Tutorials on Data Management

Lesson 4: Data Collection Entry and Manipulation

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Lesson Topics

- Best Practices for Creating Data Files
- Data Entry Options
- Data Manipulation Options

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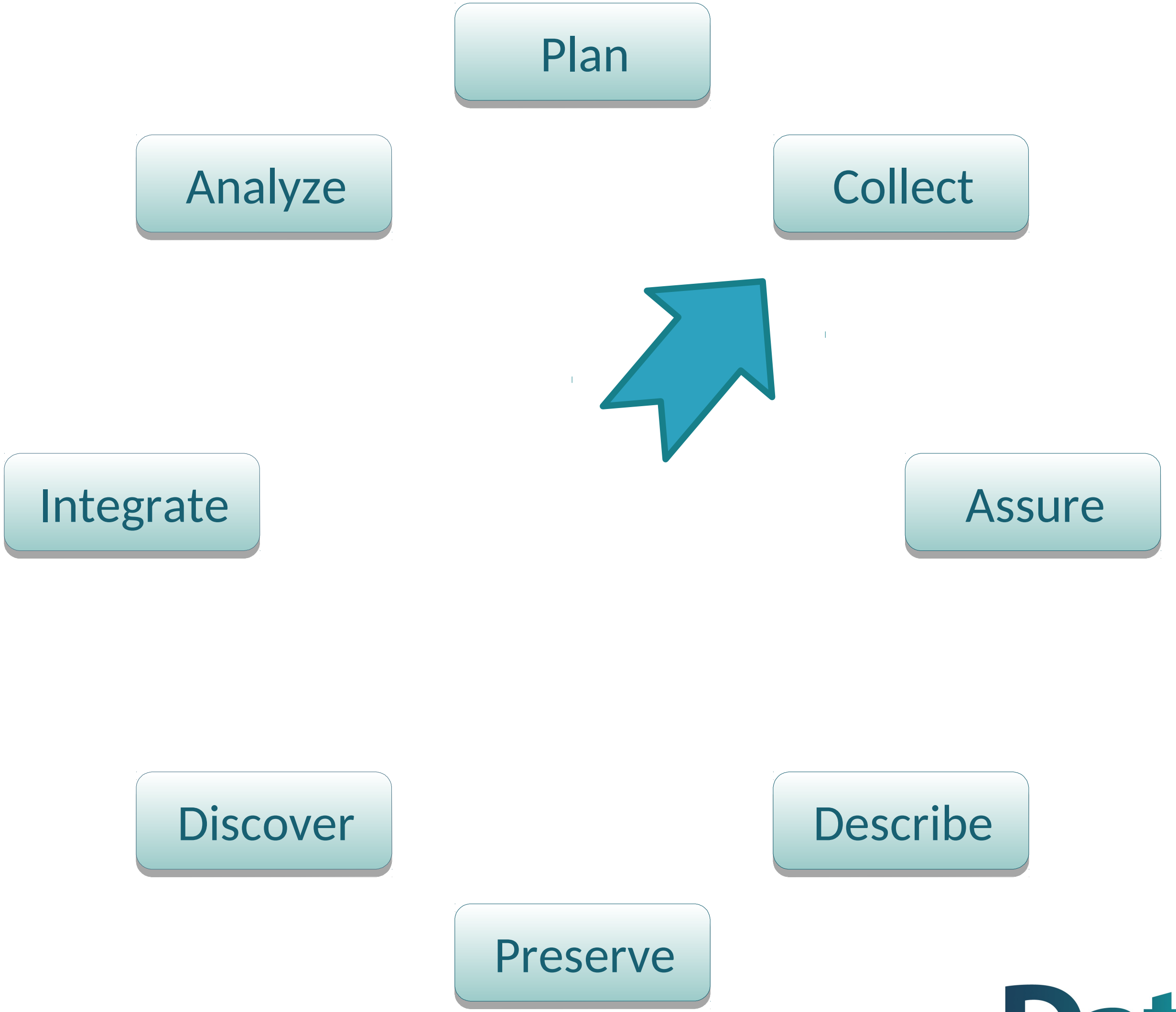
Learning Objectives

- Recognize inconsistencies that can make a dataset difficult to understand and/or manipulate
- Describe characteristics of stable data formats and list reasons for using these formats
- Identify data entry tools
- Identify validation measures that can be performed as data is entered
- Describe the basic components of a relational database

The Data Life Cycle



Plan

Collect

Assure

Describe

Preserve

Discover

Integrate

Analyze

Goals of Data Entry

- Create data sets that are:
  - Valid
  - Organized to support ease of use

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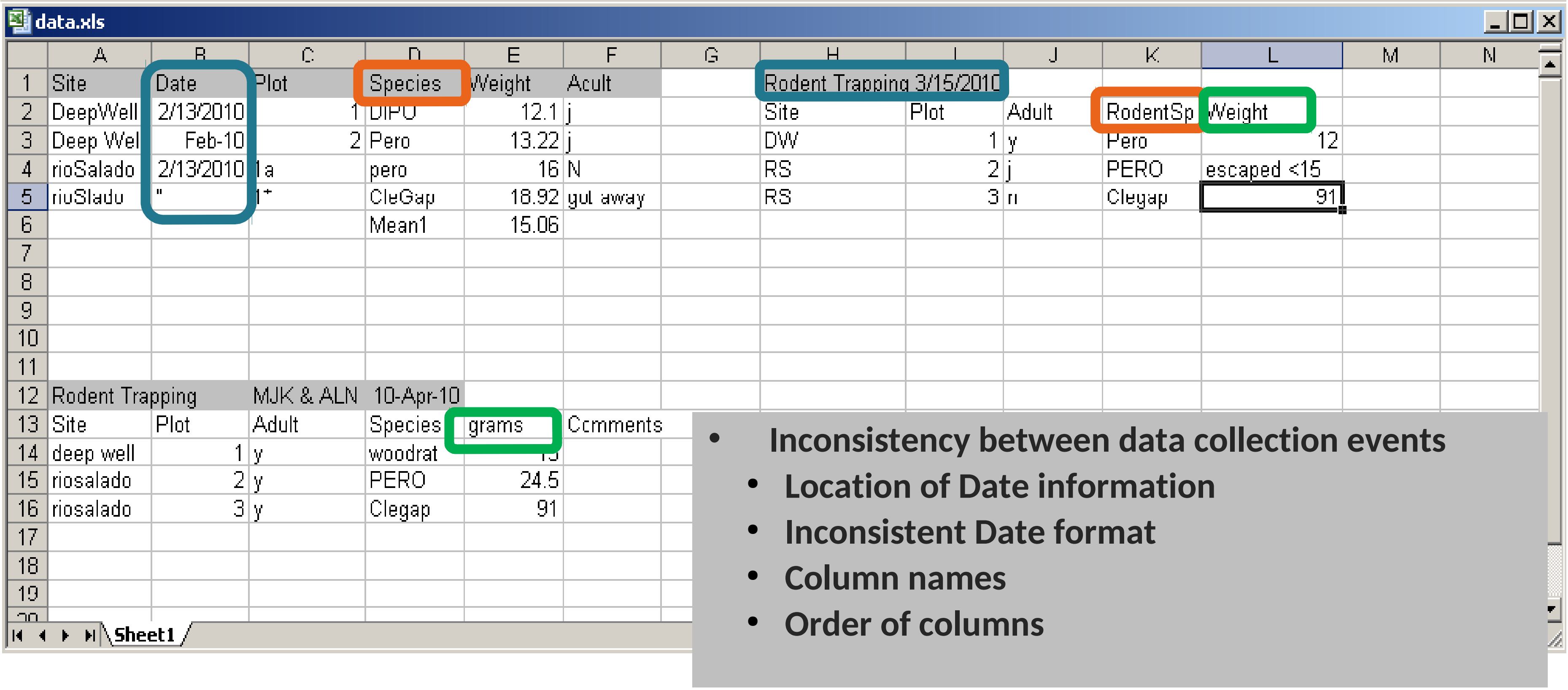
Example: Poor Data Entry



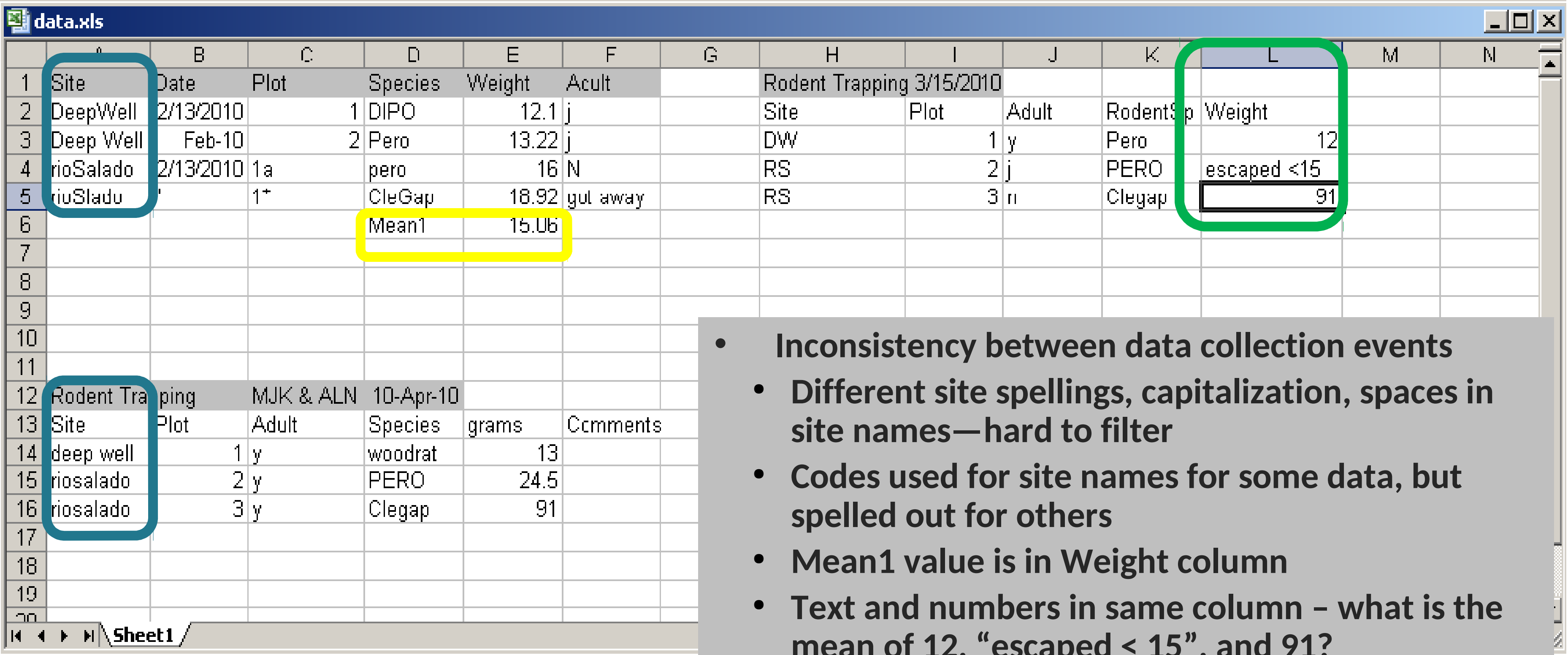
data.xls

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Site	Date	Plot	Species	Weight	Acult		Rodent Trapping 3/15/2010						
2	DeepWell	2/13/2010	1	DIPO	12.1	j		Site	Plot	Adult	RodentSp	Weight		
3	Deep Wel	Feb-10	2	Pero	13.22	j		DW	1	y	Pero	12		
4	rioSalado	2/13/2010	1 a	pero	16	N		RS	2	j	PERO	escaped <15		
5	riuSladu	"	1*	CleGap	18.92	gul away		RS	3	n	Clegap	91		
6				Mean1	15.06									
7														
8														
9														
10														
11														
12	Rodent Trapping		MJK & ALN	10-Apr-10										
13	Site	Plot	Adult	Species	grams	Ccmments								
14	deep well	1	y	woodrat	15									
15	riosalado	2	y	PERO	24.5									
16	riosalado	3	y	Clegap	91									
17														
18														
19														

- Inconsistency between data collection events
  - Location of Date information
  - Inconsistent Date format
  - Column names
  - Order of columns

DataONE

Example: Poor Data Entry

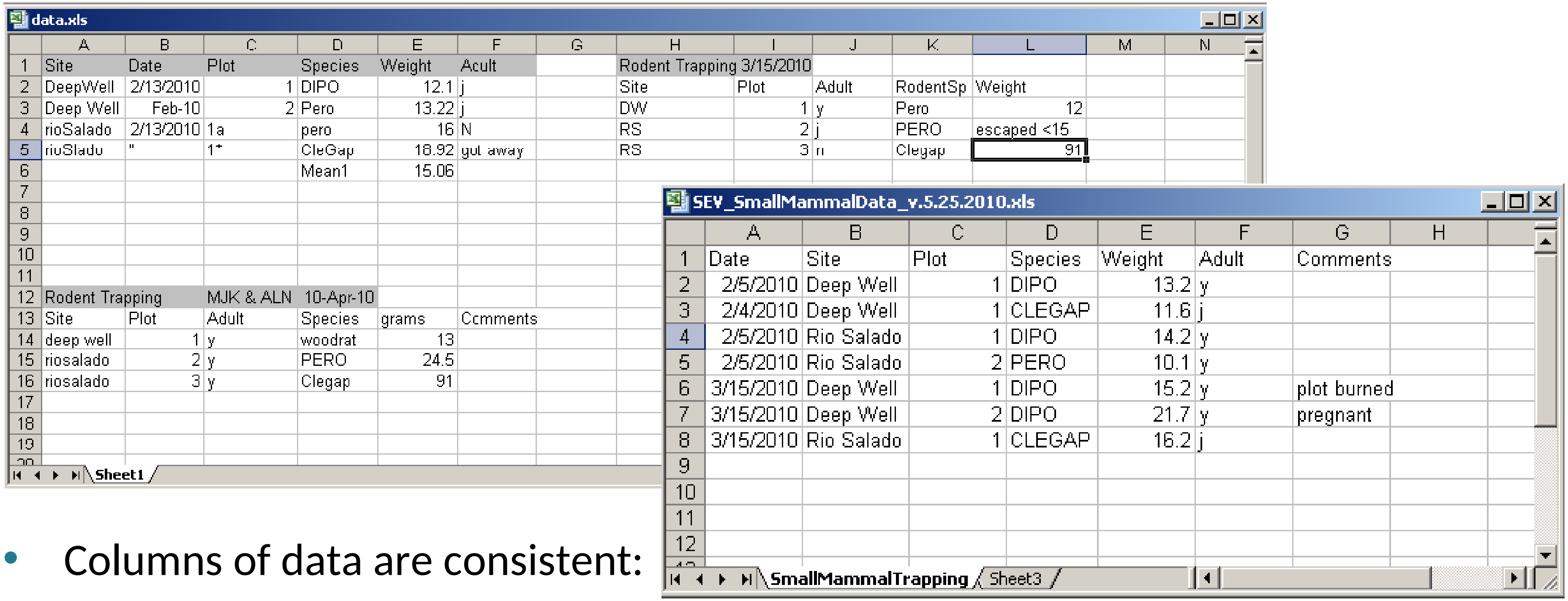


data.xls

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Site	Date	Plot	Species	Weight	Acult		Rodent Trapping 3/15/2010						
2	DeepWell	2/13/2010	1	DIPO	12.1	j		Site	Plot	Adult	RodentSp	Weight		
3	Deep Well	Feb-10	2	Pero	13.22	j		DW	1	y	Pero	12		
4	rioSalado	2/13/2010	1a		pero	16	N	RS	2	j	PERO	escaped <15		
5	riuSladu	'	1*	CleGap	18.92	gul away		RS	3	n	Clegap	91		
6				Mean1	15.06									
7														
8														
9														
10														
11														
12	Rodent Trapping		MJK & ALN	10-Apr-10										
13	Site	Plot	Adult	Species	grams	Ccmments								
14	deep well	1	y	woodrat	13									
15	riosalado	2	y	PERO	24.5									
16	riosalado	3	y	Clegap	91									
17														
18														
19														

- **Inconsistency between data collection events**
  - **Different site spellings, capitalization, spaces in site names—hard to filter**
  - **Codes used for site names for some data, but spelled out for others**
  - **Mean1 value is in Weight column**
  - **Text and numbers in same column – what is the mean of 12, “escaped < 15”, and 91?**

Best Practices



data.xls

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Site	Date	Plot	Species	Weight	Acult		Rodent Trapping 3/15/2010						
2	DeepWell	2/13/2010	1	DIPO	12.1	j		Site	Plot	Adult	RodentSp	Weight		
3	Deep Well	Feb-10	2	Pero	13.22	j		DW	1	y	Pero	12		
4	rioSalado	2/13/2010	1a	pero	16	N		RS	2	j	PERO	escaped <15		
5	riuSladu	"	1*	CleGap	18.92	gul away		RS	3	n	Clegap	91		
6				Mean1	15.06									
7														
8														
9														
10														
11														
12	Rodent Trapping		MJK & ALN	10-Apr-10										
13	Site	Plot	Adult	Species	grams	Ccmments								
14	deep well	1	y	woodrat	13									
15	riosalado	2	y	PERO	24.5									
16	riosalado	3	y	Clegap	91									
17														
18														
19														

SEV_SmallMammalData_v.5.25.2010.xls

	A	B	C	D	E	F	G	H
1	Date	Site	Plot	Species	Weight	Adult	Comments	
2	2/5/2010	Deep Well	1	DIPO	13.2	y		
3	2/4/2010	Deep Well	1	CLEGAP	11.6	j		
4	2/5/2010	Rio Salado	1	DIPO	14.2	y		
5	2/5/2010	Rio Salado	2	PERO	10.1	y		
6	3/15/2010	Deep Well	1	DIPO	15.2	y	plot burned	
7	3/15/2010	Deep Well	2	DIPO	21.7	y	pregnant	
8	3/15/2010	Rio Salado	1	CLEGAP	16.2	j		
9								
10								
11								
12								

- Columns of data are consistent: only numbers, dates, or text
- Consistent Names, Codes, Formats (date) used in each column
- Data are all in one table, which is much easier for a statistical program to work with than multiple small tables which each require human intervention

Best Practices

- Create descriptive column names without spaces or special characters
  - Soil T30 Soil_Temp_30cm
  - Species-Code Species_Code (avoid using -,+,*,^ in column names. Some software may interpret these symbols as an operator)
- Use a descriptive file name. For instance, a file named SEV_SmallMammalData_v.5.25.2010.csv indicates the project the data is associated with (SEV), the theme of the data (SmallMammalData) and also when this version of the data was created (v.5.25.2010).   This name is much more helpful than a file named mydata.xls.

Best Practices

- Missing data
  - Preferably leave field empty (NULL = no value)
  - In numeric fields, use a distinct value such as 9999 to indicate a missing value
  - In text fields, use NA ("Not Applicable" or "Not Available")
  - Use Data flags in a separate column to qualify missing value

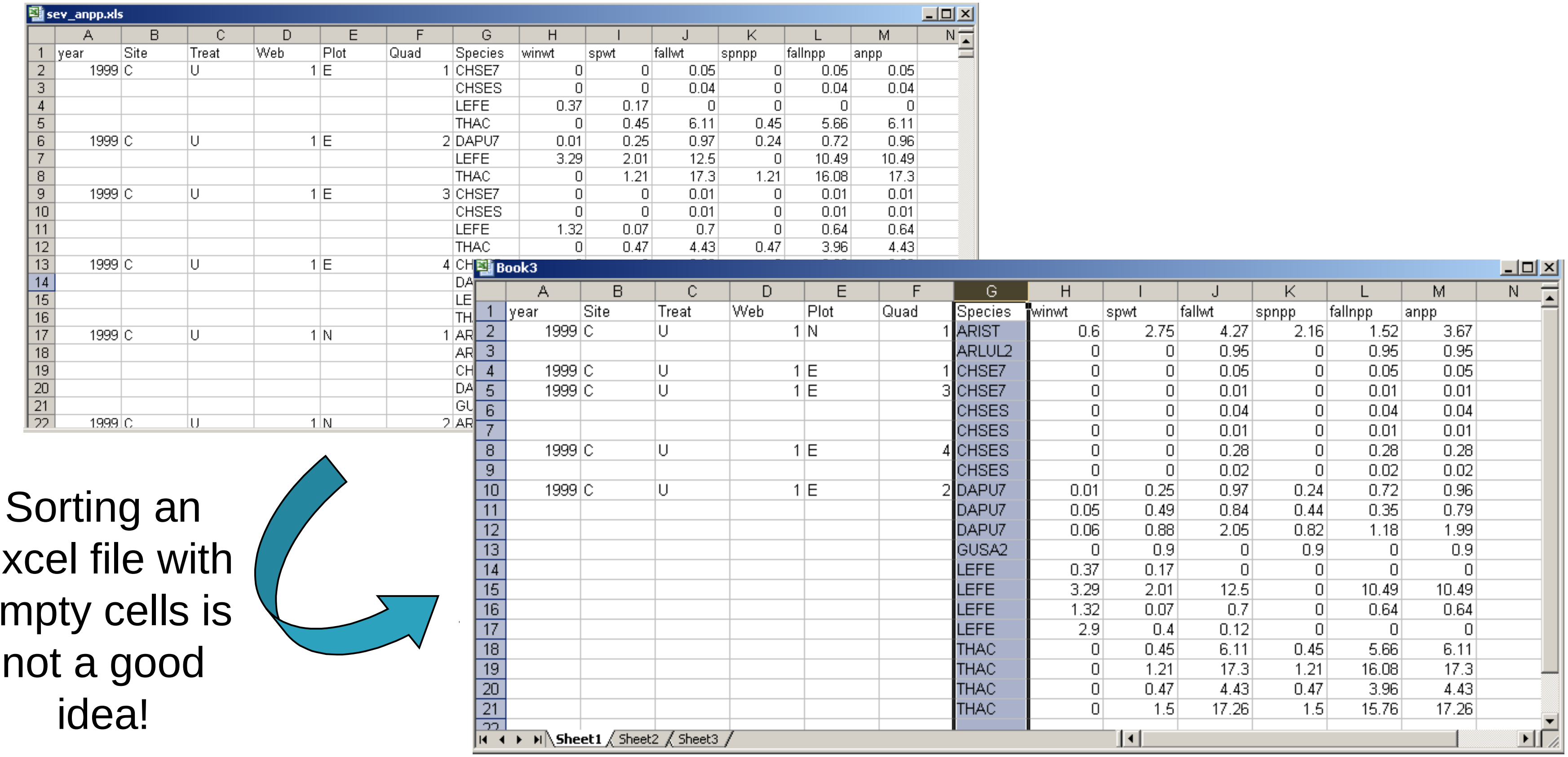
Date	Time	NO3_N_Conc	NO3_N_Conc_Flag
20081011	1300	0.013	
20081011	1330	0.016	
20081011	1400		M1
20081011	1430	0.018	
20081011	1500	0.001	E1

M1 = missing; no sample collected

E1 = estimated from grab sample

Best Practices

- Enter complete lines of data



sev_anpp.xls

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	year	Site	Treat	Web	Plot	Quad	Species	winwt	spwt	fallwt	spnpp	fallnpp	anpp	
2	1999	C	U	1	E	1	CHSE7	0	0	0.05	0	0.05	0.05	
3							CHSES	0	0	0.04	0	0.04	0.04	
4							LEFE	0.37	0.17	0	0	0	0	
5							THAC	0	0.45	6.11	0.45	5.66	6.11	
6	1999	C	U	1	E	2	DAPU7	0.01	0.25	0.97	0.24	0.72	0.96	
7							LEFE	3.29	2.01	12.5	0	10.49	10.49	
8							THAC	0	1.21	17.3	1.21	16.08	17.3	
9	1999	C	U	1	E	3	CHSE7	0	0	0.01	0	0.01	0.01	
10							CHSES	0	0	0.01	0	0.01	0.01	
11							LEFE	1.32	0.07	0.7	0	0.64	0.64	
12							THAC	0	0.47	4.43	0.47	3.96	4.43	
13	1999	C	U	1	E	4	CH							
14							DA							
15							LE							
16							TH							
17	1999	C	U	1	N	1	AR							
18							AR							
19							CH							
20							DA							
21							GU							
22	1999	C	U	1	N	2	AR							

Book3

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	year	Site	Treat	Web	Plot	Quad	Species	winwt	spwt	fallwt	spnpp	fallnpp	anpp	
2	1999	C	U	1	N	1	ARIST	0.6	2.75	4.27	2.16	1.52	3.67	
3							ARLUL2	0	0	0.95	0	0.95	0.95	
4	1999	C	U	1	E	1	CHSE7	0	0	0.05	0	0.05	0.05	
5	1999	C	U	1	E	3	CHSE7	0	0	0.01	0	0.01	0.01	
6							CHSES	0	0	0.04	0	0.04	0.04	
7							CHSES	0	0	0.01	0	0.01	0.01	
8	1999	C	U	1	E	4	CHSES	0	0	0.28	0	0.28	0.28	
9							CHSES	0	0	0.02	0	0.02	0.02	
10	1999	C	U	1	E	2	DAPU7	0.01	0.25	0.97	0.24	0.72	0.96	
11							DAPU7	0.05	0.49	0.84	0.44	0.35	0.79	
12							DAPU7	0.06	0.88	2.05	0.82	1.18	1.99	
13							GUSA2	0	0.9	0	0.9	0	0.9	
14							LEFE	0.37	0.17	0	0	0	0	
15							LEFE	3.29	2.01	12.5	0	10.49	10.49	
16							LEFE	1.32	0.07	0.7	0	0.64	0.64	
17							LEFE	2.9	0.4	0.12	0	0	0	
18							THAC	0	0.45	6.11	0.45	5.66	6.11	
19							THAC	0	1.21	17.3	1.21	16.08	17.3	
20							THAC	0	0.47	4.43	0.47	3.96	4.43	
21							THAC	0	1.5	17.26	1.5	15.76	17.26	

Sorting an Excel file with empty cells is not a good idea!

Best Practices

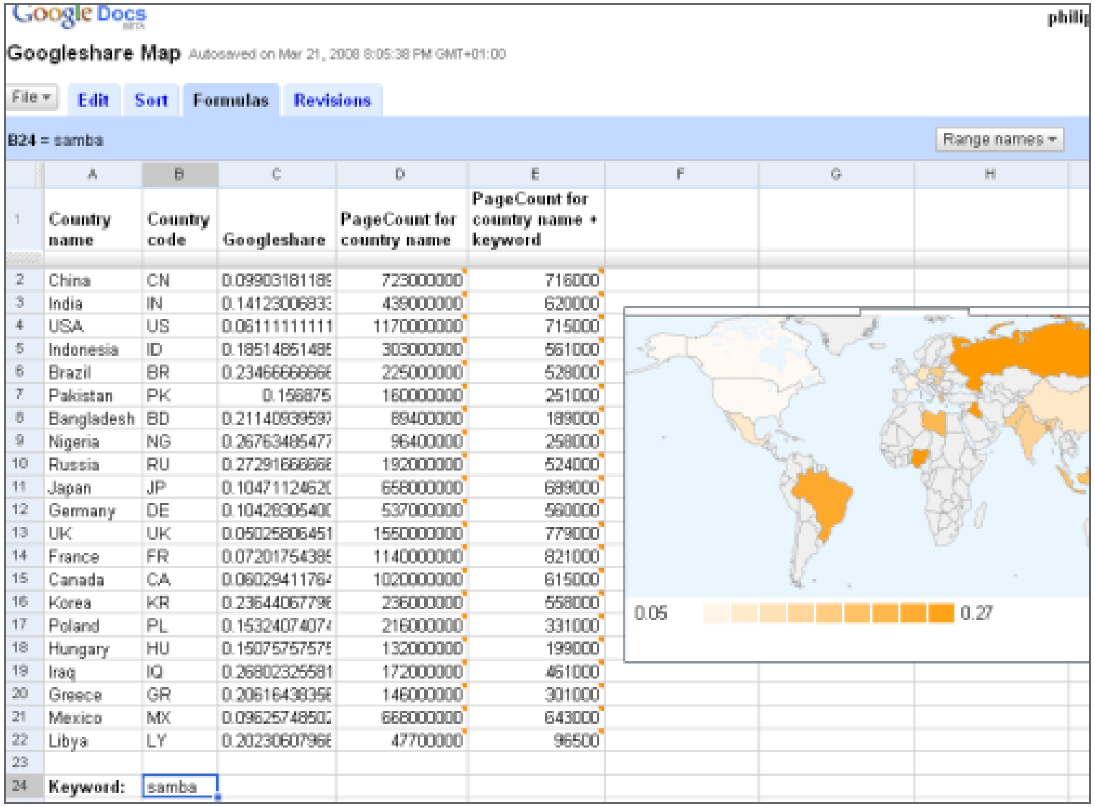
- For the long term, store data in a consistent format that can be read well in to the future and that can be used by any application now or in the future
- Appropriate file types include:
  - Non-proprietary: Open, documented standard
  - Common usage by research community: Standard representation (ASCII, Unicode)
  - Unencrypted
  - Uncompressed
- ASCII formatted files will be readable into the future
  - Use ASCII (comma-separated) for tabular data

References

1. Best Practices for Preparing Environmental Data Sets to Share and Archive. September 2010. Les A. Hook, Suresh K. Santhana Vannan, Tammy W. Beaty, Robert B. Cook, and Bruce E. Wilson. http://daac.ornl.gov/PI/BestPractices-2010.pdf

Data Entry Tools

- Googledocs Forms
- Spreadsheets

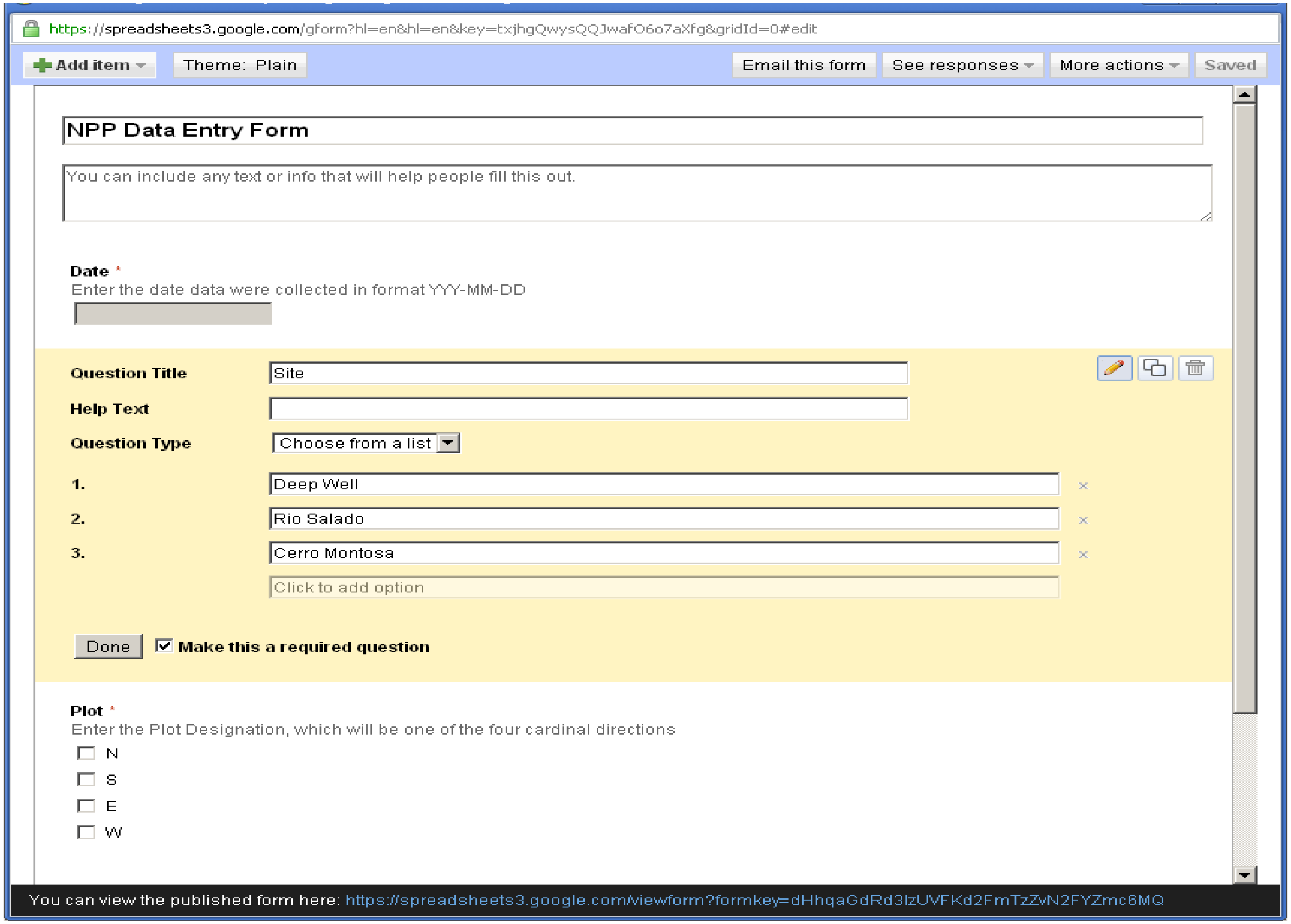


Googleshare Map Autosaved on Mar 21, 2008 8:05:38 PM GMT+01:00

B24 = samba

	A	B	C	D	E	F	G	H
1	**Country name**	**Country code**	**Googleshare**	**PageCount for country name**	**PageCount for country name + keyword**			
2	China	CN	0.0990318118	723000000	716000			
3	India	IN	0.1412300683	439000000	620000			
4	USA	US	0.0611111111	1170000000	715000			
5	Indonesia	ID	0.1851485148	303000000	561000			
6	Brazil	BR	0.2346666666	225000000	528000			
7	Pakistan	PK	0.156875	160000000	251000			
8	Bangladesh	BD	0.2114093959	89400000	189000			
9	Nigeria	NG	0.2676348547	96400000	258000			
10	Russia	RU	0.2729166666	192000000	524000			
11	Japan	JP	0.1047112462	658000000	689000			
12	Germany	DE	0.1042830540	537000000	560000			
13	UK	UK	0.0502580645	1550000000	779000			
14	France	FR	0.0720175438	1140000000	821000			
15	Canada	CA	0.0602941176	1020000000	615000			
16	Korea	KR	0.2364406779	236000000	558000			
17	Poland	PL	0.1532407407	216000000	331000			
18	Hungary	HU	0.1507575757	132000000	199000			
19	Iraq	IQ	0.2680232558	172000000	461000			
20	Greece	GR	0.2061643835	146000000	301000			
21	Mexico	MX	0.0962574850	668000000	643000			
22	Libya	LY	0.2023060796	47700000	96500			
23								
24	**Keyword:**	samba						

Googledocs Forms



https://spreadsheets3.google.com/gform?hl=en&hl=en&key=txjhgQwysQQJwafO6o7aXfg&gridId=0#edit

NPP Data Entry Form

You can include any text or info that will help people fill this out.

Date *
Enter the date data were collected in format YYY-MM-DD

Question Title Site

Help Text

Question Type Choose from a list

1. Deep Well
2. Rio Salado
3. Cerro Montosa

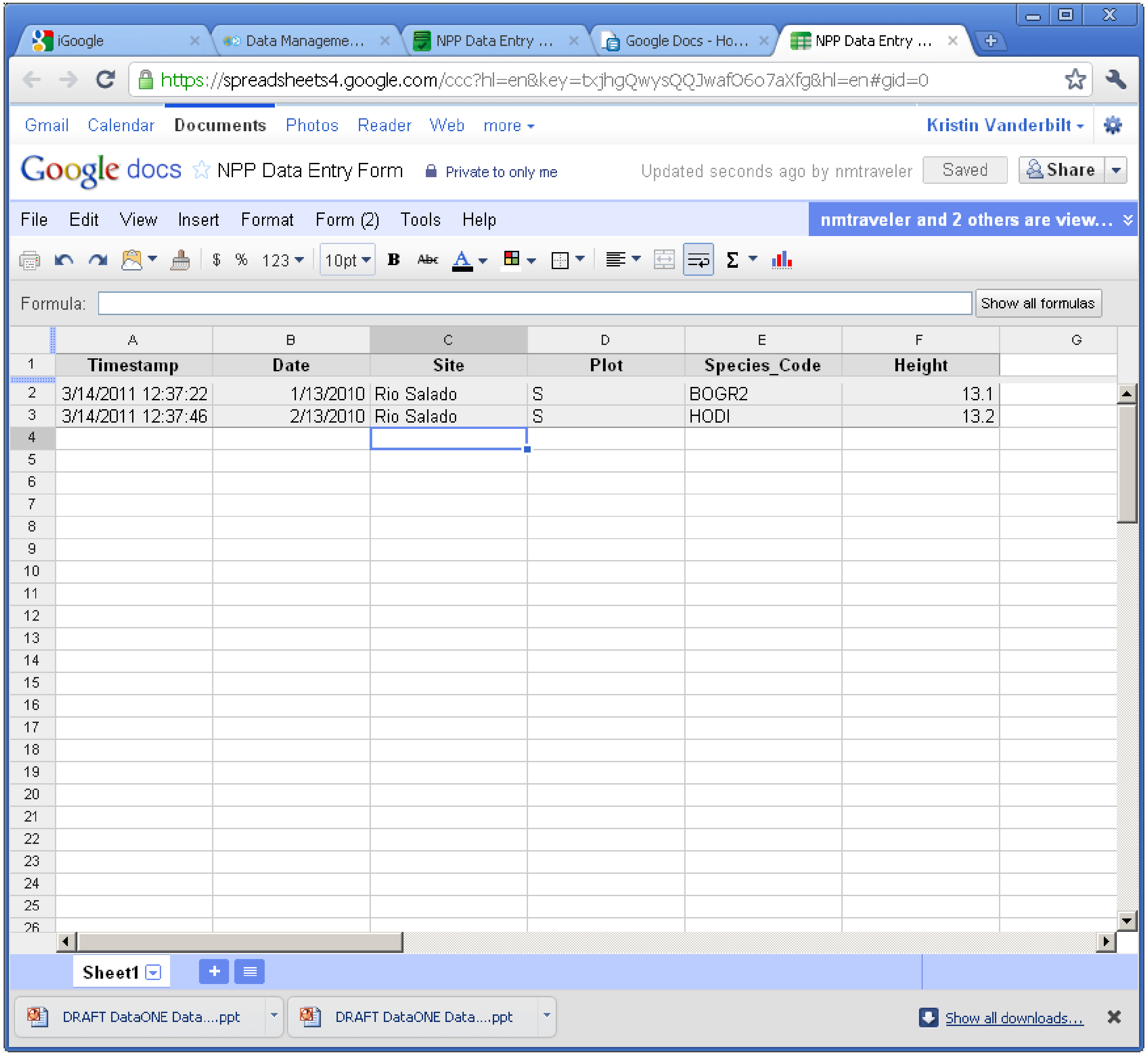
Click to add option

☑ Make this a required question

Plot *
Enter the Plot Designation, which will be one of the four cardinal directions

□ N
□ S
□ E
□ W

You can view the published form here: https://spreadsheets3.google.com/viewform?formkey=dHhqaGdRd3lzUVFKd2FmTzZvN2FYZmc6MQ

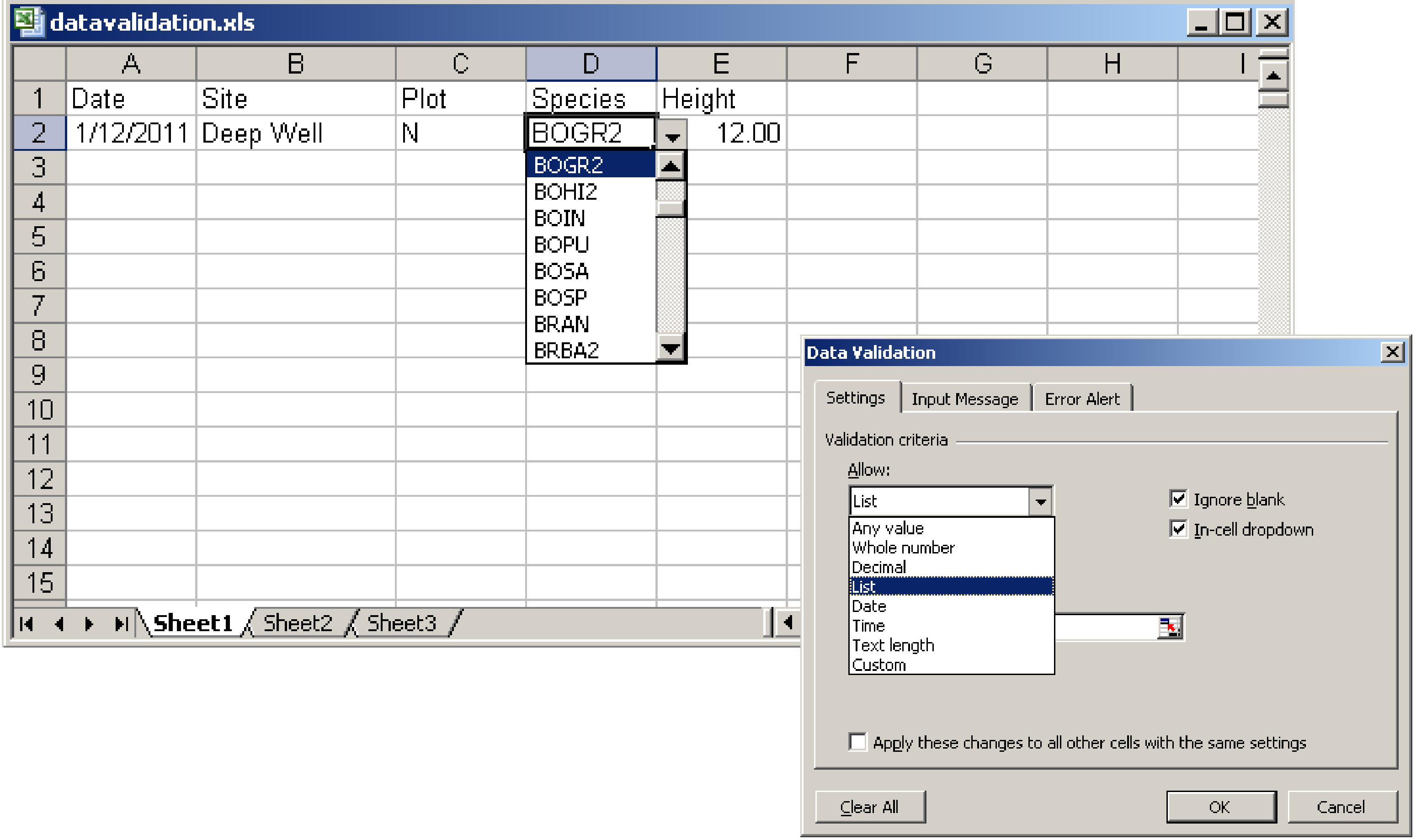


Timestamp	Date	Site	Plot	Species_Code	Height
3/14/2011 12:37:22	1/13/2010	Rio Salado	S	BOGR2	13.1
3/14/2011 12:37:46	2/13/2010	Rio Salado	S	HODI	13.2

Data Entry and Manipulation

DataONE

Data Entry Tools: Excel



datavalidation.xls

	A	B	C	D	E	F	G	H	I
1	Date	Site	Plot	Species	Height				
2	1/12/2011	Deep Well	N	BOGR2	12.00				
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

- BOGR2
- BOHI2
- BOIN
- BOPU
- BOSA
- BOSP
- BRAN
- BRBA2

Sheet1 / Sheet2 / Sheet3

Data Validation

Settings | Input Message | Error Alert

Validation criteria

Allow:

List

- Any value
- Whole number
- Decimal
- List
- Date
- Time
- Text length
- Custom

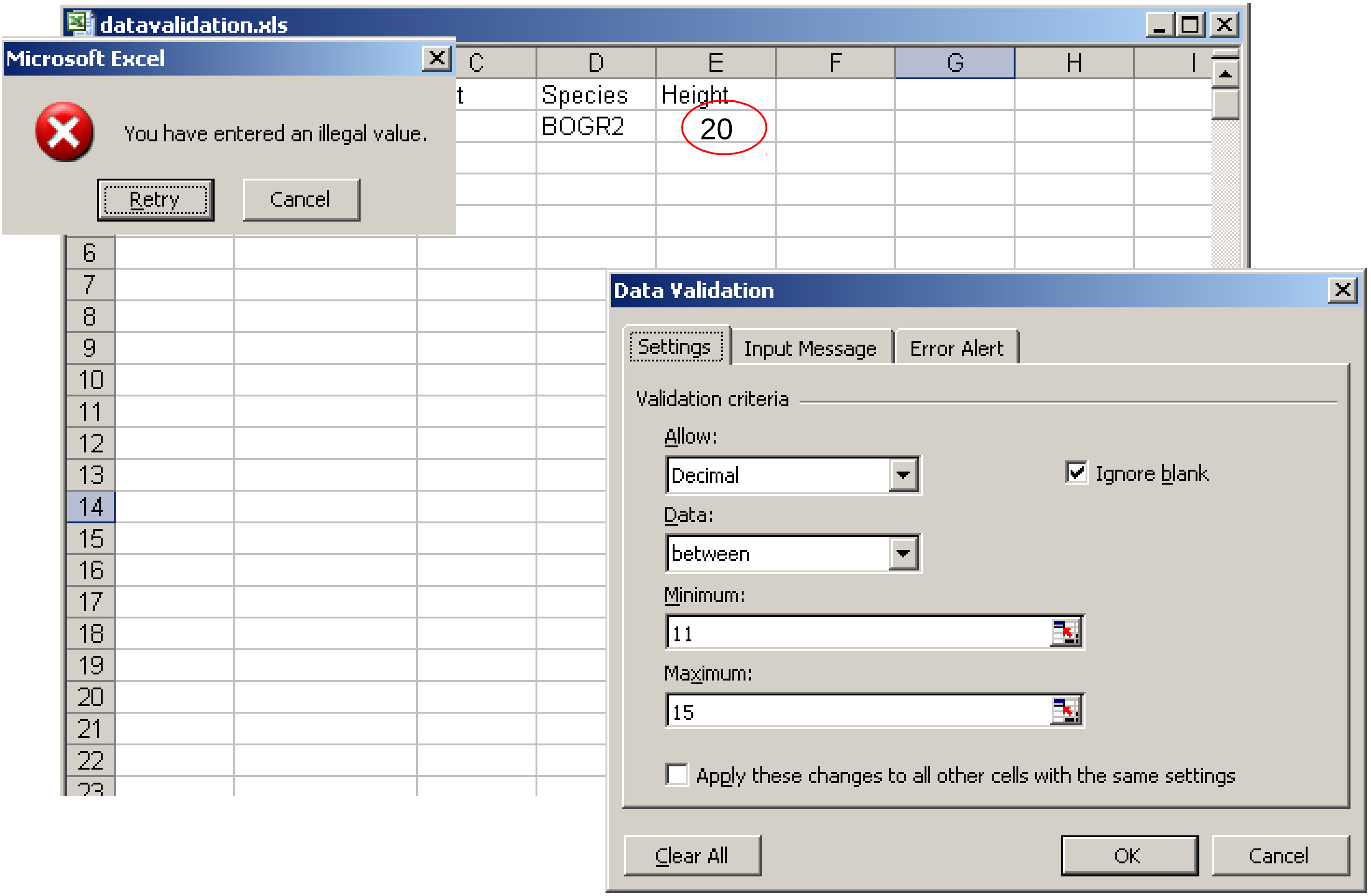
☑ Ignore blank

☑ In-cell dropdown

☐ Apply these changes to all other cells with the same settings

Clear All | OK | Cancel

Excel: Data Validation



Microsoft Excel

You have entered an illegal value.

D	E
Species	Height
BOGR2	20

Data Validation

Validation criteria

Allow: Decimal

Data: between

Minimum: 11

Maximum: 15

☑ Ignore blank

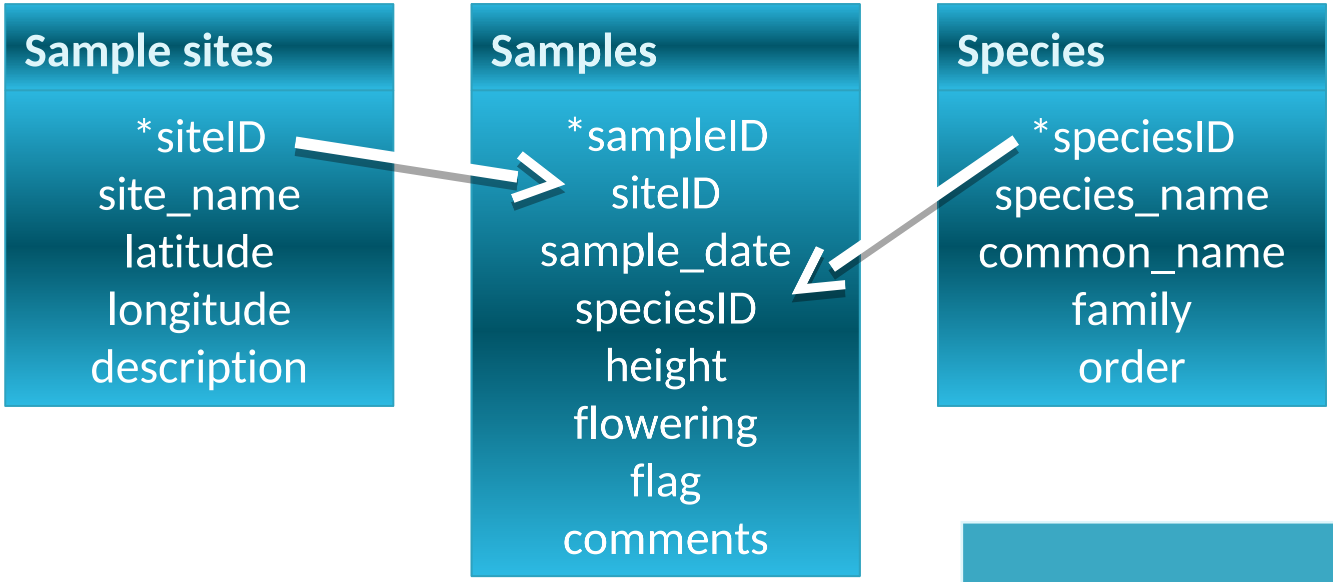
□ Apply these changes to all other cells with the same settings

Spreadsheet vs. Relational Database

- Great for charts, graphs, calculations
- Flexible about cell content type—cells in same column can contain numbers or text
- Lack record integrity--can sort a column independently of all others)
- Easy to use – but harder to maintain as complexity and size of data grows

- Easy to query to select portions of data
- Data fields are typed – For example, only integers are allowed in integer fields
- Columns cannot be sorted independently of each other
- Steeper learning curve than a spreadsheet

What is a relational database?



Sample sites

*siteID
site_name
latitude
longitude
description

Samples

*sampleID
siteID
sample_date
speciesID
height
flowering
flag
comments

Species

*speciesID
species_name
common_name
family
order

- A set of tables
- Relationships
- A command language

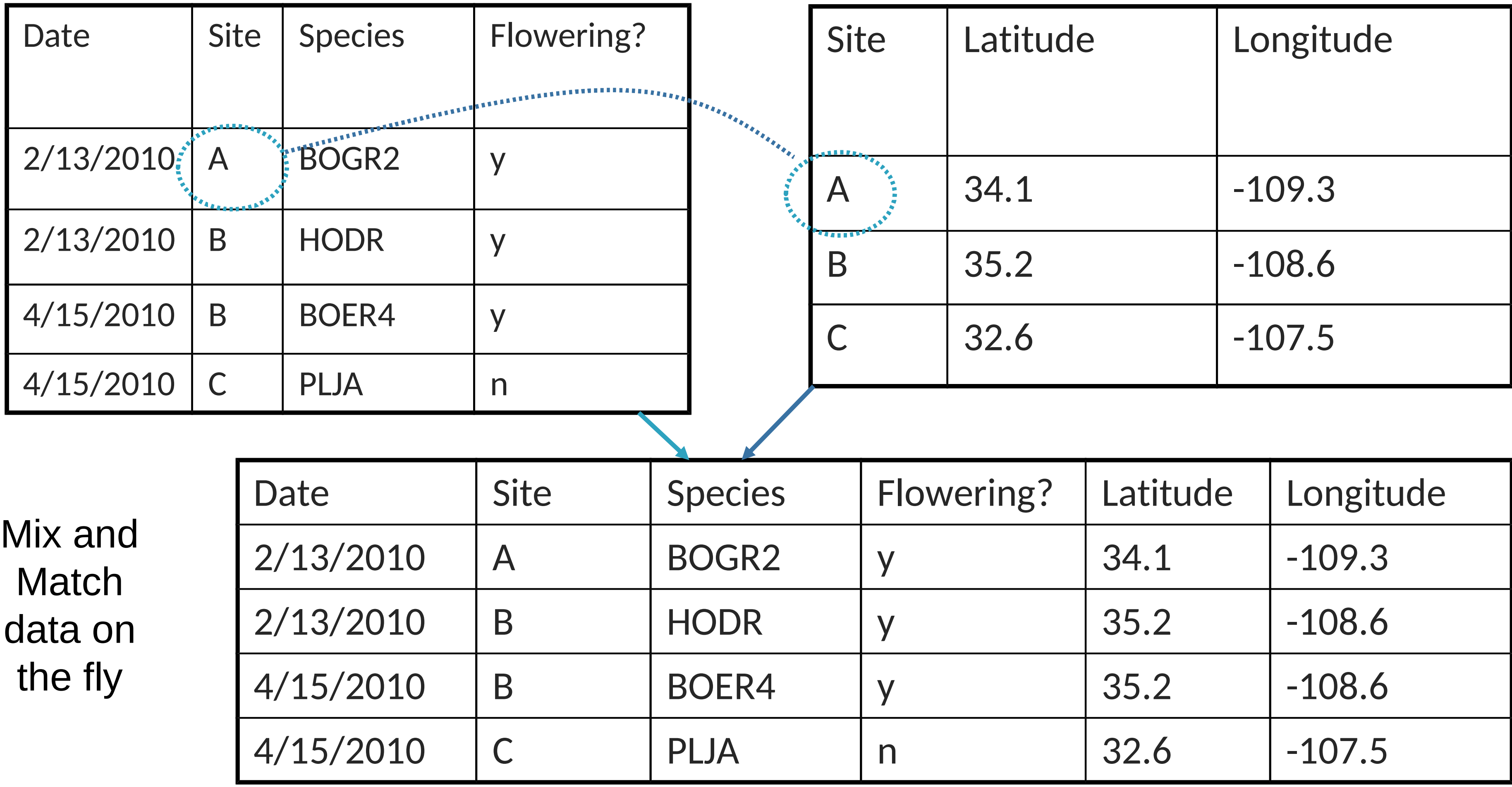
Database Features: Explicit control over data types

Date	Site	Height	Flowering
<dates only>	<text only>	< real numbers only>	< ‘y’ and ‘n’ only>

Advantages

- **quality control**
- **performance**

Relationships are defined between tables



Date	Site	Species	Flowering?
2/13/2010	A	BOGR2	y
2/13/2010	B	HODR	y
4/15/2010	B	BOER4	y
4/15/2010	C	PLJA	n

Site	Latitude	Longitude
A	34.1	-109.3
B	35.2	-108.6
C	32.6	-107.5

Mix and Match data on the fly

Date	Site	Species	Flowering?	Latitude	Longitude
2/13/2010	A	BOGR2	y	34.1	-109.3
2/13/2010	B	HODR	y	35.2	-108.6
4/15/2010	B	BOER4	y	35.2	-108.6
4/15/2010	C	PLJA	n	32.6	-107.5

Powerful Command Language called Structured Query Language (SQL)

This table is called SoilTemp

Date	Plot	Treatment	SensorDepth	Soil_Temperature
2010-02-01	C	R	30	12.8
2010-02-01	B	C	10	13.2
2010-02-02	C	R	0	6.3
2010-02-02	A	N	0	15.1

SQL examples: Select Date, Plot, Treatment, SensorDepth, Soil_Temperature from SoilTemp where Date = ‘2010-02-01’

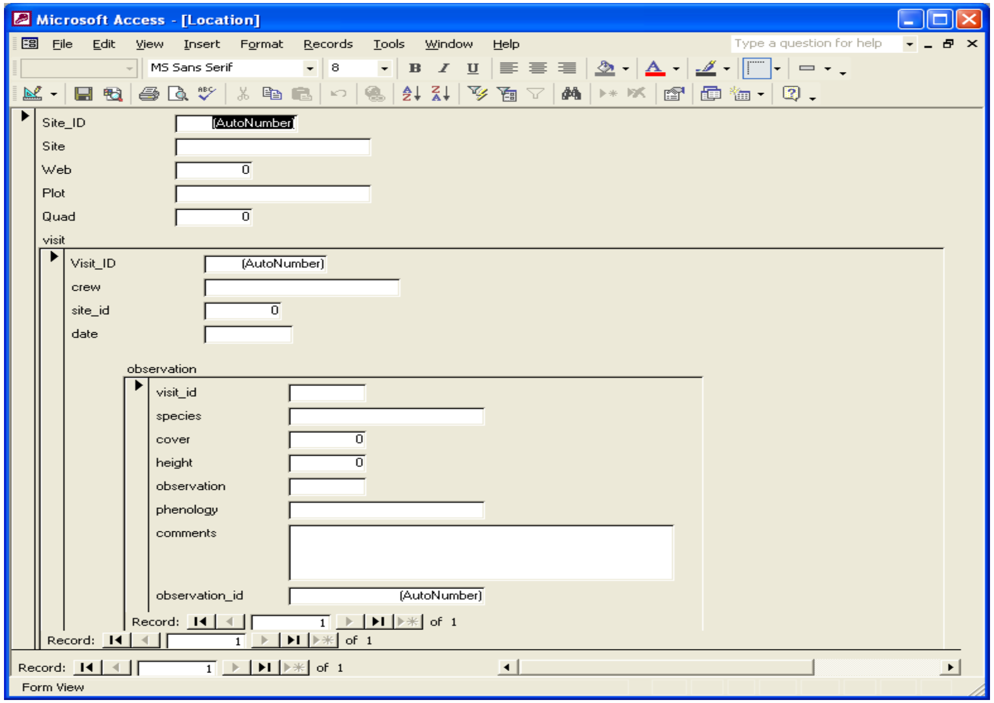
Date	Plot	Treatment	SensorDepth	Soil_Temperature
2010-02-01	C	R	30	12.8
2010-02-01	B	C	10	13.2

Select * from SoilTemp where Treatment=‘N’ and SensorDepth=‘0’

Date	Plot	Treatment	SensorDepth	Soil_Temperature
2010-02-02	A	N	0	15.1

Data Entry with a Database

- Forms can be created that make entering data in to a relational database as easy as entering it in to Excel. The screenshot below shows embedded forms that were quickly generated in MS Access for adding data to three tables in a database of plant cover measurements



Site_ID	(AutoNumber)
Site	
Web	0
Plot	
Quad	0

visit

Visit_ID	(AutoNumber)
crew	
site_id	0
date	

observation

visit_id	
species	
cover	0
height	0
observation	
phenology	
comments	
observation_id	(AutoNumber)

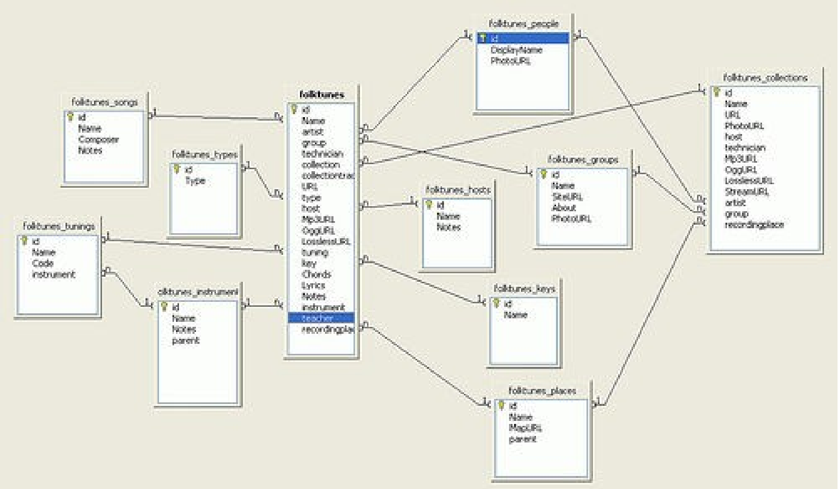
Record: 1 of 1

Record: 1 of 1

Record: 1 of 1

Conclusion

- Be aware of Best Practices when designing data file structures
- Choose a data entry method that allows some validation of data as it is entered
- Consider investing time in learning how to use a database if datasets are large or complex



CC image by fo.ol on Flickr

If you want to try a database:

- Consider trying one of these:
  - Personal, single-user databases can be developed in MS Access, which is stored as a file on the user's computer. MS Access comes with easy GUI tools to create databases, run queries, and write reports.
  - A more robust database that is free, accommodates multiple users and will run on Windows or Linux is MySQL.   GUI interfaces for MySQL include phpMyadmin (free) and Navicat (inexpensive).

To learn more about designing a relational database:

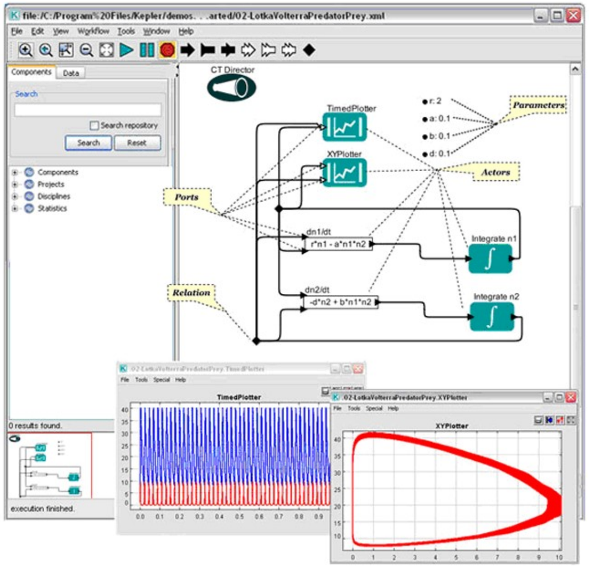
- Database Design for Mere Mortals: A Hands-On Guide to Relational Database Design (2nd Edition) by Michael J. Hernandez. Addison-Wesley. 2003.

Data Manipulation

- Useful for analyzing, subsetting and transforming data
- Can be used to quality assure data
- Options include SAS, SPSS, R, and Matlab
  - Not Free
    - SAS: Has outstanding support
    - SPSS: Has a user-friendly GUI
    - Matlab: Analysis and Visualization platform that has “toolboxes” available for different disciplines, such as modeling or genomic analyses

R

- Free (http://www.r-project.org/index.html)
- Produces publication quality graphics
- Lots of forums from which to get help
- Software (such as Kepler for developing workflows) will integrate analytical components written in R



The full slide deck may be downloaded from:

http://www.dataone.org/education-modules

Suggested citation:

DataONE Education Module: Data Entry and Manipulation. DataONE. Retrieved Nov12, 2012. From http://www.dataone.org/sites/all/documents/L04_DataEntryManipulation.pptx

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