MyArcMarineTut.mdb: Track, Shoreline, HabClass, Bathymetry, HabitatSegments, and SpeciesObservation
- Notice that HabitatSegments and SpeciesObservations are stored in object classes (no geometry).
- Spruce up the display of HabClass by right clicking on the layer and choosing <u>Properties</u> and within Layer Properties: Display (set transparency to 50 or 60%); in Symbology (show Categories in Unique Values, Value Field of "IND", Add Values of "hard", "mixed", "soft", giving them nice colors)
- Save your ArcMap document to E_Datamodel\Tutorial\MyGDB_Tutorial.mxd

Your ArcMap session should look something like this:



In order to spatially display the **HabitatSegments** and **SpeciesObservations** data, you will reference the data using dynamic segmentation. Dynamic segmentation is the process of transforming linearly referenced data (called events) stored in a table into a feature that can be displayed on a map. The habitat and fish observations contain an integer ID that is the serial time code for when the observation took place on the ROV transect. The M (measure) value that is stored in the spatial reference of the **Track** feature is the serial time code. In ArcMap you can "Display Route Events" to view these data spatially.

- In the Table of Contents, right click HabitatSegments then select Display Route Events
- For Route Reference select Track
- For 1st Route Identifier field, select *FeatureID*
- For 2nd Route Identifier field (under "Specify the table containing the route events"), select SegID
- Change the type of events to "Line Events"
- In the From-Measure field select *BTCsec*
- In the To-Measure field select *ETCsec*

Display Route Events		<u>? ×</u>						
Route events are objects with locations measured along routes. A table containing route events can be added to the map as a layer.								
Specify the routes referen	ced by the events in the tab	le						
Route Reference:	Track	▼ 🚔						
Route Identifier:	FeatureID	•						
Specify the table containing the route events								
Choose a table from the r	nap or browse for another ta	ble.						
Event Table:	HabitatSegments							
Route Identifier:	segID							
Choose the type of events the table contains:								
O Point Events: Occur at a precise location along a route								
C Line Events: Define a discontinuous portion of a route								
Choose the measure fields for line events:								
From-Measure:	BTCsec	•						
To-Measure:	ETCsec	•						
Choose the offset field. Events can be offset from their routes.								
Offset:	<none></none>	•						
🔽 Warn me if the resulting	layer will have restricted fun	ctionality						
Advanced Options	OK	Cancel						

- Click OK
- As you did above for **HabClass**, change the symbology of the **HabitatSegments** Events layer to show the unique values of the *Habitat Type* field

• Right click **SpeciesObservation** and display the route events... *SegmentID* is the Event Table Route Identifier; the events are point; set the measure field to *sec*

Display Route Events		? ×					
Route events are objects w containing route events car	vith locations measured along routes. A tabl n be added to the map as a layer.	e					
Specify the routes referen	nced by the events in the table						
Route Reference:	Track 💌						
Route Identifier:	FeatureID 💌						
Specify the table containi	ng the route events						
Choose a table from the	map or browse for another table.						
Event Table:	SpeciesObservation 🔽						
Route Identifier:	segmentID 💌						
Choose the type of events the table contains:							
Point Events: Occur at a precise location along a route							
C Line Events: Define a discontinuous portion of a route							
Choose the measure field	Choose the measure field for point events:						
Measure:	sec						
Choose the offset field. E	vents can be offset from their routes.						
Offset:	<none></none>						
☑ Warn me if the resulting	layer will have restricted functionality						
Advanced Options	OK Ca	ncel					

• You may select and create a layer for a specific species if you wish (the attribute is "COMNAME")

B. Propagating relationships

- Turn off any Species layers
- Zoom into the map until you can see individual tracklines from the **Track** layer
- In the Table of Contents, click the List by Selection button , right click on the **Track** layer and select "Make This The Only Selectable Layer"



- Using the Selection tool, select a trackline of interest
- Right click the Track layer and select "Open Attribute Table"



- Click the Selected button, 🥮 ,at the bottom of the table
- Click the Options button, , highlight <u>Related Tables</u> then select TrackHasSpObservation:
 SpeciesObservation

Table		×	
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89	Find & Replace		
5	Select By Attributes	JITEID * FeatureCo	
	Clear Selection	211134	
5	Switch Selection		
	Select All		
	Add Field		
	Turn All Fields On		
Image: A start of the start	Show Field Aliases		
	Arrange Tables		
	Restore Default Column Widths		
	Restore Default Field Order		
	Joins and Relates		
	Related Tables	TrackHasObservatio	ons : SpeciesObservation
dh	Create Graph	CruiseHasTracks : C	Iruise
	Add Table to Layout	VehicleHasTracks : 1	Vehicle
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	Reports •		
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•			
		1 out of 91 Selected)	1000
Track			and the second

• The two attribute tables with the selected records are now viewable by clicking between the two tabs at the bottom of the attribute table.

Tab	le			×	Table			×
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SpeciesObservation ×				Track				
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	1288	211134	211	7:50:40				
	1289	211134	211	7:50:40				
	1290	211134	211	7:50:43				
	1291	211134	211	7:50:49				
	1292	211134	211	7:51:01				
	1293	211134	211	7:51:14				
	1294	211134	211	7:51:26				
	1295	211134	211	7:51:49				
	1296	211134	211	7:51:57				
	1297	211134	211	7:52:06				
	1298	211134	211	7:52:58				
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(19	5 out of *2000 Se	elected)			(1 out of 91 Selec	ted)		
Tra	ick SpeciesObs	ervation			Track SpeciesOb	servation		

Notice that the *SegmentIDs* of the selected records in the **SpeciesObservation** table match the *FeatureIDs* of the selected records in the **Track** table. The record selection has been propagated through the relationship classes in the geodatabase.

For the trackline of interest that YOU chose, use the other related tables to answer:

- On which cruise did this track take place?
- What vehicle made this track?

6.0 Exploring the Z-Value (optional)

If you're interested in displaying the z-value geometry for the tracklines and observations, open the E_Datamodel\Tutorial**Tutorial3D.sxd** file. Because ArcScene doesn't support dynamic segmentation, shapefiles have been exported from the geodatabase for you to show observational features. You will have to "Repair Data Source" for the layers.

• Right click on the raster layer **clip1mhs** in the Table of Contents, select Data, Repair Data Source and navigate to E_Datamodel\Tutorial\Grids**clip1mhs**. A dialog box opens warning the base surface cannot be found; click OK.

- When the layer loads, right click on the layer name, select properties and then choose the tab Base Heights. Make sure "Floating on a custom surface" is selected. Use the folder icon and navigate to E_Datamodel\Tutorial\Grids\ and select clip1mxyz.
- Click Add, click OK. The raster surface should no longer be flat.
- Right click on the shapefile layer **Lingcod** in the Table of Contents, select Data, Repair Data Source and then navigate to E_Datamodel\Tutorial\Shapefile**LingcodZ**. The red exclamation point should no longer appear next to any layers, however none of the data are displayed.
- Right click on the layer Lingcod on Dive 209 in the Table of Contents, select Properties and then choose the Definition Query tab. Click the Query Builder... button. In the Query Builder box, build the following query:

Query Builder	<u>?</u> ×
"FID" "OBJECTID" "segmentID" "dive" "TC" "TCtext"	▲ ×
= <> Like 209 ≥ >= And 211 213 <	
Is Get Unique Values Go To: SELECT * FROM LingcodZ WHERE:	
"dive" = 209	A V
Clear Verify Help Load Save	e

- Click Ok and Ok. The lingcod observed during Dive 209 will now be displayed in the map.
- Do the same thing for the layer Lingcod on Dive 213.
- To display the tracks of dives 209 and 213, create a similar Definition Query EXCEPT use the field name *ProccessedXYZ.dive*

Query Builder	×
ProccessedXYZ.ID_visual ProccessedXYZ.H Removed ProccessedXYZ.ID_raw ProccessedXYZ.dive ProccessedXYZ.Line ProccessedXYZ.SegmentID	-
= <> Like 209 211 212 212 213 <	
ProccessedXYZ.dive = 213	
Clear Verify Help Load Save	

• Your final ArcScene map should look similar to:

