WRRC
WATER RESOURCES RESEARCH CENTER

ARIZONA | COLLEGE OF AGRICULTURE & LIFE SCIENCES

Exploring Environmental Flow Needs and Responses in Arizona:

The Environmental Water Demands Database

Kelly Mott Lacroix
Brittany Choate Xiu
Dr. Sharon B. Megdal

August 21, 2013

Water for the Environment in Arizona?!

You may think of this….

But really we are talking about this….

And this….

And this….

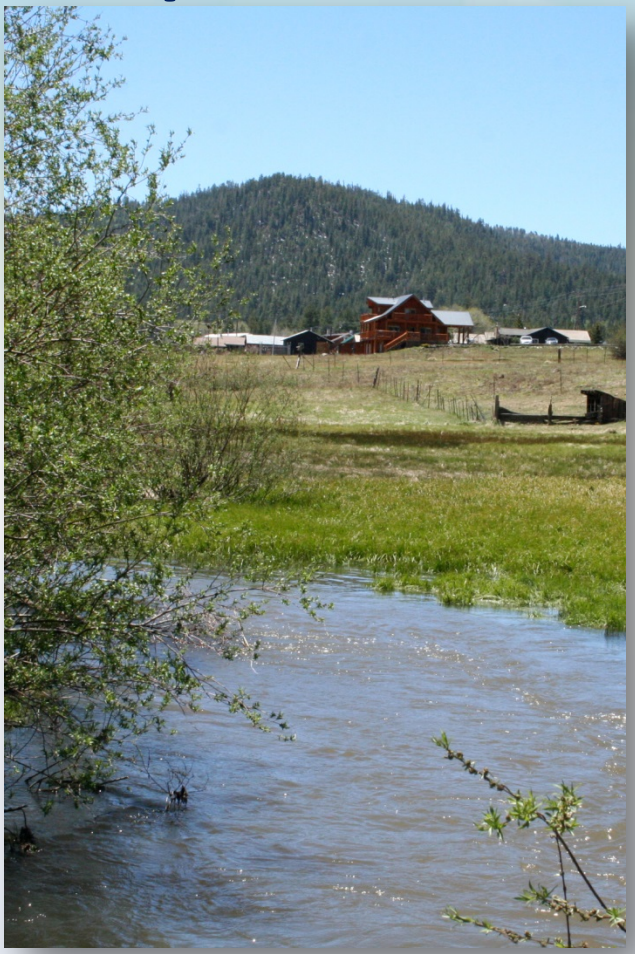
And this….

And this….

But there isn’t much water there…

Connecting the Environment to Arizona Water Planning (EnWaP)

1. **Provide information** on environmental water demands
2. **Offer technical support** to communities for incorporating the environment into their management and planning
3. **Create a stakeholder driven "Roadmap"** for considering the environment in AZ water planning and management



Little Colorado River at Greer
Photo Credit: Kelly Mott Lacroix

OK But What *IS* Environmental Water Demand?

Many words…similar ideas

- Ecological flow requirements
- Environmental flow or level needs
- Instream flow requirements
- Environmental water demand

Bill Williams River
Photo Credit: Kelly Mott Lacroix

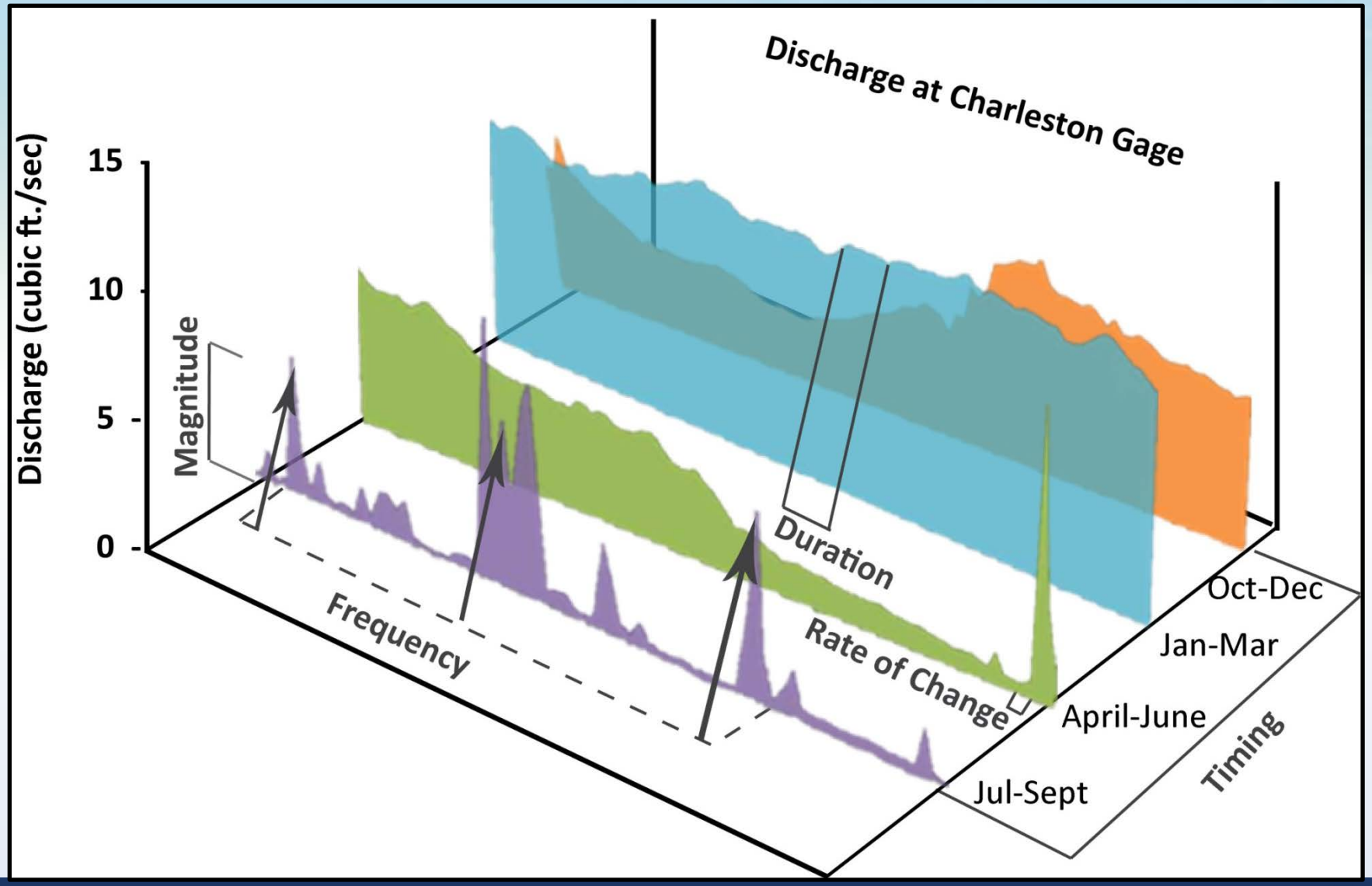
Environmental Water Demand

The amount of water needed in a watercourse to sustain a healthy ecosystem

- Magnitude (how much)
- Frequency (how often)
- Duration (how long)
- Timing (how predictable)
- Rate of Change (how variable)

- Includes priority setting by the community as well

Environmental Water Demands



Examining Environmental Flows

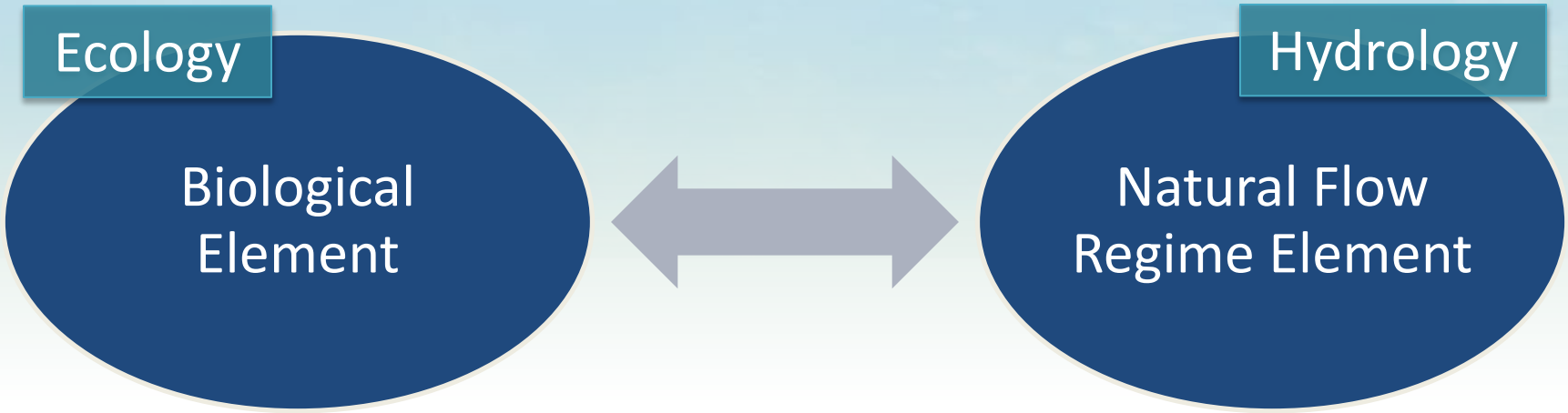
- **Arizona Environmental Water Needs Assessment**
  - 2010, 92 studies
  - Gray and published literature identified by advisory committee
- **Environmental Water Demands Database**
  - 111 studies in database
  - Updated through July 2013

Environmental Water Demands Database

- Contains information on
  - Author/Year
  - Study location
  - Taxa
  - Species or functional group
  - Method(s) used
  - Flow needs/flow responses
    - Qualitative data
    - Quantitative data

San Pedro River Valley.
Photo Credit: SPRV.org

Database Methodology – Flow Needs and Responses



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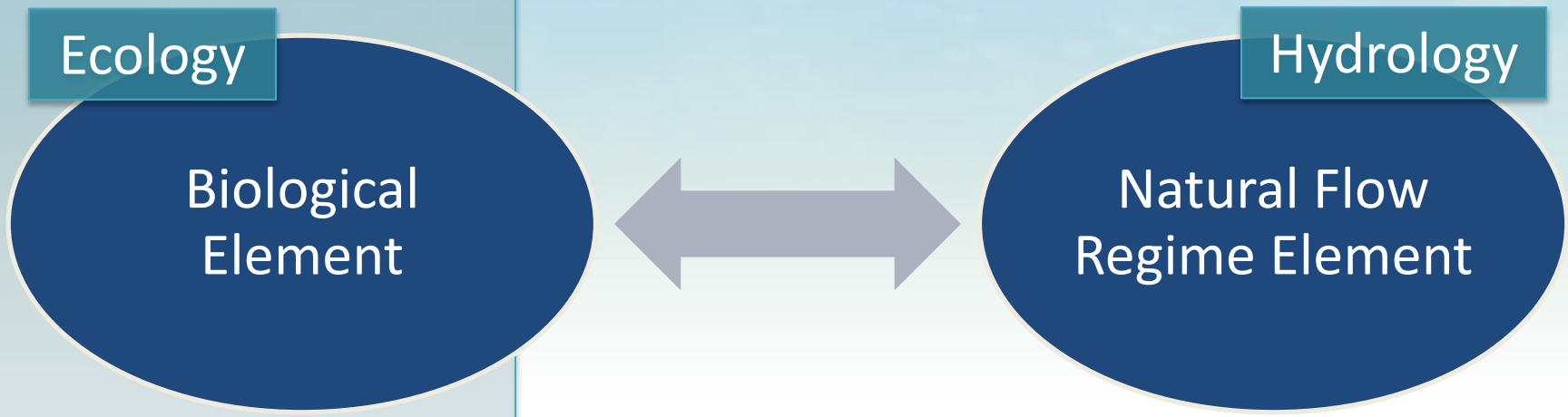
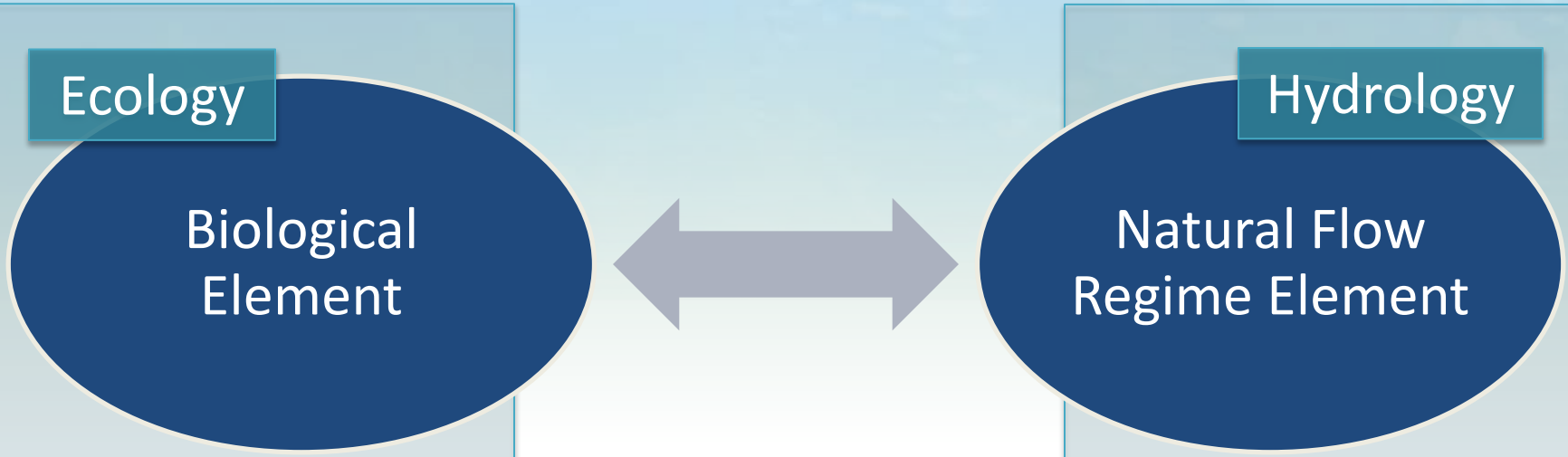


- Abundance
- Age structure
- Composition
- Diversity
- Health
- Survivorship
- Reproduction

Database Methodology – Flow Needs and Responses



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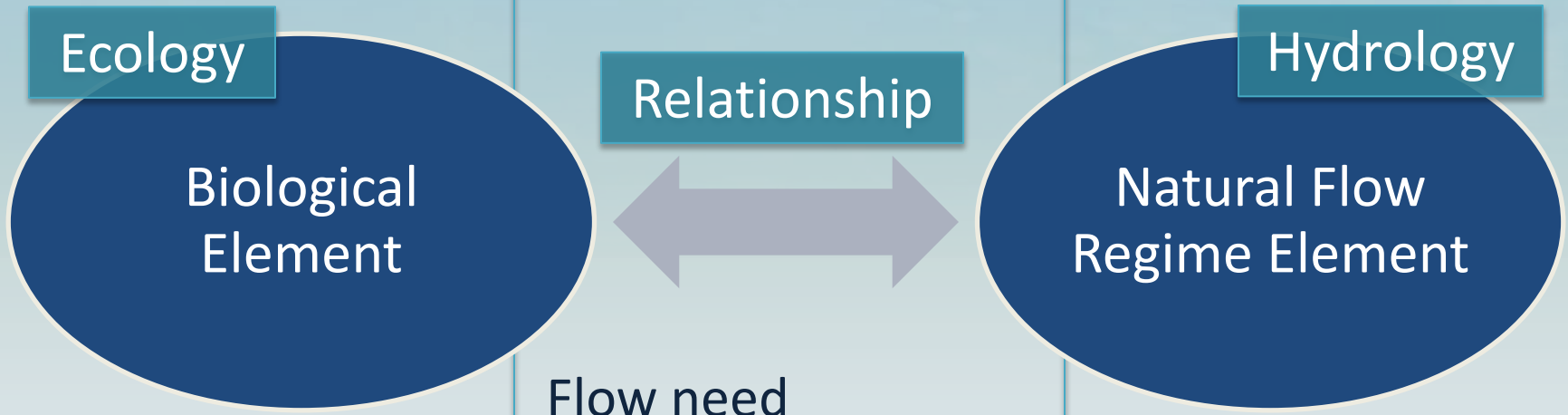

- Abundance
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- Diversity
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- Reproduction

Flow need
- Depends upon
- Does not depend on
- Uses
- Associated with

Flow response
- Influenced
- Enhanced
- Harmed

- Magnitude
- Frequency
- Duration
- Timing
- Rate of Change

Quantified Flow Needs and Levels Keywords

Biological - Health

- Biomass
- Growth rate
- Vigor
- Plant growth
- Stem density
- Basal area

Hydrological - Rate of Change

- Rate of groundwater depth decline
- Flood intensity
- Surface flow permanence
- Variability of depth to groundwater

Environmental Water Demands Database Tour…

Microsoft Access

File | Home | Create | External Data | Database Tools | Acrobat

View | Paste | Cut | Copy | Format Painter | Filter | Ascending | Descending | Remove Sort | Selection | Advanced | Toggle Filter | Refresh All | New | Save | Delete | Totals | Spelling | More | Find | Replace | Go To | Select | Size to Fit Form | Switch Windows | Text Formatting

All Access Objects

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- 9_species_key
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- GDB_Items_Shape_Index
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- stream_segments_Shape_Index

Queries

- Simple_Quant_Query

Forms

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Connecting the Environment to Arizona Water Planning (EnWaP) Database

A database of available information and studies on environmental flow needs and flow responses for Arizona. This version contains studies through July 2013.

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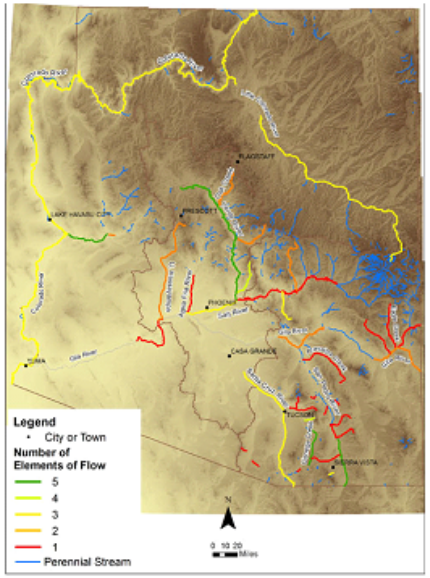
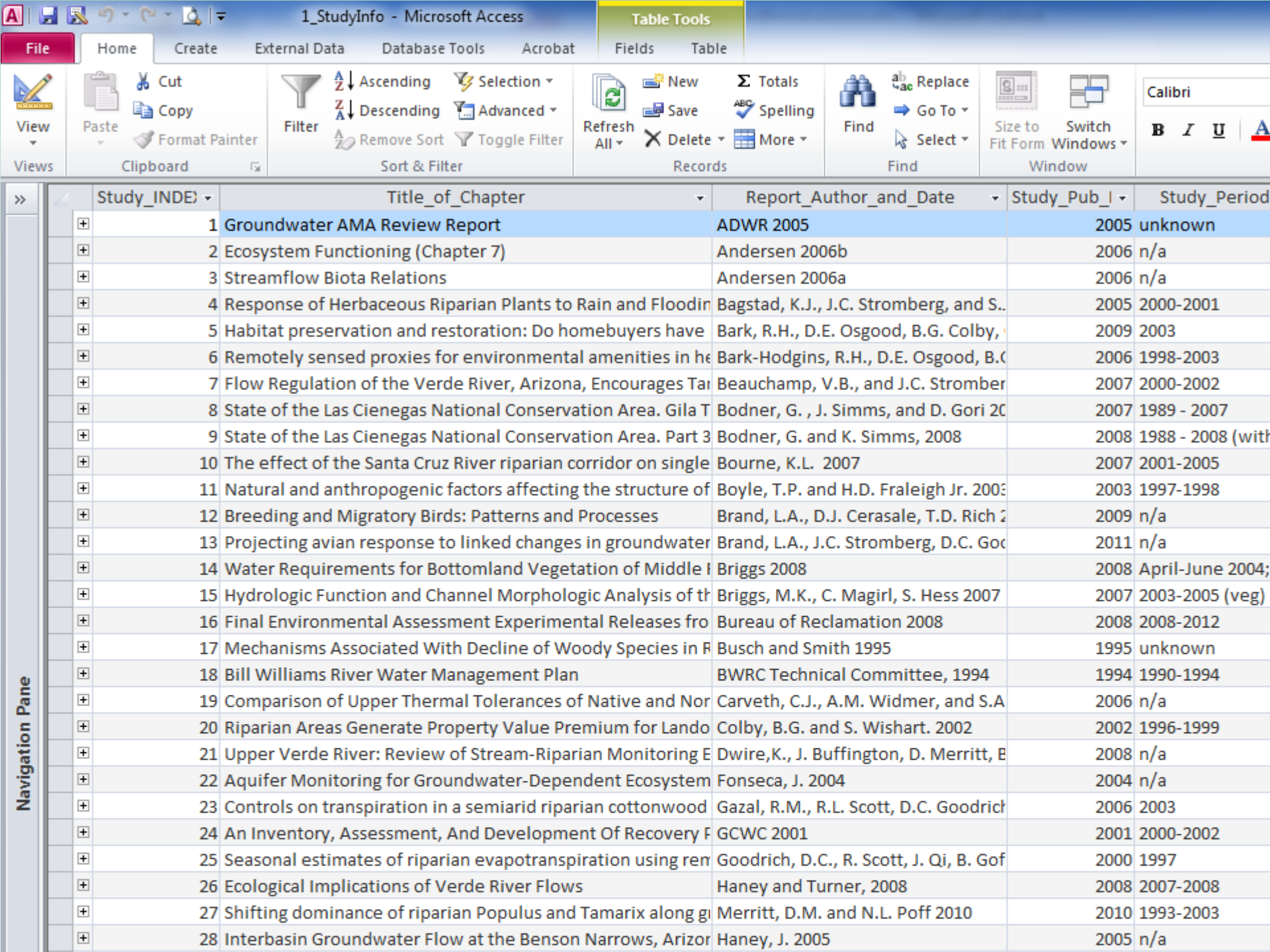
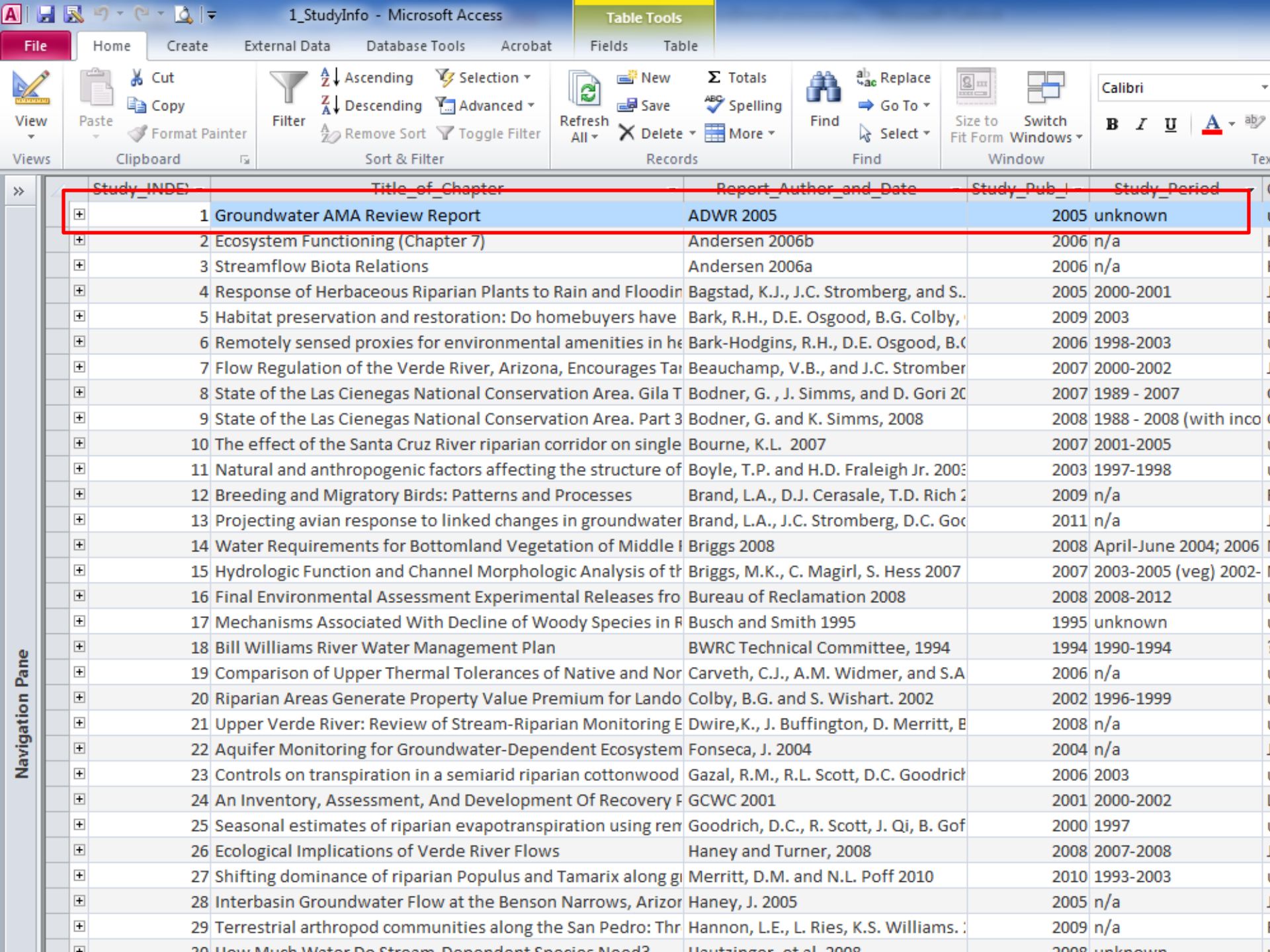


This database is a work in progress! Both the structure and content will be periodically updated. We would like to maintian a list of those using the database so that we can provide you with updates. We also welcome suggestions for format, additional studies and corrections to the data contained within. To recieve updates, provide feedback or ask questions please contact Kelly Mott Lacroix (klacroix@cals.arizona.edu) at the Water Resources Research Center so we can add your name to our list. If you did not recieve detailed metadata describing the tables and table content with this database contact Kelly and she will provide it to you.

Close



Study_INDE	Title_of_Chapter	Report_Author_and_Date	Study_Pub_I	Study_Period
1	Groundwater AMA Review Report	ADWR 2005	2005	unknown
2	Ecosystem Functioning (Chapter 7)	Andersen 2006b	2006	n/a
3	Streamflow Biota Relations	Andersen 2006a	2006	n/a
4	Response of Herbaceous Riparian Plants to Rain and Floodin	Bagstad, K.J., J.C. Stromberg, and S..	2005	2000-2001
5	Habitat preservation and restoration: Do homebuyers have	Bark, R.H., D.E. Osgood, B.G. Colby,	2009	2003
6	Remotely sensed proxies for environmental amenities in he	Bark-Hodgins, R.H., D.E. Osgood, B.(	2006	1998-2003
7	Flow Regulation of the Verde River, Arizona, Encourages Tar	Beauchamp, V.B., and J.C. Stromber	2007	2000-2002
8	State of the Las Cienegas National Conservation Area. Gila T	Bodner, G. , J. Simms, and D. Gori 20	2007	1989 - 2007
9	State of the Las Cienegas National Conservation Area. Part 3	Bodner, G. and K. Simms, 2008	2008	1988 - 2008 (with
10	The effect of the Santa Cruz River riparian corridor on single	Bourne, K.L. 2007	2007	2001-2005
11	Natural and anthropogenic factors affecting the structure of	Boyle, T.P. and H.D. Fraleigh Jr. 2003	2003	1997-1998
12	Breeding and Migratory Birds: Patterns and Processes	Brand, L.A., D.J. Cerasale, T.D. Rich 2	2009	n/a
13	Projecting avian response to linked changes in groundwater	Brand, L.A., J.C. Stromberg, D.C. Goo	2011	n/a
14	Water Requirements for Bottomland Vegetation of Middle F	Briggs 2008	2008	April-June 2004;
15	Hydrologic Function and Channel Morphologic Analysis of th	Briggs, M.K., C. Magirl, S. Hess 2007	2007	2003-2005 (veg)
16	Final Environmental Assessment Experimental Releases fro	Bureau of Reclamation 2008	2008	2008-2012
17	Mechanisms Associated With Decline of Woody Species in R	Busch and Smith 1995	1995	unknown
18	Bill Williams River Water Management Plan	BWRC Technical Committee, 1994	1994	1990-1994
19	Comparison of Upper Thermal Tolerances of Native and Nor	Carveth, C.J., A.M. Widmer, and S.A	2006	n/a
20	Riparian Areas Generate Property Value Premium for Lando	Colby, B.G. and S. Wishart. 2002	2002	1996-1999
21	Upper Verde River: Review of Stream-Riparian Monitoring E	Dwire,K., J. Buffington, D. Merritt, E	2008	n/a
22	Aquifer Monitoring for Groundwater-Dependent Ecosystem	Fonseca, J. 2004	2004	n/a
23	Controls on transpiration in a semiarid riparian cottonwood	Gazal, R.M., R.L. Scott, D.C. Goodrich	2006	2003
24	An Inventory, Assessment, And Development Of Recovery P	GCWC 2001	2001	2000-2002
25	Seasonal estimates of riparian evapotranspiration using rem	Goodrich, D.C., R. Scott, J. Qi, B. Gof	2000	1997
26	Ecological Implications of Verde River Flows	Haney and Turner, 2008	2008	2007-2008
27	Shifting dominance of riparian Populus and Tamarix along gr	Merritt, D.M. and N.L. Poff 2010	2010	1993-2003
28	Interbasin Groundwater Flow at the Benson Narrows, Arizor	Haney, J. 2005	2005	n/a



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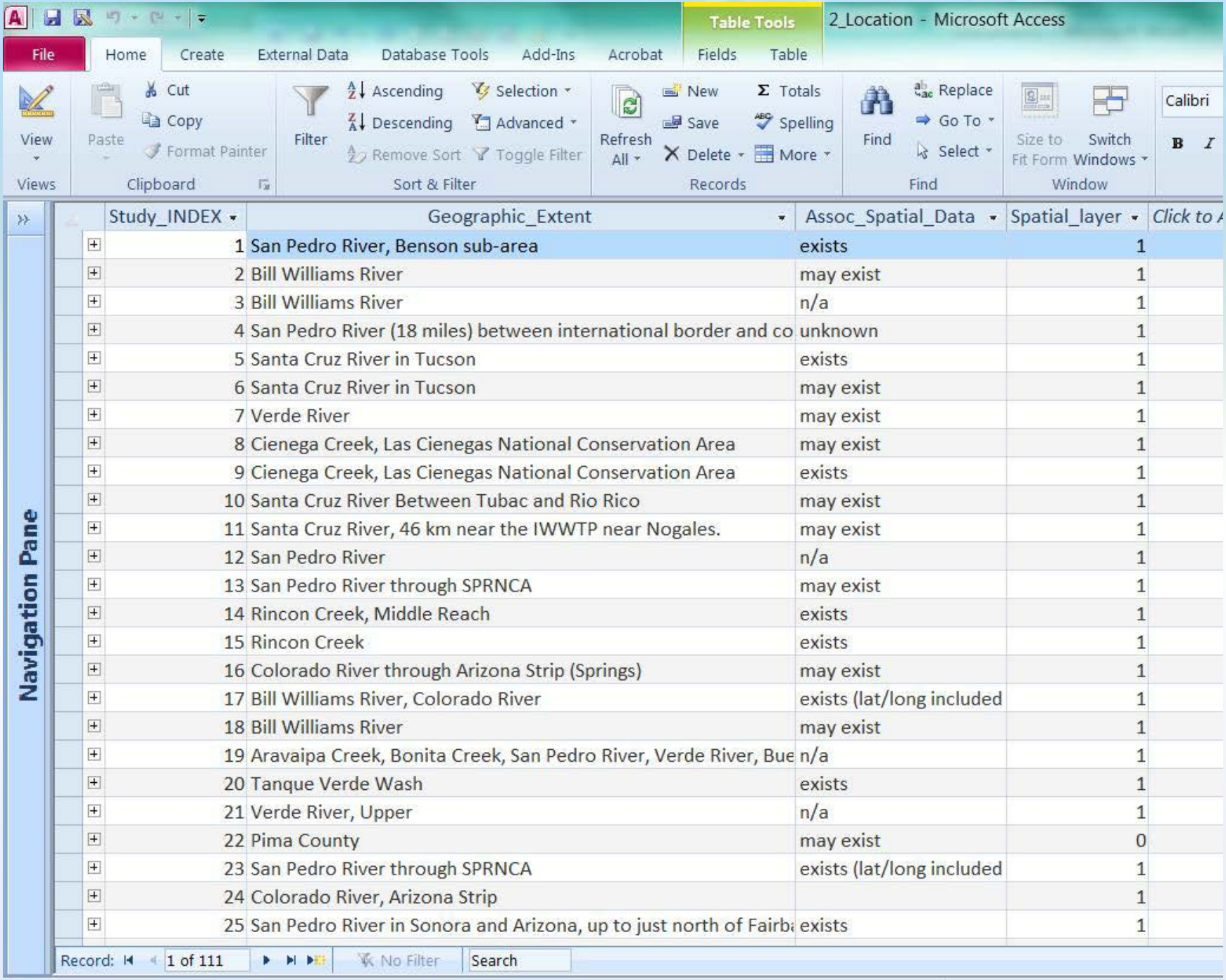
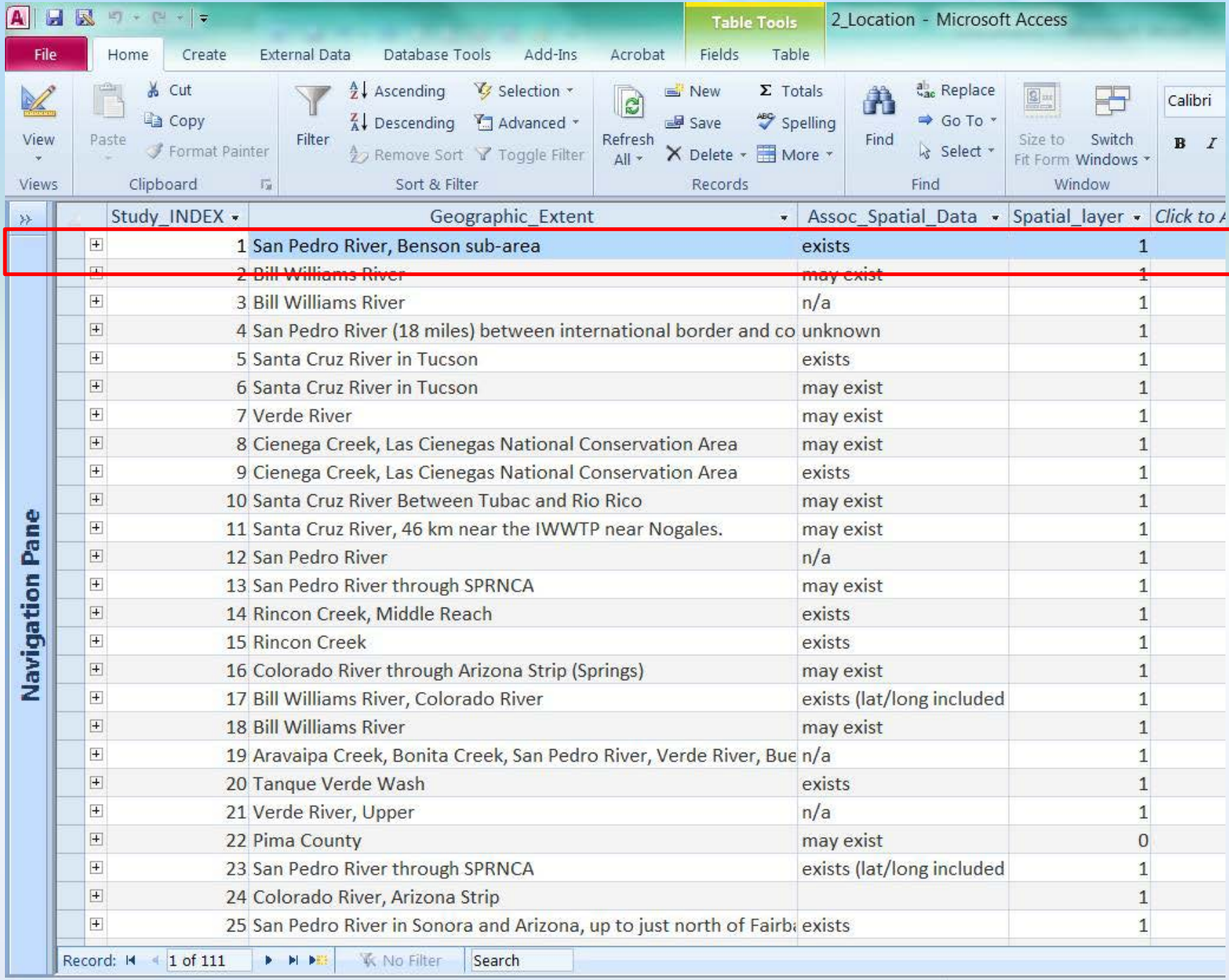
29	Terrestrial arthropod communities along the San Pedro: Thr	Hannon, L.E., L. Ries, K.S. Williams.	2009	n/a



Study_INDEX	Geographic_Extent	Assoc_Spatial_Data	Spatial_layer	Click to A
1	San Pedro River, Benson sub-area	exists	1	
2	Bill Williams River	may exist	1	
3	Bill Williams River	n/a	1	
4	San Pedro River (18 miles) between international border and co	unknown	1	
5	Santa Cruz River in Tucson	exists	1	
6	Santa Cruz River in Tucson	may exist	1	
7	Verde River	may exist	1	
8	Cienega Creek, Las Cienegas National Conservation Area	may exist	1	
9	Cienega Creek, Las Cienegas National Conservation Area	exists	1	
10	Santa Cruz River Between Tubac and Rio Rico	may exist	1	
11	Santa Cruz River, 46 km near the IWWTP near Nogales.	may exist	1	
12	San Pedro River	n/a	1	
13	San Pedro River through SPRNCA	may exist	1	
14	Rincon Creek, Middle Reach	exists	1	
15	Rincon Creek	exists	1	
16	Colorado River through Arizona Strip (Springs)	may exist	1	
17	Bill Williams River, Colorado River	exists (lat/long included	1	
18	Bill Williams River	may exist	1	
19	Aravaipa Creek, Bonita Creek, San Pedro River, Verde River, Bue	n/a	1	
20	Tanque Verde Wash	exists	1	
21	Verde River, Upper	n/a	1	
22	Pima County	may exist	0	
23	San Pedro River through SPRNCA	exists (lat/long included	1	
24	Colorado River, Arizona Strip		1	
25	San Pedro River in Sonora and Arizona, up to just north of Fairb	exists	1	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24 Colorado River, Arizona Strip 1
25 San Pedro River in Sonora and Arizona, up to just north of Fairb exists 1
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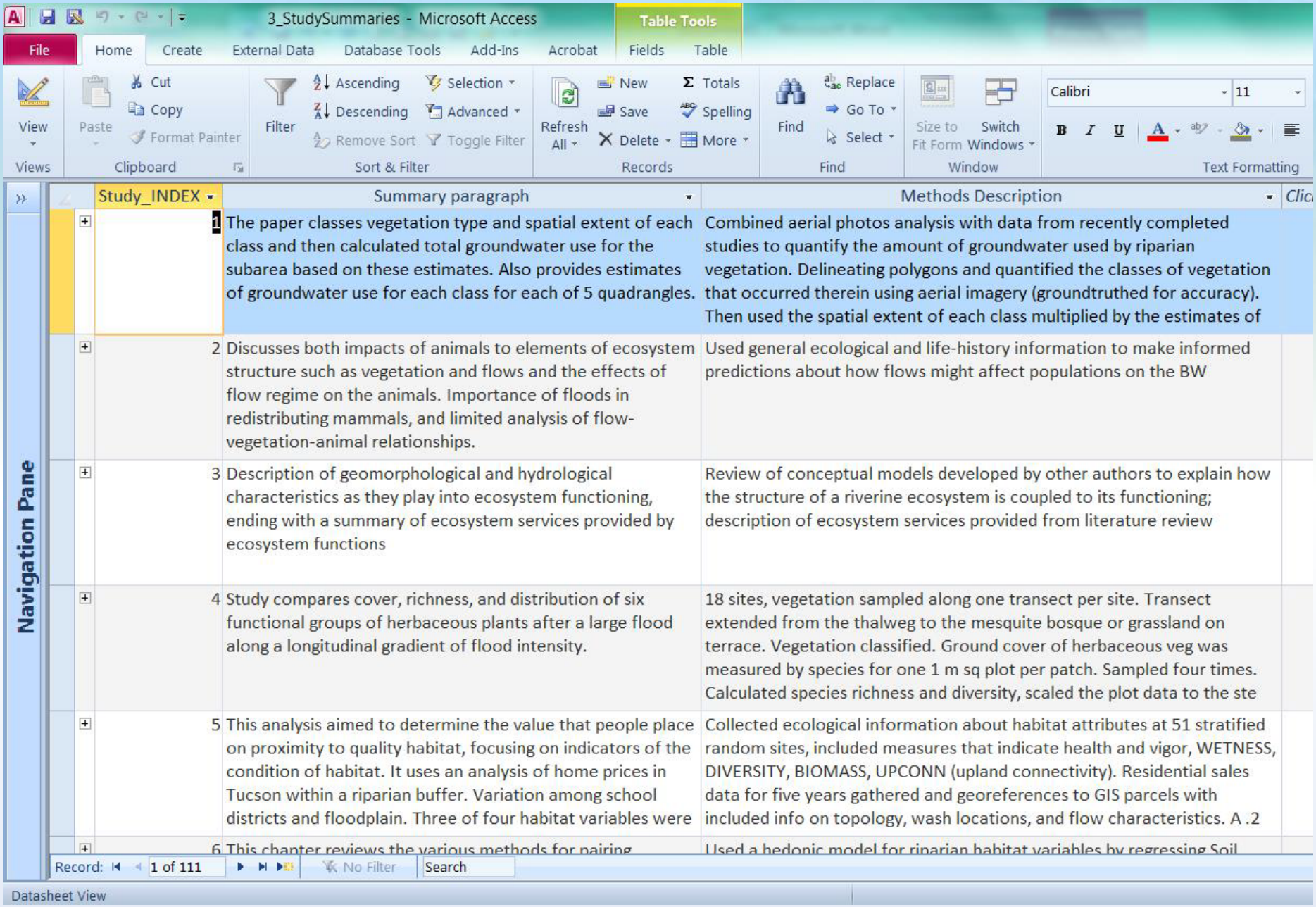
3_StudySummaries - Microsoft Access
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Study_INDEX
Summary paragraph
Methods Description
1 The paper classes vegetation type and spatial extent of each class and then calculated total groundwater use for the subarea based on these estimates. Also provides estimates of groundwater use for each class for each of 5 quadrangles. Combined aerial photos analysis with data from recently completed studies to quantify the amount of groundwater used by riparian vegetation. Delineating polygons and quantified the classes of vegetation that occurred therein using aerial imagery (groundtruthed for accuracy). Then used the spatial extent of each class multiplied by the estimates of
2 Discusses both impacts of animals to elements of ecosystem structure such as vegetation and flows and the effects of flow regime on the animals. Importance of floods in redistributing mammals, and limited analysis of flow-vegetation-animal relationships. Used general ecological and life-history information to make informed predictions about how flows might affect populations on the BW
3 Description of geomorphological and hydrological characteristics as they play into ecosystem functioning, ending with a summary of ecosystem services provided by ecosystem functions Review of conceptual models developed by other authors to explain how the structure of a riverine ecosystem is coupled to its functioning; description of ecosystem services provided from literature review
4 Study compares cover, richness, and distribution of six functional groups of herbaceous plants after a large flood along a longitudinal gradient of flood intensity. 18 sites, vegetation sampled along one transect per site. Transect extended from the thalweg to the mesquite bosque or grassland on terrace. Vegetation classified. Ground cover of herbaceous veg was measured by species for one 1 m sq plot per patch. Sampled four times. Calculated species richness and diversity, scaled the plot data to the ste
5 This analysis aimed to determine the value that people place on proximity to quality habitat, focusing on indicators of the condition of habitat. It uses an analysis of home prices in Tucson within a riparian buffer. Variation among school districts and floodplain. Three of four habitat variables were Collected ecological information about habitat attributes at 51 stratified random sites, included measures that indicate health and vigor, WETNESS, DIVERSITY, BIOMASS, UPCONN (upland connectivity). Residential sales data for five years gathered and georeferences to GIS parcels with included info on topology, wash locations, and flow characteristics. A .2
6 This chapter reviews the various methods for pairing Used a hedonic model for riparian habitat variables by regressing Soil
Record: 1 of 111
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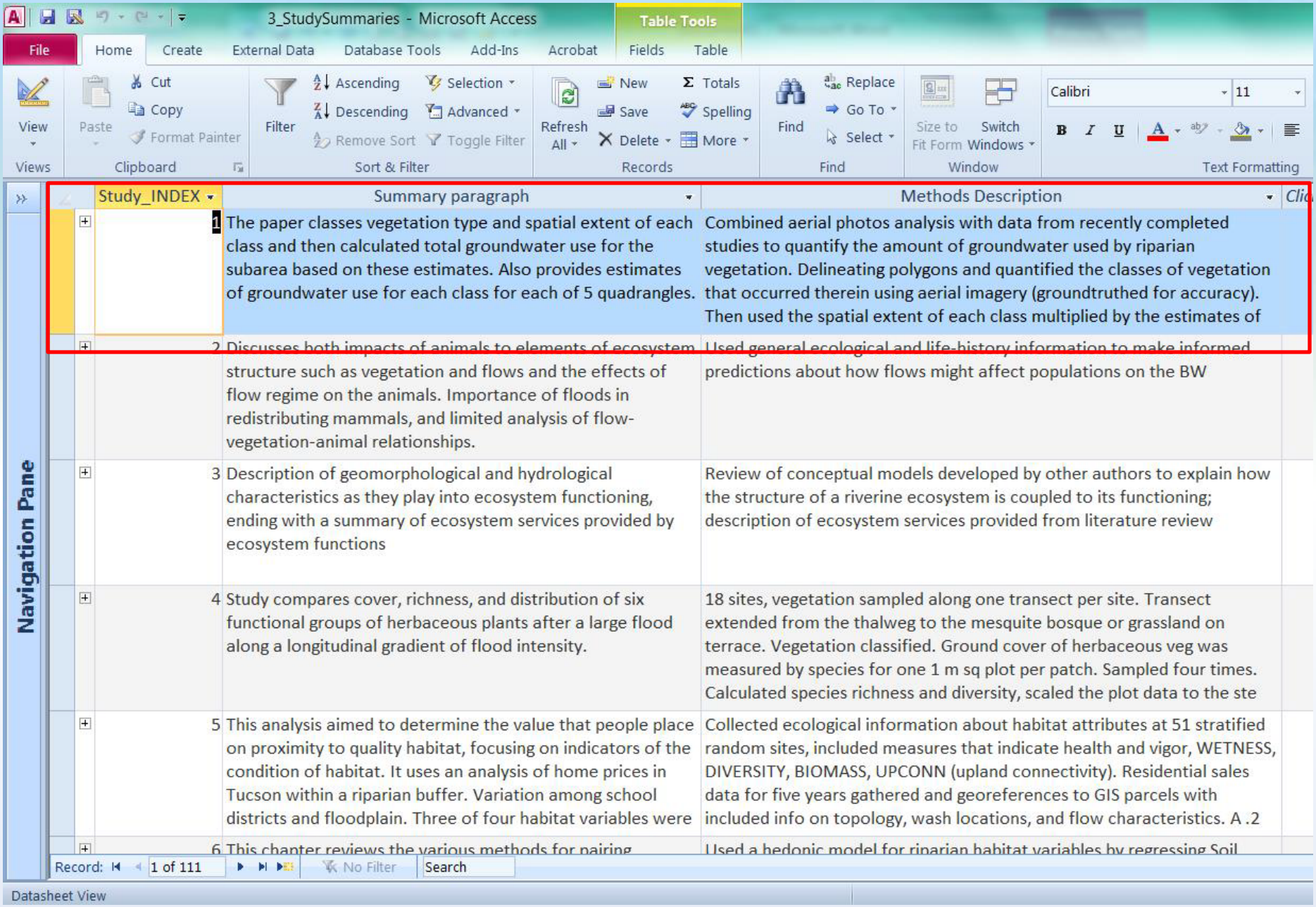
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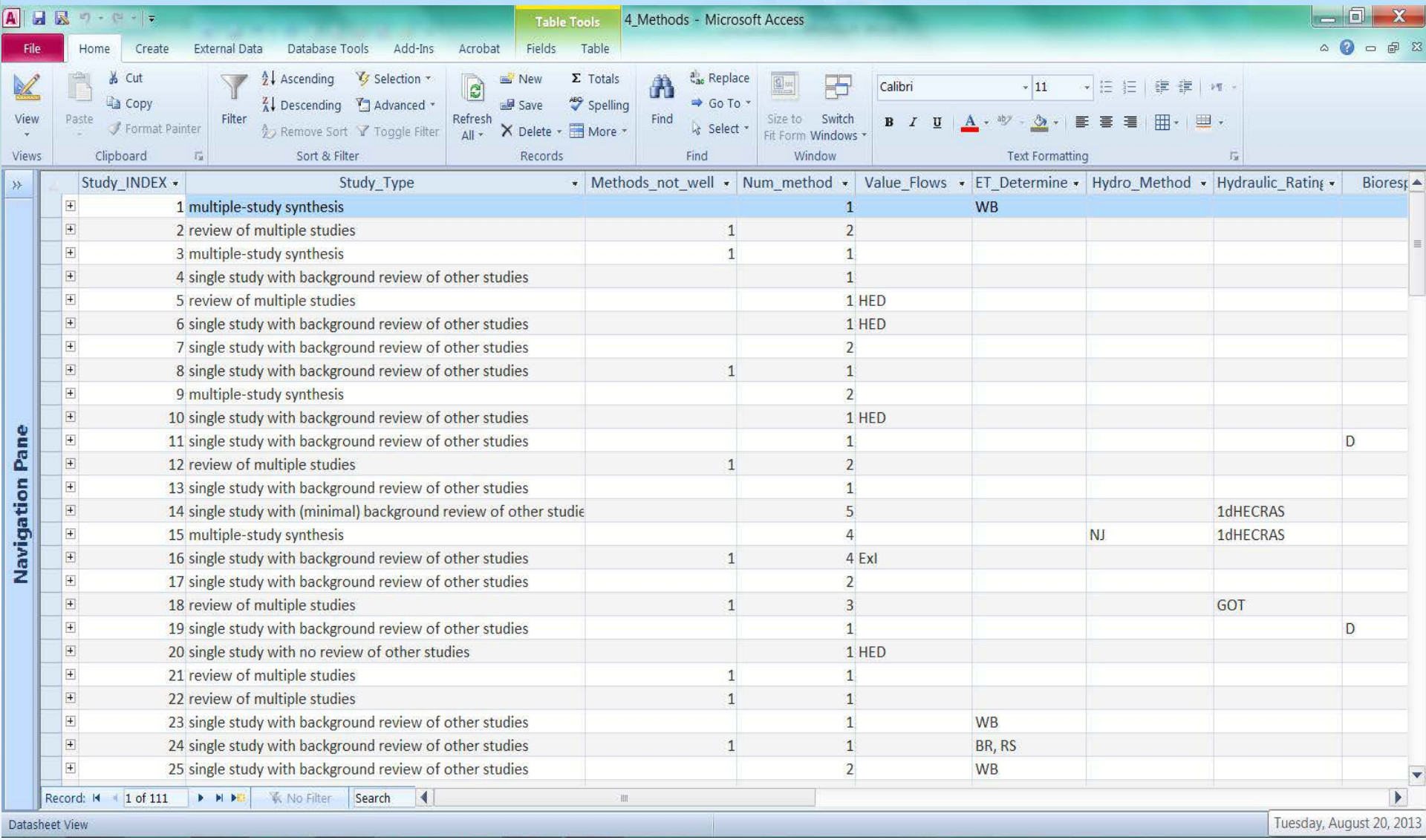
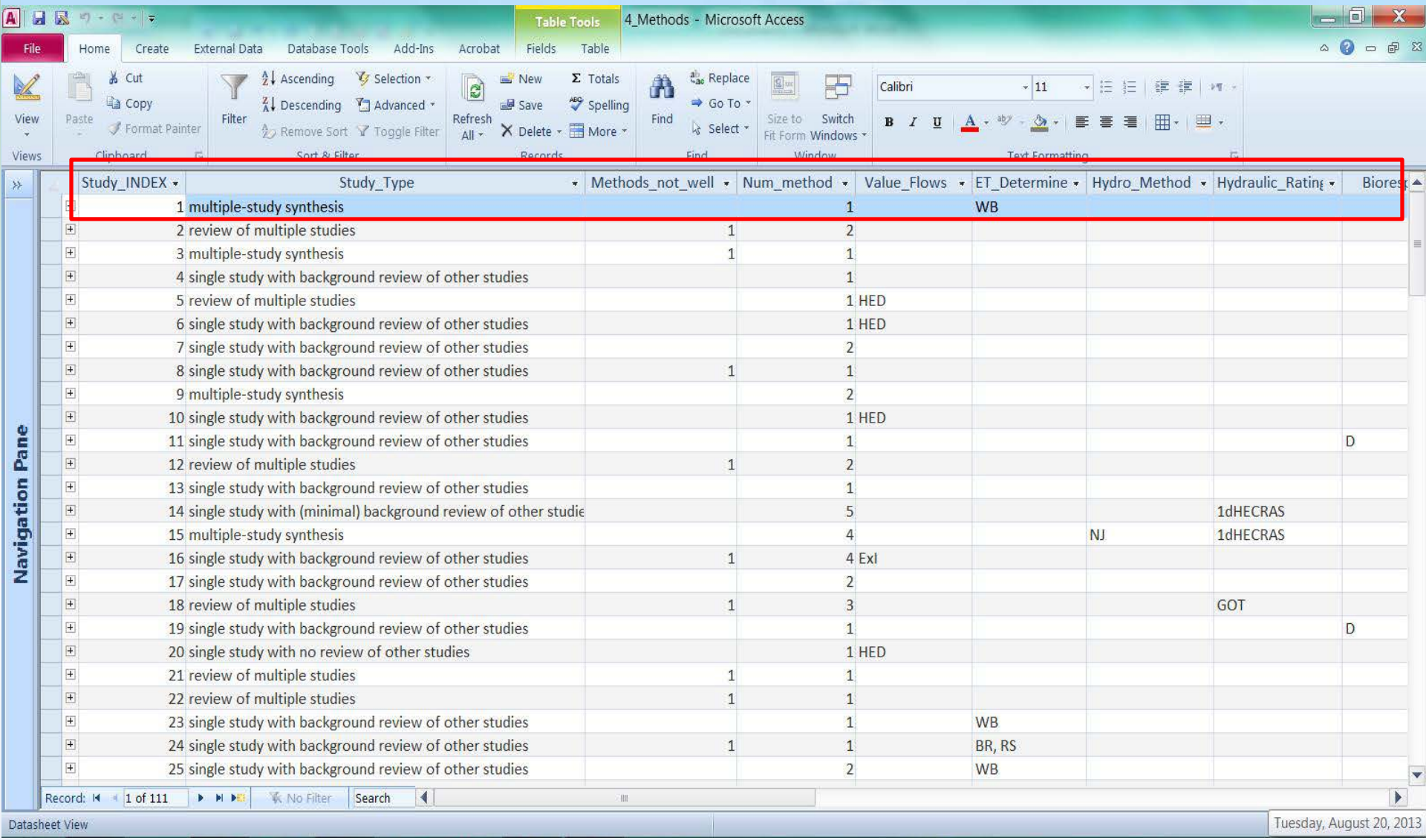


Study_INDEX	Study_Type	Methods_not_well	Num_method	Value_Flows	ET_Determine	Hydro_Method	Hydraulic_Rating	Bioresp
1	multiple-study synthesis		1		WB			
2	review of multiple studies	1	2					
3	multiple-study synthesis	1	1					
4	single study with background review of other studies		1					
5	review of multiple studies		1	HED				
6	single study with background review of other studies		1	HED				
7	single study with background review of other studies		2					
8	single study with background review of other studies	1	1					
9	multiple-study synthesis		2					
10	single study with background review of other studies		1	HED				
11	single study with background review of other studies		1					D
12	review of multiple studies	1	2					
13	single study with background review of other studies		1					
14	single study with (minimal) background review of other studie		5				1dHECRAS	
15	multiple-study synthesis		4			NJ	1dHECRAS	
16	single study with background review of other studies	1	4	ExI				
17	single study with background review of other studies		2					
18	review of multiple studies	1	3				GOT	
19	single study with background review of other studies		1					D
20	single study with no review of other studies		1	HED				
21	review of multiple studies	1	1					
22	review of multiple studies	1	1					
23	single study with background review of other studies		1		WB			
24	single study with background review of other studies	1	1		BR, RS			
25	single study with background review of other studies		2		WB			



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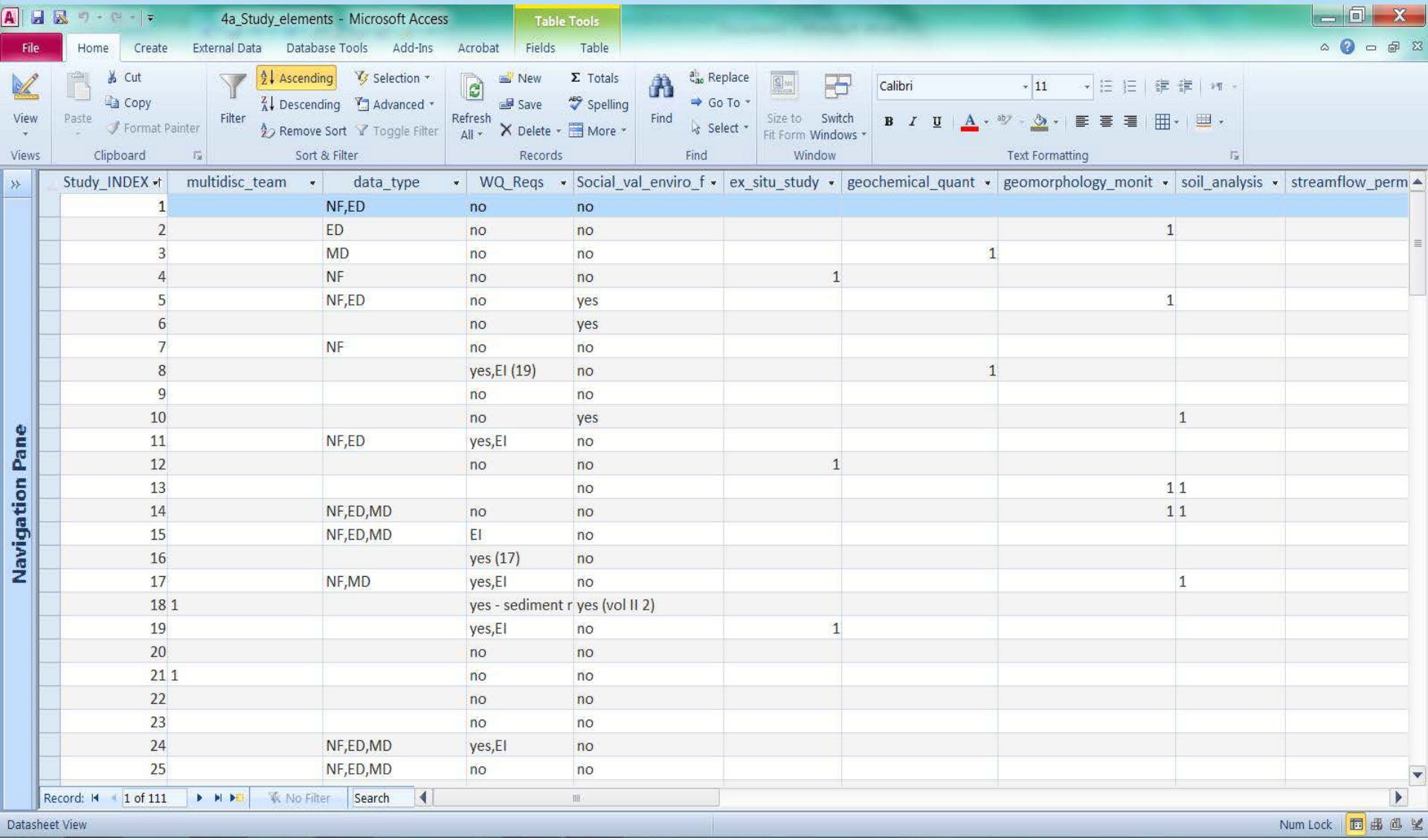
1	multiple-study synthesis		1		WB			
2	review of multiple studies	1	2					
3	multiple-study synthesis	1	1					
4	single study with background review of other studies		1					
5	review of multiple studies		1	HED				
6	single study with background review of other studies		1	HED				
7	single study with background review of other studies		2					
8	single study with background review of other studies	1	1					
9	multiple-study synthesis		2					
10	single study with background review of other studies		1	HED				
11	single study with background review of other studies		1					D
12	review of multiple studies	1	2					
13	single study with background review of other studies		1					
14	single study with (minimal) background review of other studie		5				1dHECRAS	
15	multiple-study synthesis		4			NJ	1dHECRAS	
16	single study with background review of other studies	1	4	ExI				
17	single study with background review of other studies		2					
18	review of multiple studies	1	3				GOT	
19	single study with background review of other studies		1					D
20	single study with no review of other studies		1	HED				
21	review of multiple studies	1	1					
22	review of multiple studies	1	1					
23	single study with background review of other studies		1		WB			
24	single study with background review of other studies	1	1		BR, RS			
25	single study with background review of other studies		2		WB			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Social_val_enviro_f
ex_situ_study
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geomorphology_monit
soil_analysis
streamflow_perm
1 NF,ED no no
2 ED no no 1
3 MD no no 1
4 NF no no 1
5 NF,ED no yes 1
6 no yes
7 NF no no
8 yes,EI (19) no 1
9 no no
10 no yes 1
11 NF,ED yes,EI no
12 no no 1
13 no 1 1
14 NF,ED,MD no no 1 1
15 NF,ED,MD EI no
16 yes (17) no
17 NF,MD yes,EI no 1
18 1 yes - sediment r yes (vol II 2)
19 yes,EI no 1
20 no no
21 1 no no
22 no no
23 no no
24 NF,ED,MD yes,EI no
25 NF,ED,MD no no
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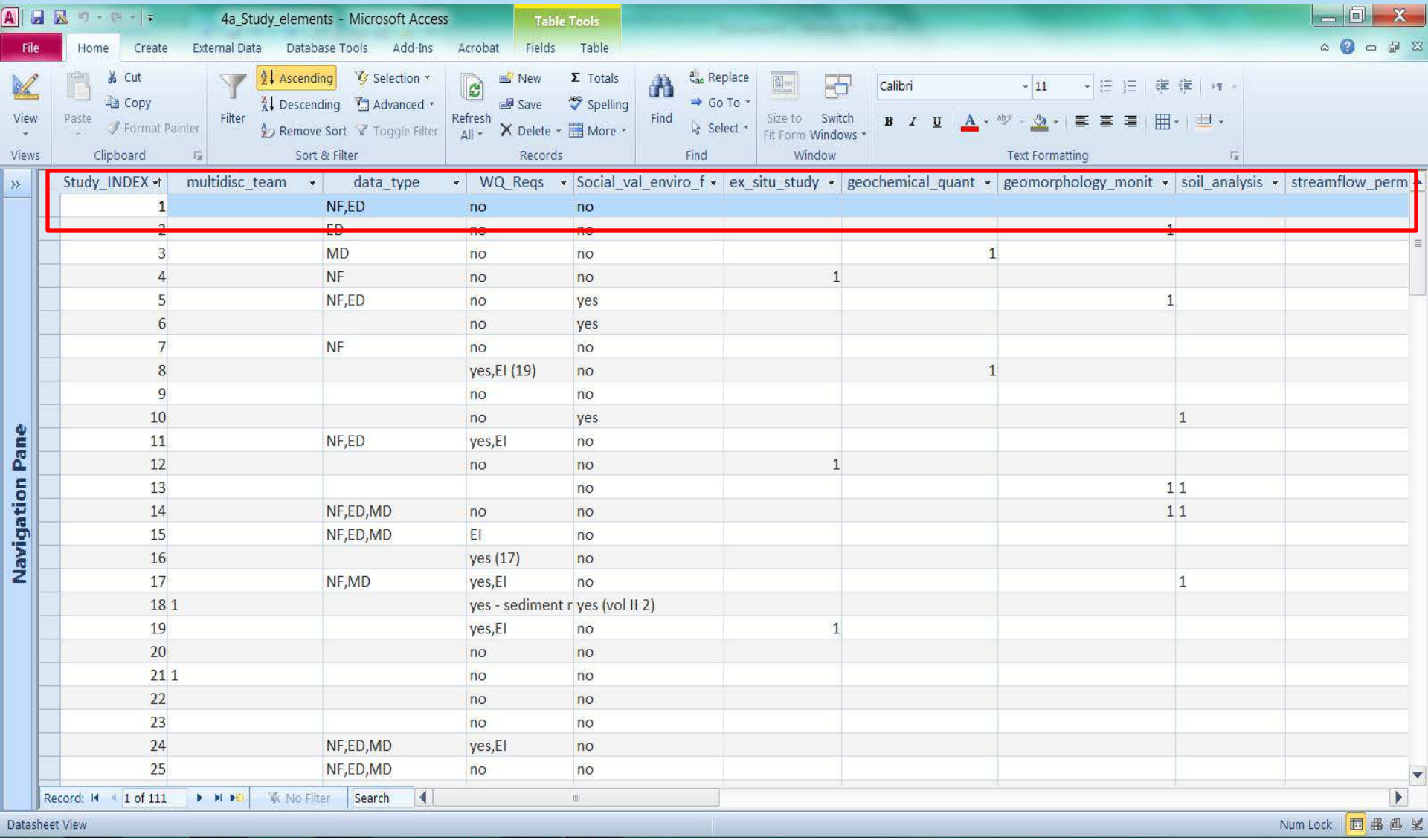
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soil_analysis
streamflow_perm
1 NF,ED no no
2 ED no no 1
3 MD no no 1
4 NF no no 1
5 NF,ED no yes 1
6 no yes
7 NF no no
8 yes,EI (19) no 1
9 no no
10 no yes 1
11 NF,ED yes,EI no
12 no no 1
13 no 1 1
14 NF,ED,MD no no 1 1
15 NF,ED,MD EI no
16 yes (17) no
17 NF,MD yes,EI no 1
18 1 yes - sediment r yes (vol II 2)
19 yes,EI no 1
20 no no
21 1 no no
22 no no
23 no no
24 NF,ED,MD yes,EI no
25 NF,ED,MD no no
Record: 1 of 111
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Search
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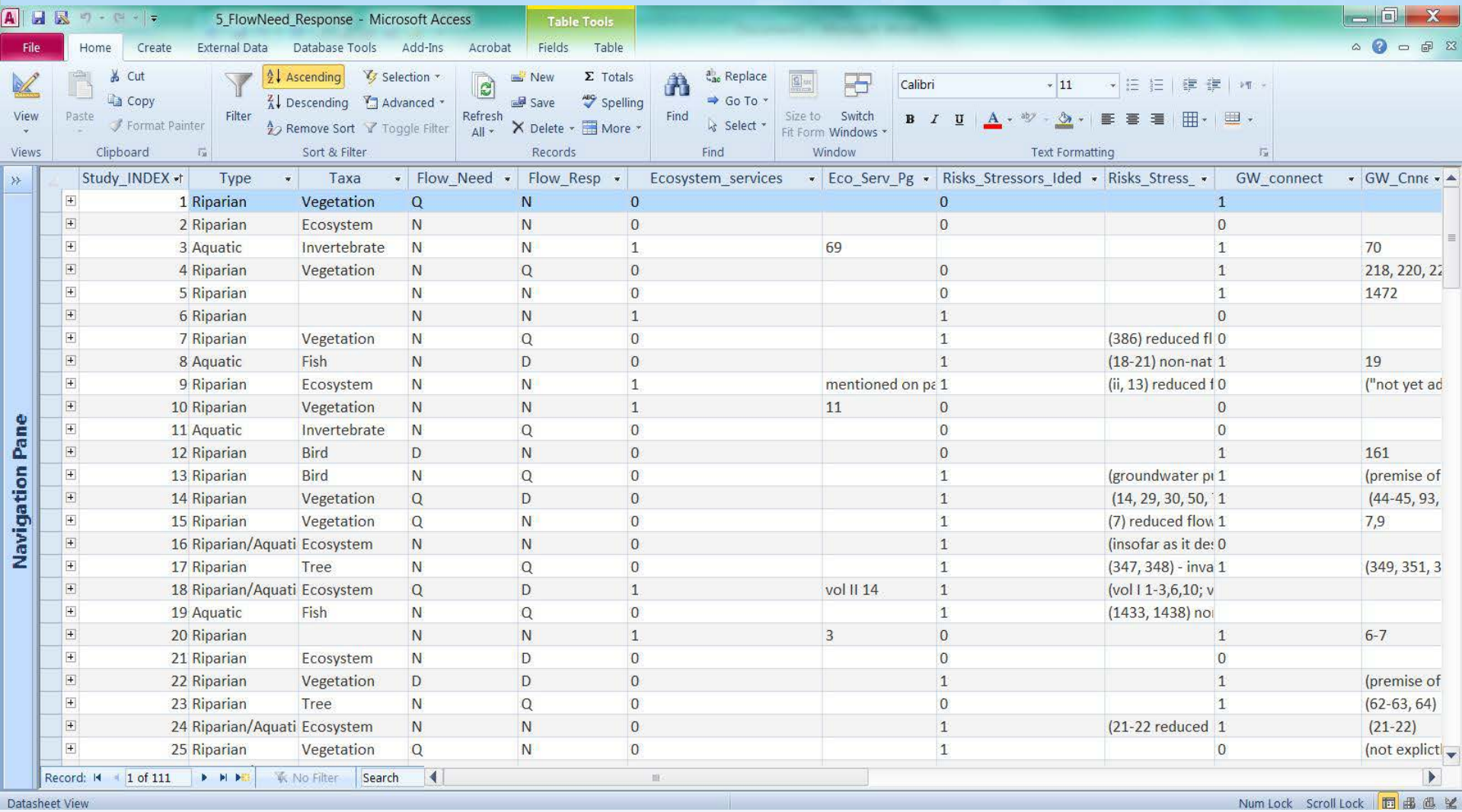
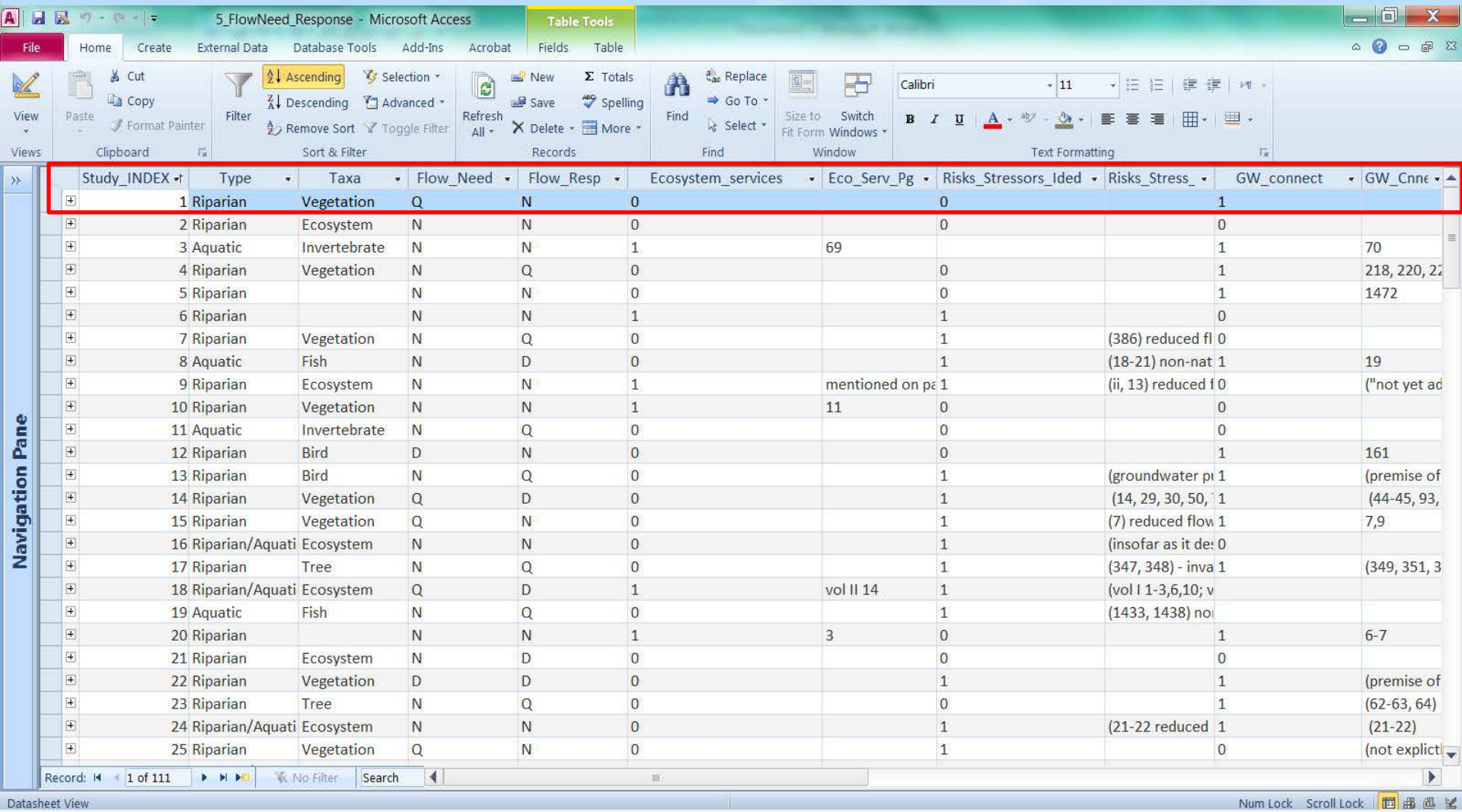
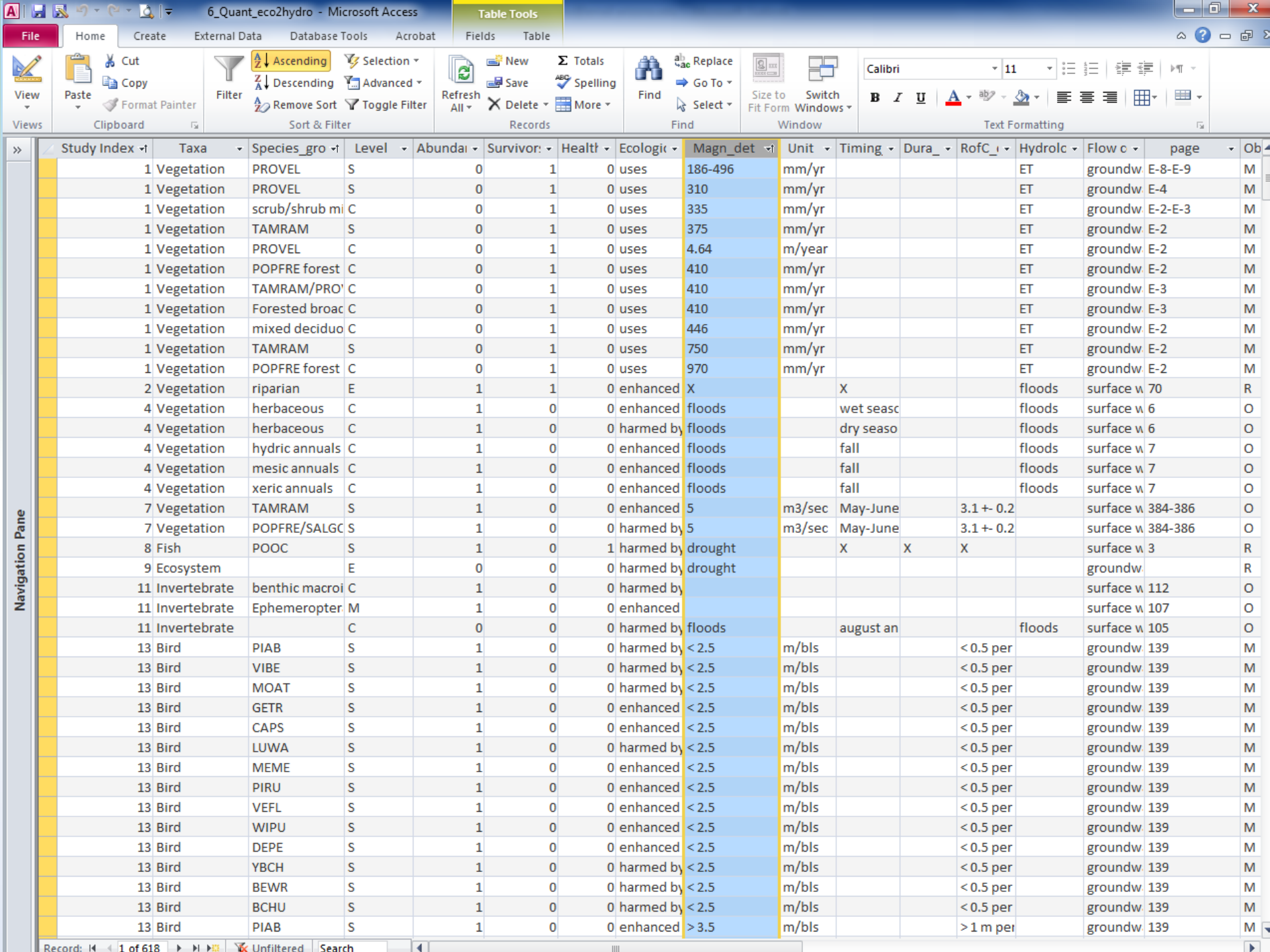


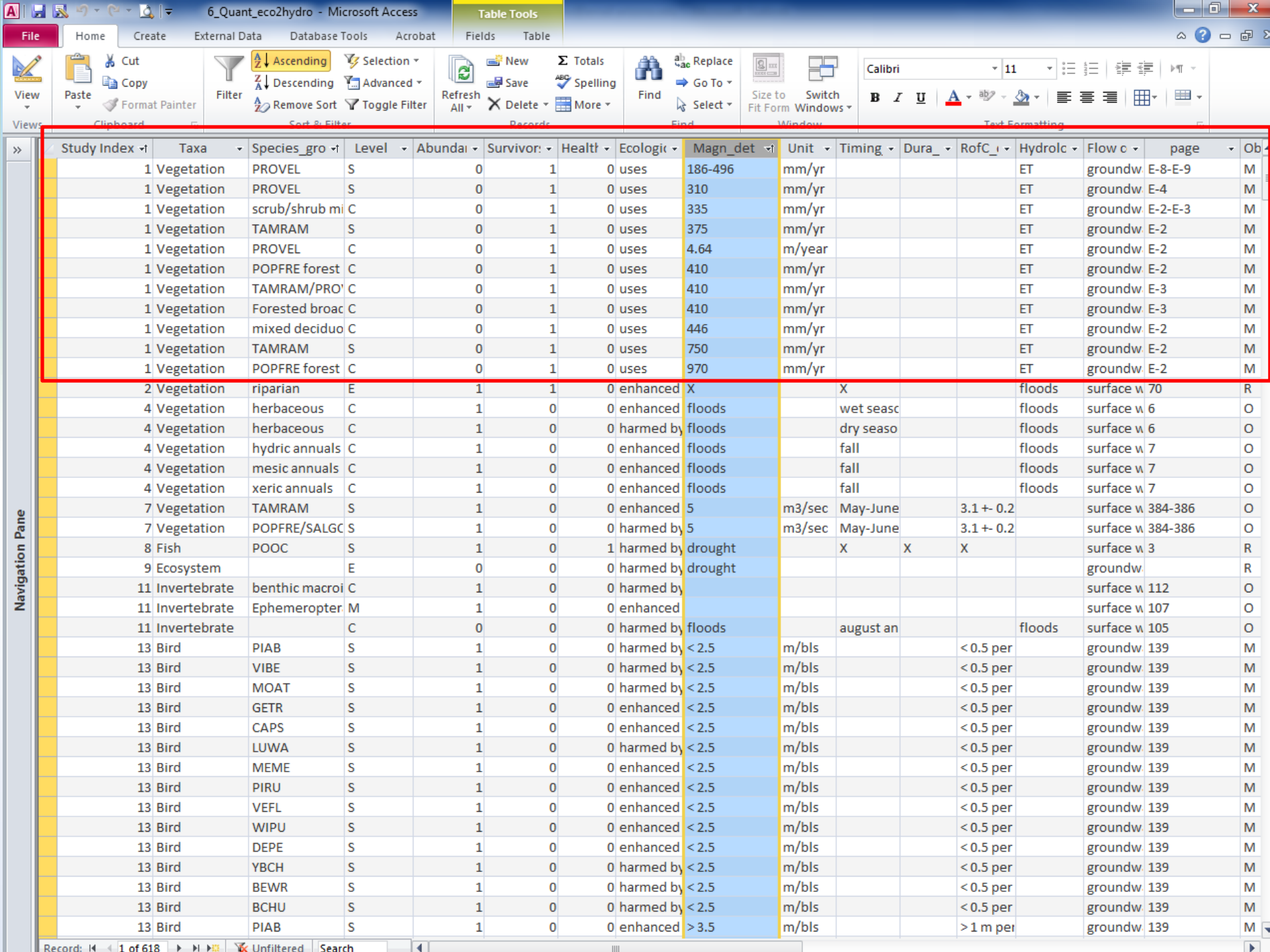
Study_INDEX	Type	Taxa	Flow_Need	Flow_Resp	Ecosystem_services	Eco_Serv_Pg	Risks_Stressors_Ided	Risks_Stress_	GW_connect	GW_Cnne
1	Riparian	Vegetation	Q	N	0		0		1	
2	Riparian	Ecosystem	N	N	0		0		0	
3	Aquatic	Invertebrate	N	N	1	69			1	70
4	Riparian	Vegetation	N	Q	0		0		1	218, 220, 22
5	Riparian		N	N	0		0		1	1472
6	Riparian		N	N	1		1		0	
7	Riparian	Vegetation	N	Q	0		1	(386) reduced fl	0	
8	Aquatic	Fish	N	D	0		1	(18-21) non-nat	1	19
9	Riparian	Ecosystem	N	N	1	mentioned on pa	1	(ii, 13) reduced f	0	("not yet ad
10	Riparian	Vegetation	N	N	1	11	0		0	
11	Aquatic	Invertebrate	N	Q	0		0		0	
12	Riparian	Bird	D	N	0		0		1	161
13	Riparian	Bird	N	Q	0		1	(groundwater pu	1	(premise of
14	Riparian	Vegetation	Q	D	0		1	(14, 29, 30, 50,	1	(44-45, 93,
15	Riparian	Vegetation	Q	N	0		1	(7) reduced flow	1	7,9
16	Riparian/Aquati	Ecosystem	N	N	0		1	(insofar as it des	0	
17	Riparian	Tree	N	Q	0		1	(347, 348) - inva	1	(349, 351, 3
18	Riparian/Aquati	Ecosystem	Q	D	1	vol II 14	1	(vol I 1-3,6,10; v		
19	Aquatic	Fish	N	Q	0		1	(1433, 1438) no		
20	Riparian		N	N	1	3	0		1	6-7
21	Riparian	Ecosystem	N	D	0		0		0	
22	Riparian	Vegetation	D	D	0		1		1	(premise of
23	Riparian	Tree	N	Q	0		0		1	(62-63, 64)
24	Riparian/Aquati	Ecosystem	N	N	0		1	(21-22 reduced	1	(21-22)
25	Riparian	Vegetation	Q	N	0		1		0	(not explicit



Study_INDEX	Type	Taxa	Flow_Need	Flow_Resp	Ecosystem_services	Eco_Serv_Pg	Risks_Stressors_Ided	Risks_Stress_	GW_connect	GW_Cnne
1	Riparian	Vegetation	Q	N	0		0		1	
2	Riparian	Ecosystem	N	N	0		0		0	
3	Aquatic	Invertebrate	N	N	1	69			1	70
4	Riparian	Vegetation	N	Q	0		0		1	218, 220, 22
5	Riparian		N	N	0		0		1	1472
6	Riparian		N	N	1		1		0	
7	Riparian	Vegetation	N	Q	0		1	(386) reduced fl	0	
8	Aquatic	Fish	N	D	0		1	(18-21) non-nat	1	19
9	Riparian	Ecosystem	N	N	1	mentioned on pa	1	(ii, 13) reduced f	0	("not yet ad
10	Riparian	Vegetation	N	N	1	11	0		0	
11	Aquatic	Invertebrate	N	Q	0		0		0	
12	Riparian	Bird	D	N	0		0		1	161
13	Riparian	Bird	N	Q	0		1	(groundwater pu	1	(premise of
14	Riparian	Vegetation	Q	D	0		1	(14, 29, 30, 50,	1	(44-45, 93,
15	Riparian	Vegetation	Q	N	0		1	(7) reduced flow	1	7,9
16	Riparian/Aquati	Ecosystem	N	N	0		1	(insofar as it des	0	
17	Riparian	Tree	N	Q	0		1	(347, 348) - inva	1	(349, 351, 3
18	Riparian/Aquati	Ecosystem	Q	D	1	vol II 14	1	(vol I 1-3,6,10; v		
19	Aquatic	Fish	N	Q	0		1	(1433, 1438) no		
20	Riparian		N	N	1	3	0		1	6-7
21	Riparian	Ecosystem	N	D	0		0		0	
22	Riparian	Vegetation	D	D	0		1		1	(premise of
23	Riparian	Tree	N	Q	0		0		1	(62-63, 64)
24	Riparian/Aquati	Ecosystem	N	N	0		1	(21-22 reduced	1	(21-22)
25	Riparian	Vegetation	Q	N	0		1		0	(not explicit



Study Index	Taxa	Species_gro	Level	Abundai	Survivor:	Healtl	Ecologic	Magn_det	Unit	Timing	Dura_	RofC_	Hydrolc	Flow c	page	Ob
1	Vegetation	PROVEL	S	0	1	0	uses	186-496	mm/yr				ET	groundw	E-8-E-9	M
1	Vegetation	PROVEL	S	0	1	0	uses	310	mm/yr				ET	groundw	E-4	M
1	Vegetation	scrub/shrub mi	C	0	1	0	uses	335	mm/yr				ET	groundw	E-2-E-3	M
1	Vegetation	TAMRAM	S	0	1	0	uses	375	mm/yr				ET	groundw	E-2	M
1	Vegetation	PROVEL	C	0	1	0	uses	4.64	m/year				ET	groundw	E-2	M
1	Vegetation	POPFRE forest	C	0	1	0	uses	410	mm/yr				ET	groundw	E-2	M
1	Vegetation	TAMRAM/PRO'	C	0	1	0	uses	410	mm/yr				ET	groundw	E-3	M
1	Vegetation	Forested broac	C	0	1	0	uses	410	mm/yr				ET	groundw	E-3	M
1	Vegetation	mixed deciduo	C	0	1	0	uses	446	mm/yr				ET	groundw	E-2	M
1	Vegetation	TAMRAM	S	0	1	0	uses	750	mm/yr				ET	groundw	E-2	M
1	Vegetation	POPFRE forest	C	0	1	0	uses	970	mm/yr				ET	groundw	E-2	M
2	Vegetation	riparian	E	1	1	0	enhanced	X		X			floods	surface w	70	R
4	Vegetation	herbaceous	C	1	0	0	enhanced	floods		wet seasc			floods	surface w	6	O
4	Vegetation	herbaceous	C	1	0	0	harmed by	floods		dry seaso			floods	surface w	6	O
4	Vegetation	hydric annuals	C	1	0	0	enhanced	floods		fall			floods	surface w	7	O
4	Vegetation	mesic annuals	C	1	0	0	enhanced	floods		fall			floods	surface w	7	O
4	Vegetation	xeric annuals	C	1	0	0	enhanced	floods		fall			floods	surface w	7	O
7	Vegetation	TAMRAM	S	1	0	0	enhanced	5	m3/sec	May-June		3.1 +- 0.2		surface w	384-386	O
7	Vegetation	POPFRE/SALGC	S	1	0	0	harmed by	5	m3/sec	May-June		3.1 +- 0.2		surface w	384-386	O
8	Fish	POOC	S	1	0	1	harmed by	drought		X	X	X		surface w	3	R
9	Ecosystem		E	0	0	0	harmed by	drought						groundw		R
11	Invertebrate	benthic macroi	C	1	0	0	harmed by							surface w	112	O
11	Invertebrate	Ephemeropter	M	1	0	0	enhanced							surface w	107	O
11	Invertebrate		C	0	0	0	harmed by	floods		august an			floods	surface w	105	O
13	Bird	PIAB	S	1	0	0	harmed by	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	VIBE	S	1	0	0	harmed by	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	MOAT	S	1	0	0	harmed by	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	GETR	S	1	0	0	enhanced	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	CAPS	S	1	0	0	enhanced	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	LUWA	S	1	0	0	harmed by	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	MEME	S	1	0	0	enhanced	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	PIRU	S	1	0	0	enhanced	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	VEFL	S	1	0	0	enhanced	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	WIPU	S	1	0	0	enhanced	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	DEPE	S	1	0	0	enhanced	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	YBCH	S	1	0	0	harmed by	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	BEWR	S	1	0	0	harmed by	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	BCHU	S	1	0	0	harmed by	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	PIAB	S	1	0	0	enhanced	> 3.5	m/bls			> 1 m per		groundw	139	M



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Navigation Pane

Study Index	Taxa	Species_gro	Level	Abundai	Survivor:	Healtl	Ecologic	Magn_det	Unit	Timing	Dura_	RofC_	Hydrolc	Flow c	page	Ob
1	Vegetation	PROVEL	S	0	1	0	uses	186-496	mm/yr				ET	groundw	E-8-E-9	M
1	Vegetation	PROVEL	S	0	1	0	uses	310	mm/yr				ET	groundw	E-4	M
1	Vegetation	scrub/shrub mi	C	0	1	0	uses	335	mm/yr				ET	groundw	E-2-E-3	M
1	Vegetation	TAMRAM	S	0	1	0	uses	375	mm/yr				ET	groundw	E-2	M
1	Vegetation	PROVEL	C	0	1	0	uses	4.64	m/year				ET	groundw	E-2	M
1	Vegetation	POPFRE forest	C	0	1	0	uses	410	mm/yr				ET	groundw	E-2	M
1	Vegetation	TAMRAM/PRO'	C	0	1	0	uses	410	mm/yr				ET	groundw	E-3	M
1	Vegetation	Forested broac	C	0	1	0	uses	410	mm/yr				ET	groundw	E-3	M
1	Vegetation	mixed deciduo	C	0	1	0	uses	446	mm/yr				ET	groundw	E-2	M
1	Vegetation	TAMRAM	S	0	1	0	uses	750	mm/yr				ET	groundw	E-2	M
1	Vegetation	POPFRE forest	C	0	1	0	uses	970	mm/yr				ET	groundw	E-2	M
2	Vegetation	riparian	E	1	1	0	enhanced	X		X			floods	surface w	70	R
4	Vegetation	herbaceous	C	1	0	0	enhanced	floods		wet seasc			floods	surface w	6	O
4	Vegetation	herbaceous	C	1	0	0	harmed by	floods		dry seaso			floods	surface w	6	O
4	Vegetation	hydric annuals	C	1	0	0	enhanced	floods		fall			floods	surface w	7	O
4	Vegetation	mesic annuals	C	1	0	0	enhanced	floods		fall			floods	surface w	7	O
4	Vegetation	xeric annuals	C	1	0	0	enhanced	floods		fall			floods	surface w	7	O
7	Vegetation	TAMRAM	S	1	0	0	enhanced	5	m3/sec	May-June		3.1 +- 0.2		surface w	384-386	O
7	Vegetation	POPFRE/SALGC	S	1	0	0	harmed by	5	m3/sec	May-June		3.1 +- 0.2		surface w	384-386	O
8	Fish	POOC	S	1	0	1	harmed by	drought		X	X	X		surface w	3	R
9	Ecosystem		E	0	0	0	harmed by	drought						groundw		R
11	Invertebrate	benthic macroi	C	1	0	0	harmed by							surface w	112	O
11	Invertebrate	Ephemeropter	M	1	0	0	enhanced							surface w	107	O
11	Invertebrate		C	0	0	0	harmed by	floods		august an			floods	surface w	105	O
13	Bird	PIAB	S	1	0	0	harmed by	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	VIBE	S	1	0	0	harmed by	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	MOAT	S	1	0	0	harmed by	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	GETR	S	1	0	0	enhanced	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	CAPS	S	1	0	0	enhanced	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	LUWA	S	1	0	0	harmed by	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	MEME	S	1	0	0	enhanced	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	PIRU	S	1	0	0	enhanced	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	VEFL	S	1	0	0	enhanced	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	WIPU	S	1	0	0	enhanced	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	DEPE	S	1	0	0	enhanced	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	YBCH	S	1	0	0	harmed by	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	BEWR	S	1	0	0	harmed by	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	BCHU	S	1	0	0	harmed by	< 2.5	m/bls			< 0.5 per		groundw	139	M
13	Bird	PIAB	S	1	0	0	enhanced	> 3.5	m/bls			> 1 m per		groundw	139	M

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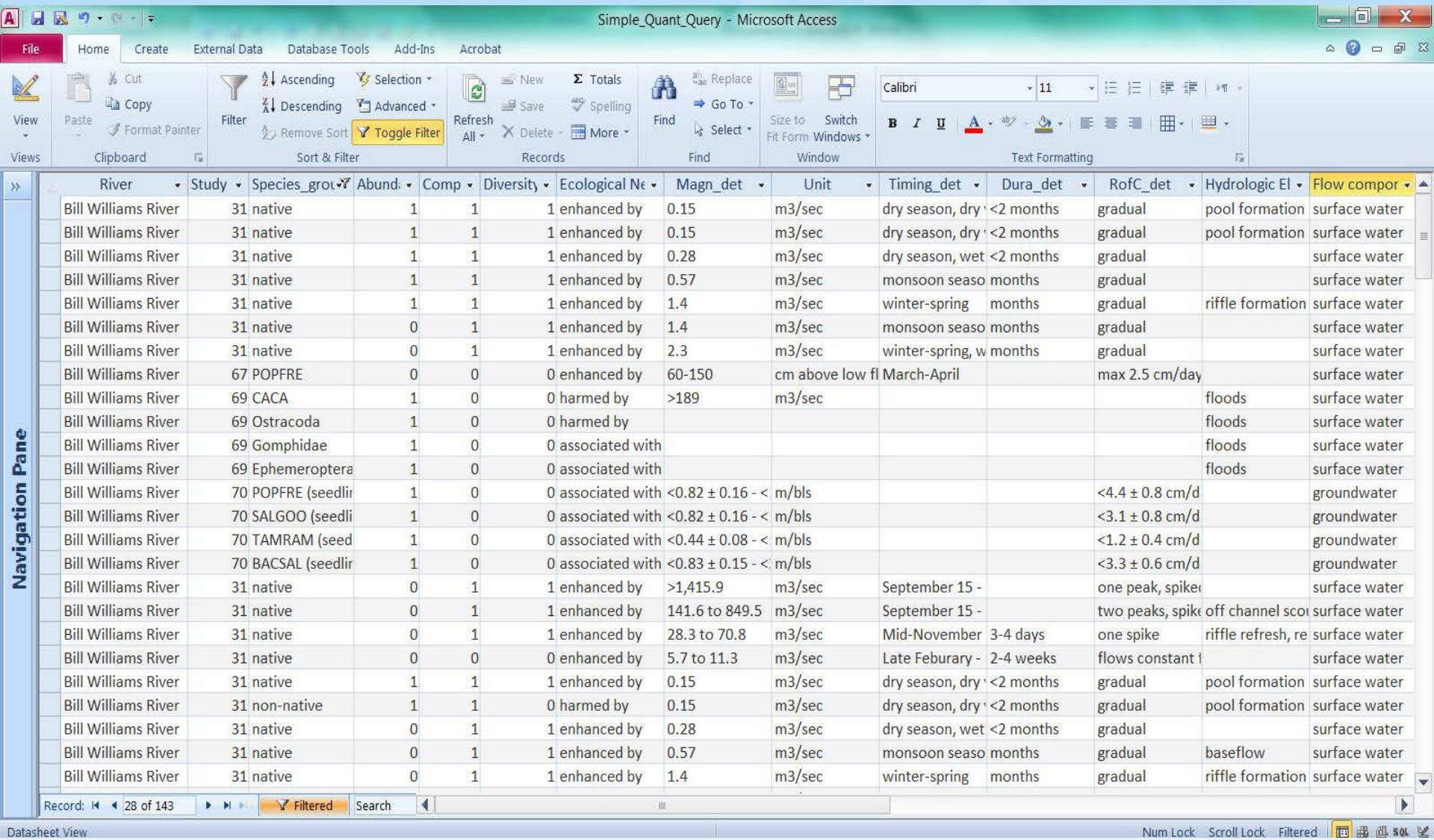
Simple_Quant_Query - Microsoft Access
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Magn_det
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Timing_det
Dura_det
RofC_det
Hydrologic El
Flow compor
Bill Williams River 31 native 1 1 1 enhanced by 0.15 m3/sec dry season, dry <2 months gradual pool formation surface water
Bill Williams River 31 native 1 1 1 enhanced by 0.15 m3/sec dry season, dry <2 months gradual pool formation surface water
Bill Williams River 31 native 1 1 1 enhanced by 0.28 m3/sec dry season, wet <2 months gradual surface water
Bill Williams River 31 native 1 1 1 enhanced by 0.57 m3/sec monsoon seaso months gradual surface water
Bill Williams River 31 native 1 1 1 enhanced by 1.4 m3/sec winter-spring months gradual riffle formation surface water
Bill Williams River 31 native 0 1 1 enhanced by 1.4 m3/sec monsoon seaso months gradual surface water
Bill Williams River 31 native 0 1 1 enhanced by 2.3 m3/sec winter-spring, w months gradual surface water
Bill Williams River 67 POPFRE 0 0 0 enhanced by 60-150 cm above low fl March-April max 2.5 cm/day surface water
Bill Williams River 69 CACA 1 0 0 harmed by >189 m3/sec floods surface water
Bill Williams River 69 Ostracoda 1 0 0 harmed by floods surface water
Bill Williams River 69 Gomphidae 1 0 0 associated with floods surface water
Bill Williams River 69 Ephemeroptera 1 0 0 associated with floods surface water
Bill Williams River 70 POPFRE (seedlir 1 0 0 associated with <0.82 ± 0.16 - < m/bls <4.4 ± 0.8 cm/d groundwater
Bill Williams River 70 SALGOO (seedli 1 0 0 associated with <0.82 ± 0.16 - < m/bls <3.1 ± 0.8 cm/d groundwater
Bill Williams River 70 TAMRAM (seed 1 0 0 associated with <0.44 ± 0.08 - < m/bls <1.2 ± 0.4 cm/d groundwater
Bill Williams River 70 BACSAL (seedlir 1 0 0 associated with <0.83 ± 0.15 - < m/bls <3.3 ± 0.6 cm/d groundwater
Bill Williams River 31 native 0 1 1 enhanced by >1,415.9 m3/sec September 15 - one peak, spike surface water
Bill Williams River 31 native 0 1 1 enhanced by 141.6 to 849.5 m3/sec September 15 - two peaks, spik off channel sco surface water
Bill Williams River 31 native 0 1 1 enhanced by 28.3 to 70.8 m3/sec Mid-November 3-4 days one spike riffle refresh, re surface water
Bill Williams River 31 native 0 0 0 enhanced by 5.7 to 11.3 m3/sec Late Feburary - 2-4 weeks flows constant surface water
Bill Williams River 31 native 1 1 1 enhanced by 0.15 m3/sec dry season, dry <2 months gradual pool formation surface water
Bill Williams River 31 non-native 1 1 0 harmed by 0.15 m3/sec dry season, dry <2 months gradual pool formation surface water
Bill Williams River 31 native 0 1 1 enhanced by 0.28 m3/sec dry season, wet <2 months gradual surface water
Bill Williams River 31 native 0 1 1 enhanced by 0.57 m3/sec monsoon seaso months gradual baseflow surface water
Bill Williams River 31 native 0 1 1 enhanced by 1.4 m3/sec winter-spring months gradual riffle formation surface water
Record: 28 of 143
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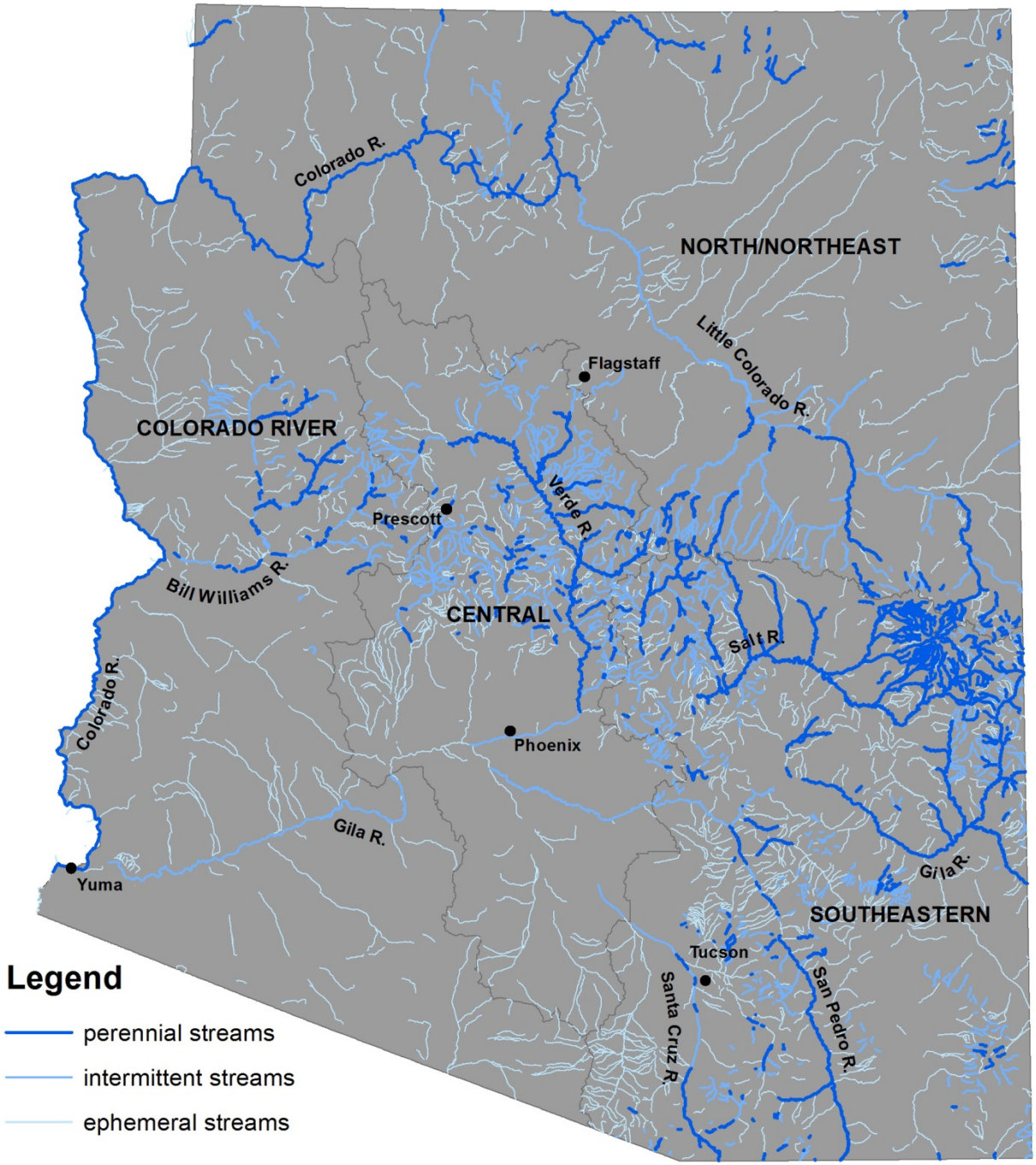
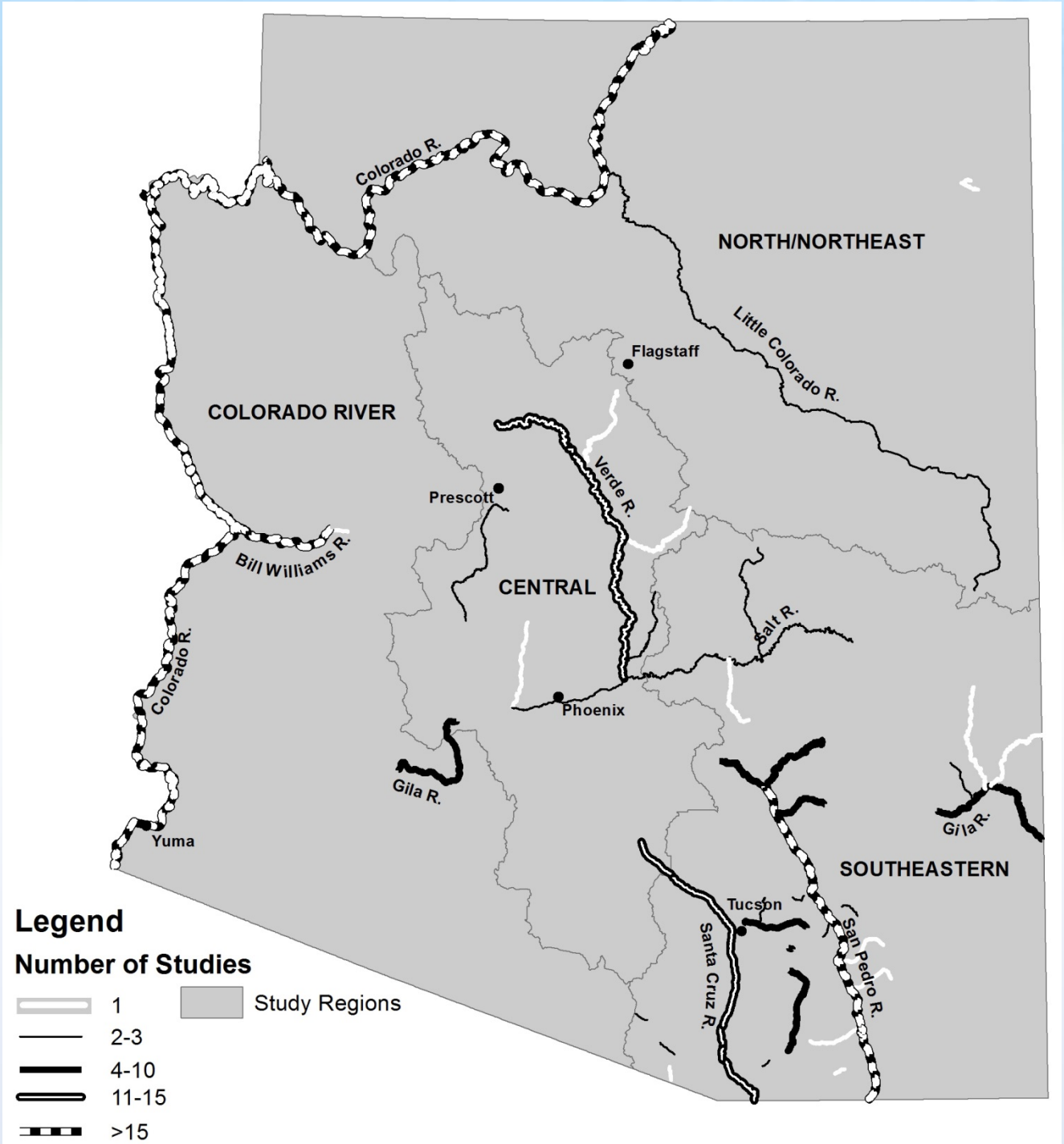
Findings

- 22% of river miles in Arizona Studied
  - 40% of perennial river miles
  - 11% of intermittent river miles
- 135 species
  - 25% studied >1
  - 11% studied > 2

Study Subject	Taxa	Number of Studies
Populous fremonti	Veg	27
Salix gooddingii	Veg	15
Tamarix ramosissima	Veg	14
Prosopis velutina	Veg	13
Cottonwood/Willow Forest	Veg	7
Native flora/fauna	NA	5
Tamarix chinensis	Veg	5
Rhinichthys osculus	Fish	5
Baccharis salicifolia	Veg	5
Gila robusta	Fish	5
Sporobolus wrightii	Veg	5
Herbaceous plants	Veg	4
Typha	Veg	4
Platanus wrightii	Veg	3
Xyrauchen texanus	Fish	3
Gila cypha	Fish	3
Castor canadensis	Mammal	3
Agosia chrysogaster	Fish	3
Atriplex	Veg	3


Colorado R.
NORTH/NORTHEAST
Little Colorado R.
Flagstaff
COLORADO RIVER
Verde R.
Prescott
Bill Williams R.
CENTRAL
Salt R.
Colorado R.
Phoenix
Gila R.
Yuma
Gila R.
SOUTHEASTERN
Tucson
Santa Cruz R.
San Pedro R.
Legend
perennial streams
intermittent streams
ephemeral streams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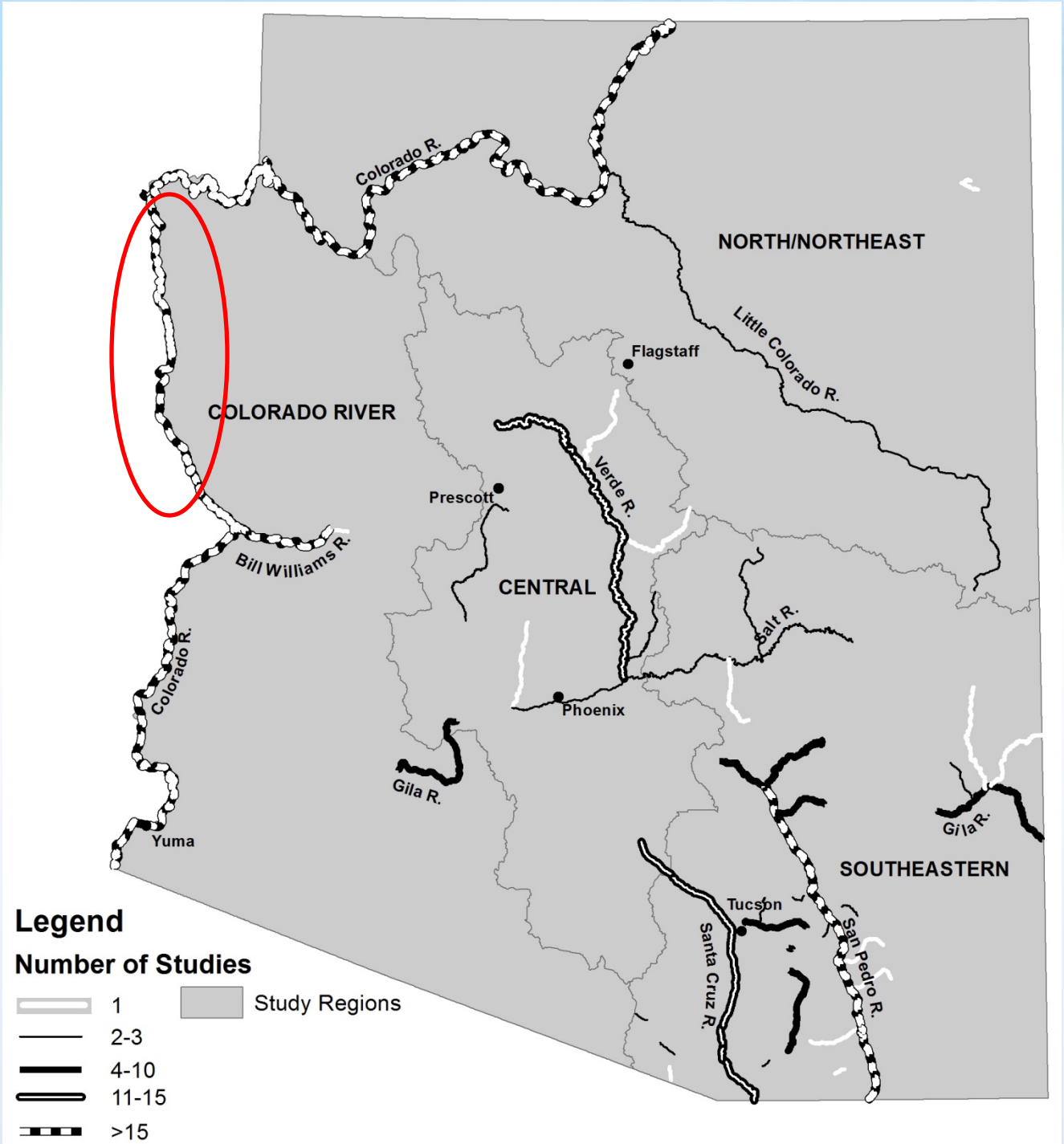
Salt R.
Colorado R.
Phoenix
Gila R.
Yuma
Gila R.
SOUTHEASTERN
Tucson
Santa Cruz R.
San Pedro R.
Legend
Number of Studies
1
2-3
4-10
11-15
>15
Study Regions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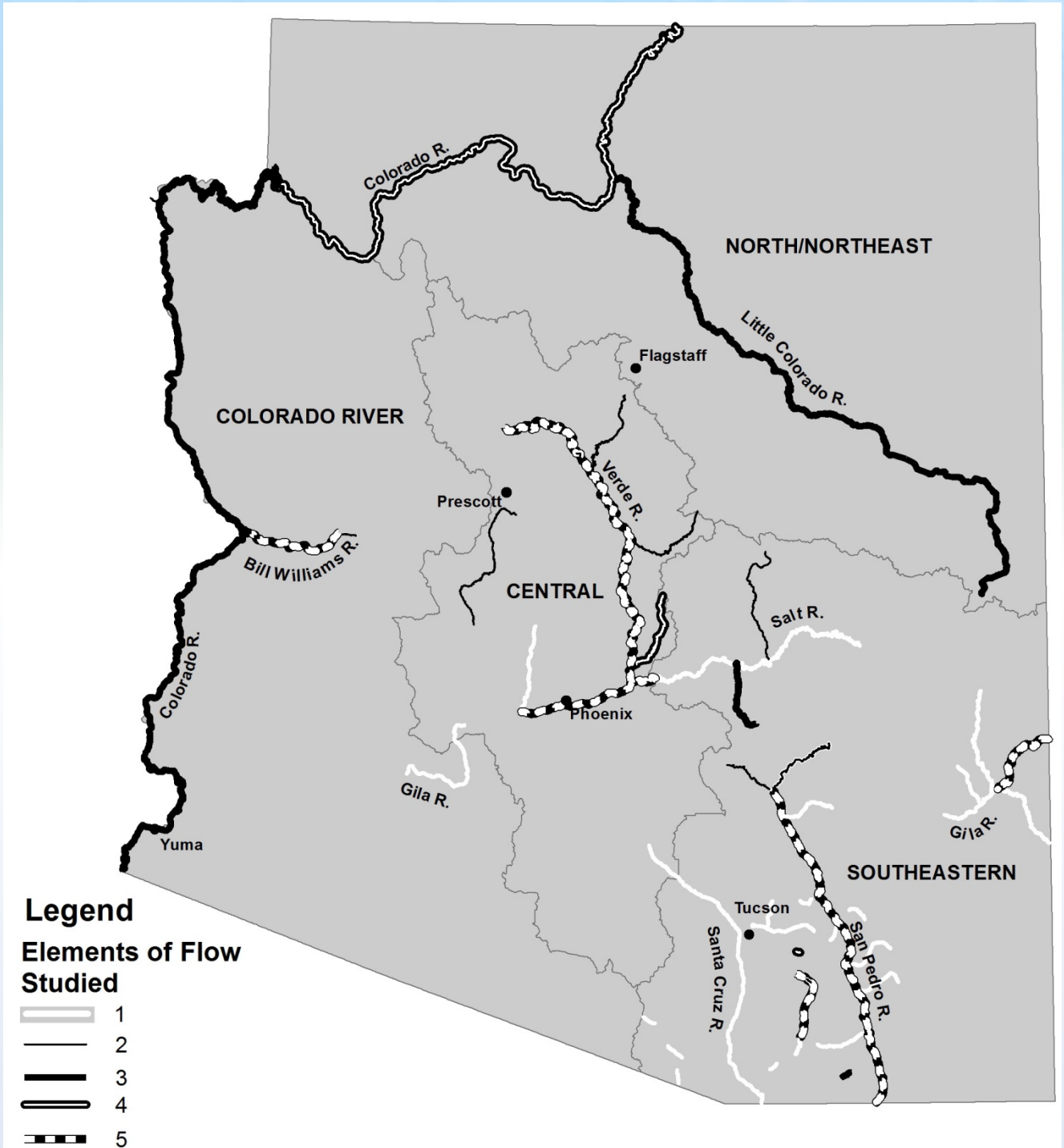
Study Regions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Phoenix
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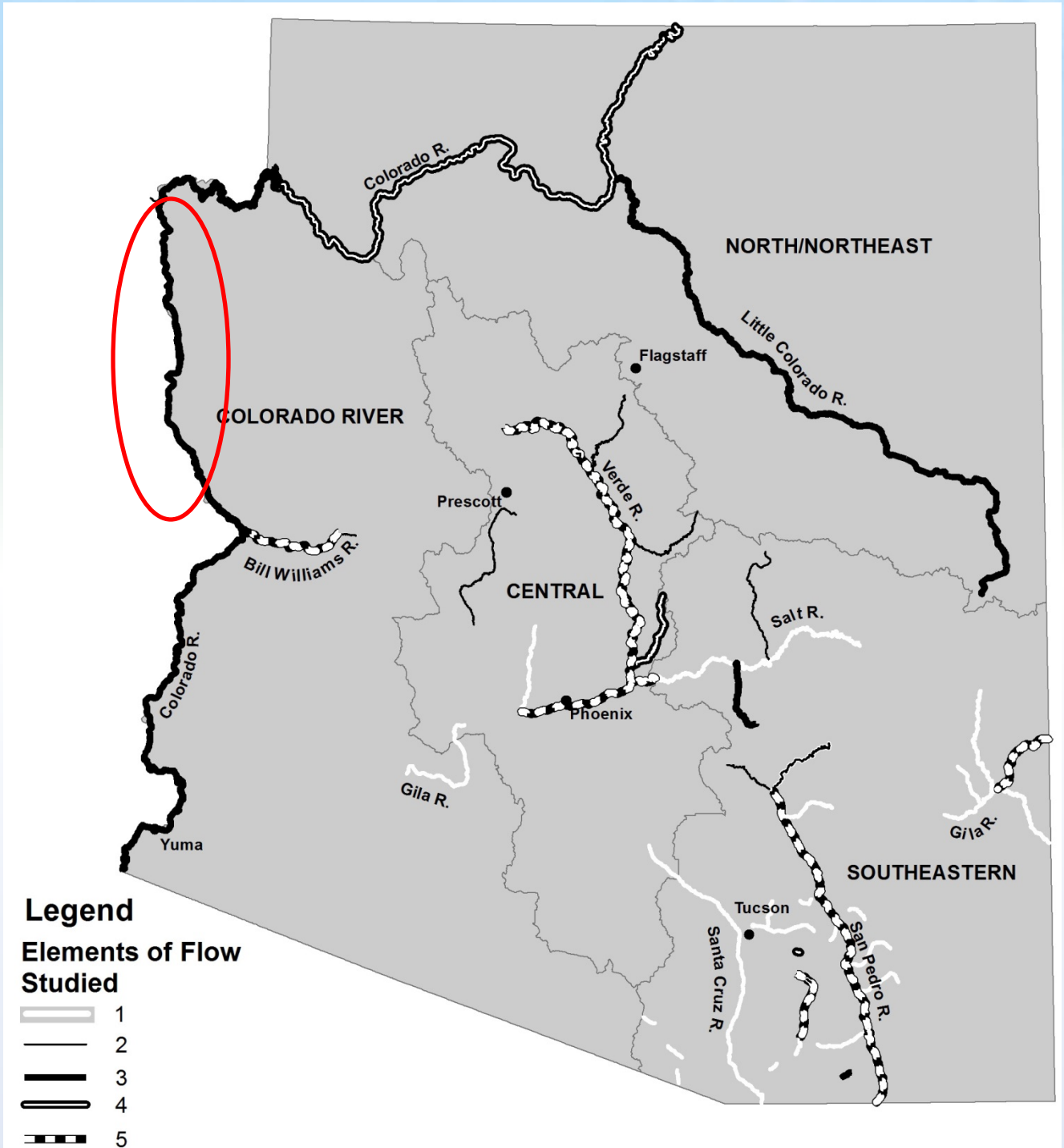
Yuma
Gila R.
SOUTHEASTERN
Tucson
Santa Cruz R.
San Pedro R.
Legend
Elements of Flow Studied
1
2
3
4
5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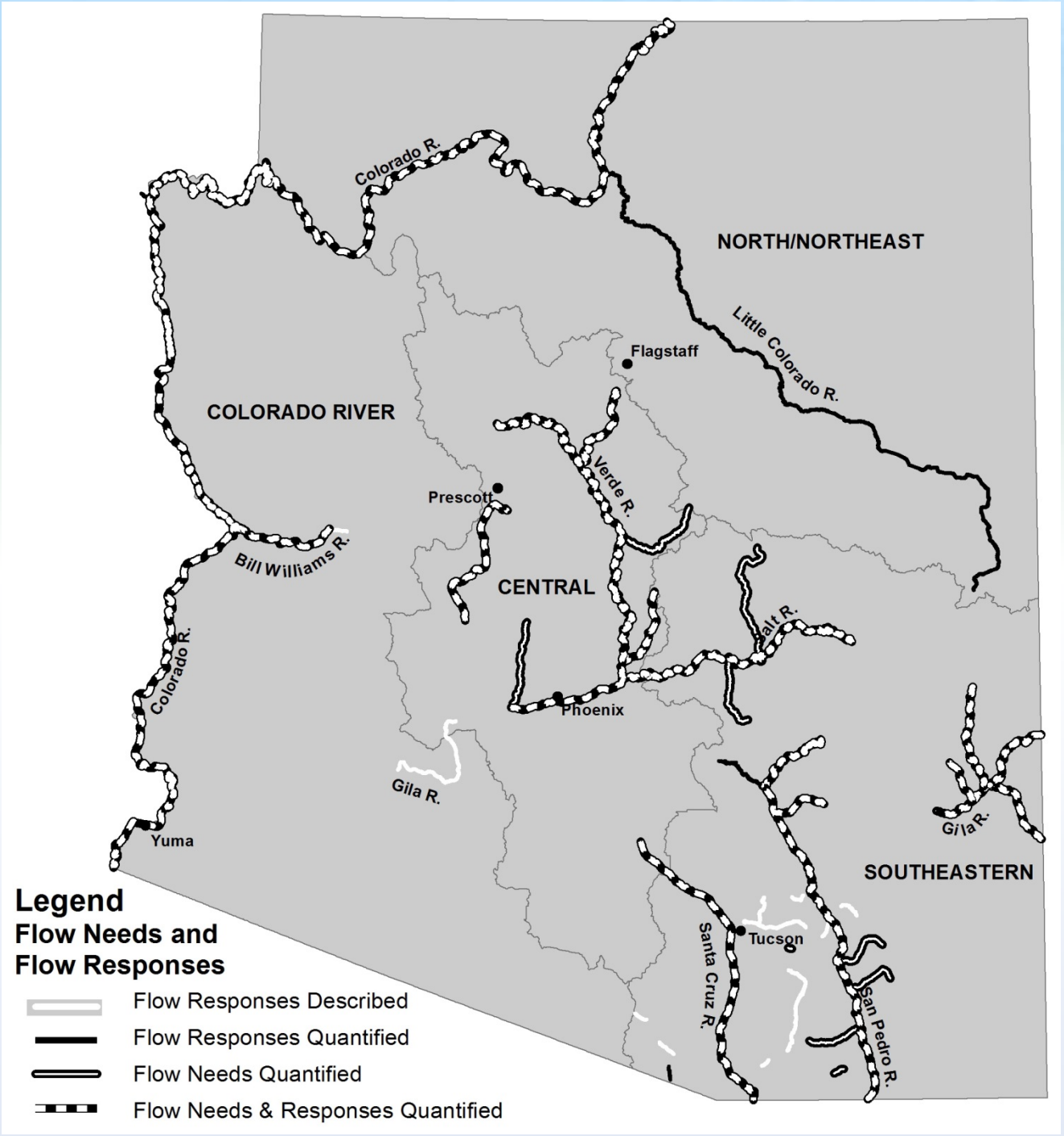
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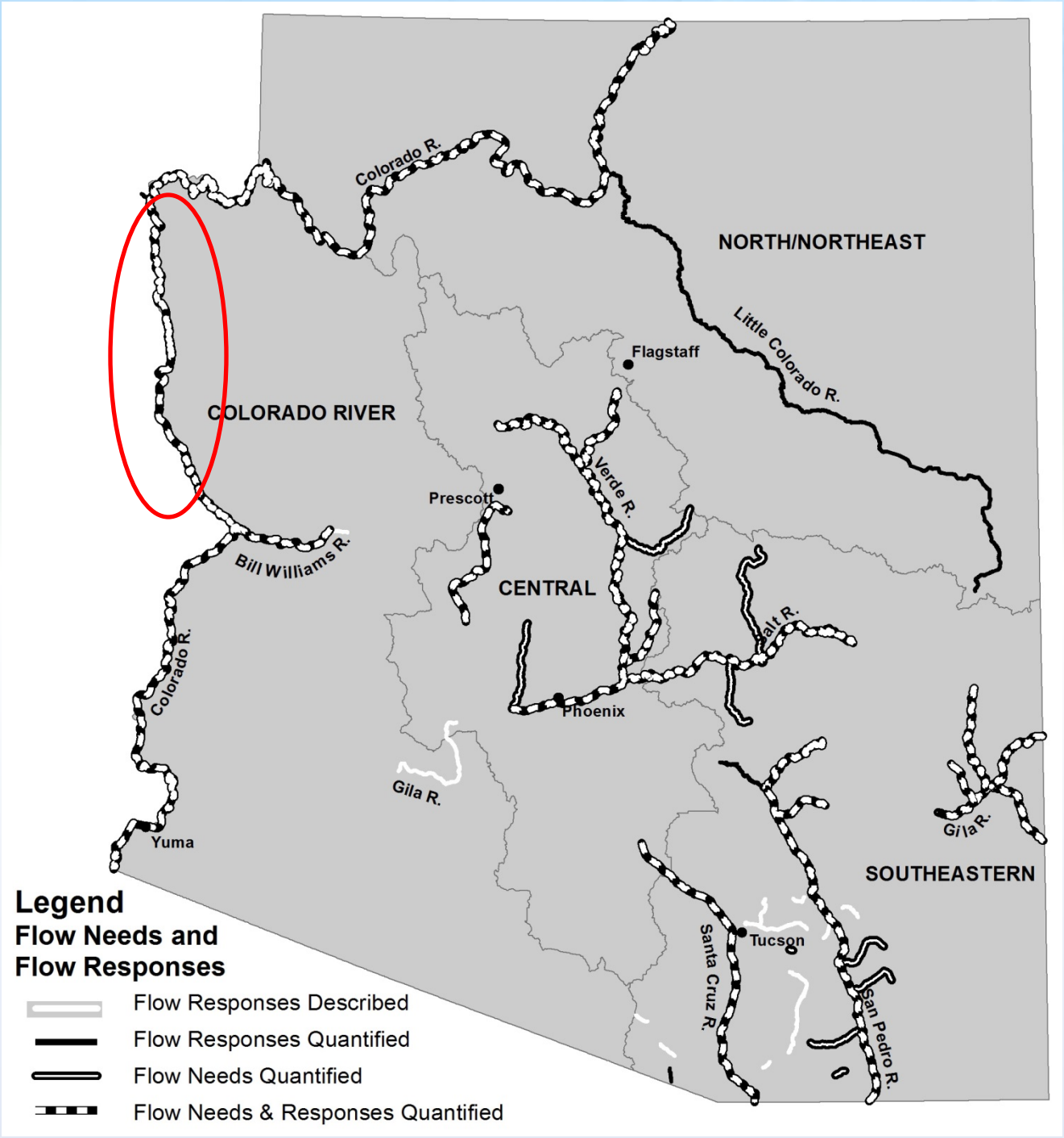
SOUTHEASTERN
Tucson
Santa Cruz R.
San Pedro R.
Legend
Flow Needs and
Flow Responses
Flow Responses Described
Flow Responses Quantified
Flow Needs Quantified
Flow Needs & Responses Quantified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Flow Needs and
Flow Responses
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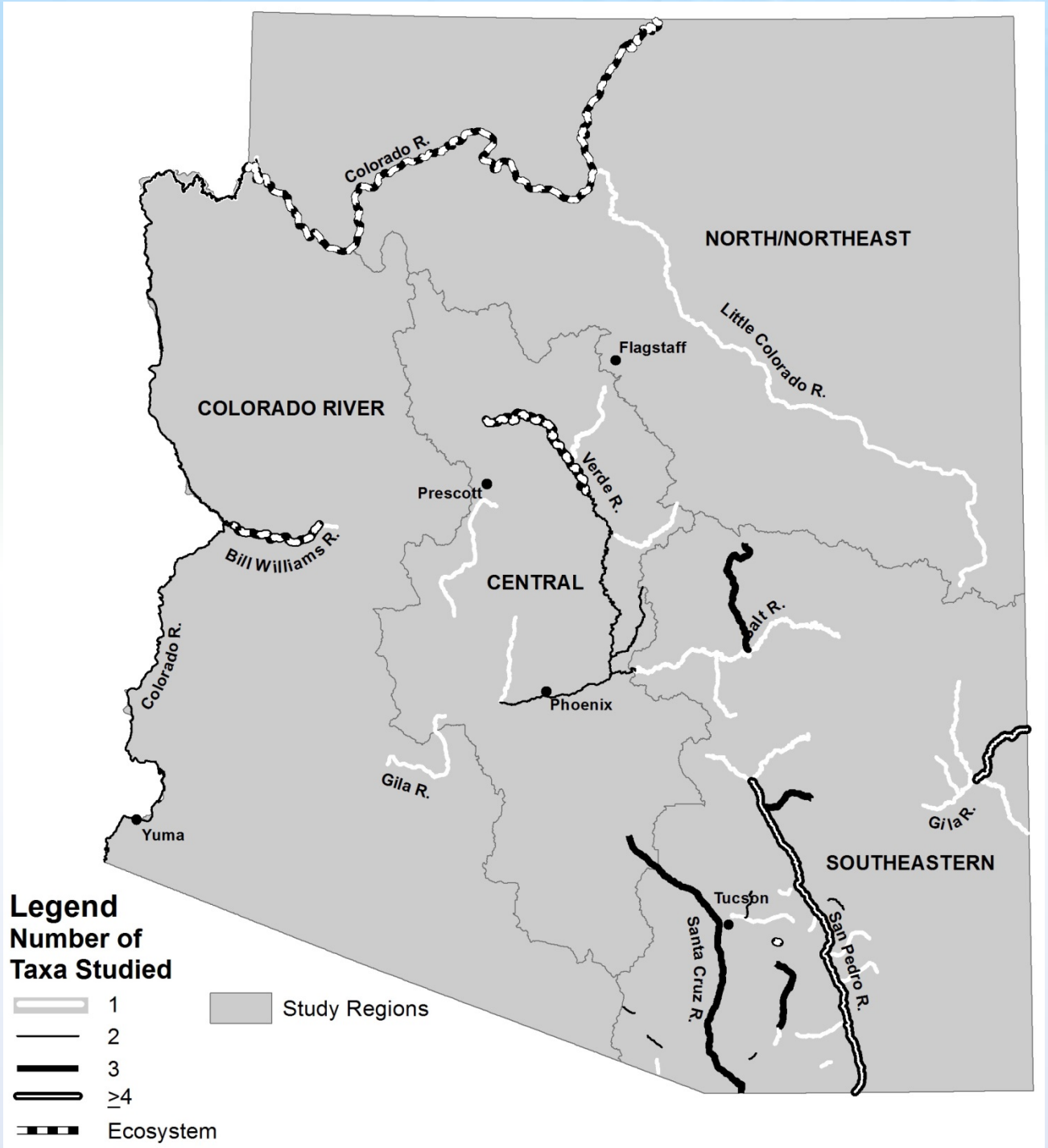
Flow Responses Quantified
Flow Needs Quantified
Flow Needs & Responses Quantified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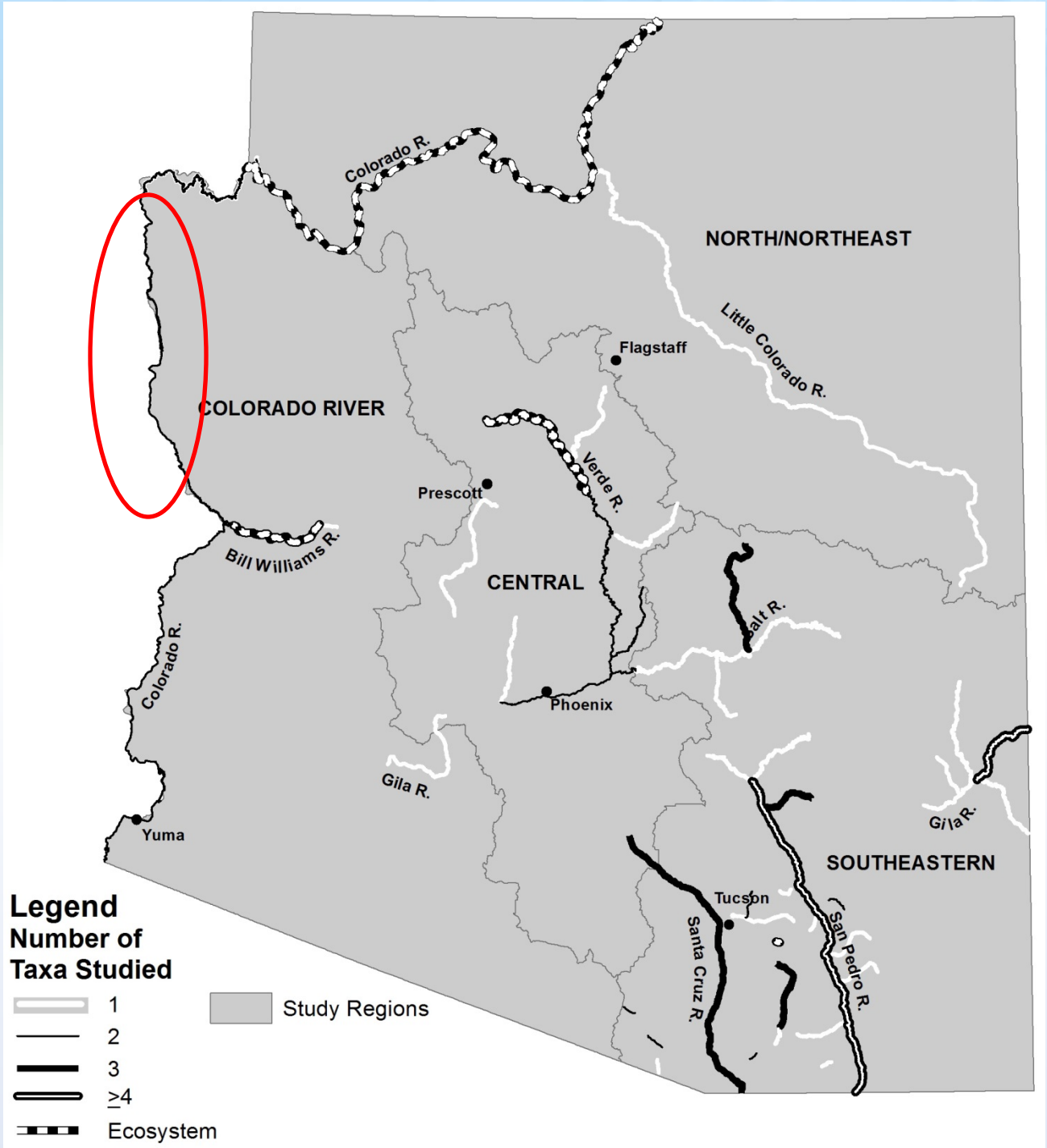
Salt R.
Colorado R.
Phoenix
Gila R.
Yuma
Gila R.
SOUTHEASTERN
Tucson
Santa Cruz R.
San Pedro R.
Legend
Number of Taxa Studied
1
2
3
≥4
Ecosystem
Study Regions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San Pedro R.
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Ecosystem
Study Regions

Database Example:
What quantitative information is available on the ecological flow needs or responses of cottonwoods?

Populus fremontii
Photo Credit: cals.arizona.edu

Age	Ecology	Relationship	Hydrology						Study Types	Citations
			Water	Magnitude	Timing	Frequency	Duration	Rate of Change		
Cottonwood (Populous Fremonti)										
Flow or Level Needs										
seed	A	assoc. with	GW	<0.82 ± 0.16 - <1.58 ± 0.14				<4.4 ± 0.8 cm/day	O	Shafroth et al 1998
seed	S	assoc. with	GW	<1 m/bls				~2 cm/ day	O	Stromberg et al. 1996
juv.	A, S	assoc. with	GW	0.2 to 2 m/bls					O	Pima County 2009; Stromberg et al 1996
	A, C	assoc. with	GW	1 to 3 m/bls			Year Round	<1 m yr flux	O	Leenhouts et al. 2005; NPS 2008; Pima County 2009; Stromberg et al. 2009
	A, S, H	assoc. with	GW	0.1 to 5.1 m/bls			Year Round		O	Horton et al. 2001; Stromberg et al. 1996
	H	depends upon	SW	0.28 to 2.8 m3/s		baseflow			R	Hautzinger et al. 2006
	R	assoc. with	SW	0.06 -0.15 m above low flow	March-April			max 2.5 cm/day	R	Shafroth & Beauchamp 2006
	R	depends upon	SW	198.2 m3/s	winter-spring, wet yr	1:10 yrs			R	Hautzinger et al. 2006
	R	depends upon	SW	56.6 m3/s	winter-spring, dry yr	every 2-3 yrs			R	Hautzinger et al. 2006

A= Abundance, C = Composition, H = Health, R = Reproduction, S = Survival

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A= Abundance, C = Composition, H = Health, R = Reproduction, S = Survival

So WHAT?

How can we use this information?

- Inform water management and planning decisions
  - initial thresholds
  - flow requirements
  - priority areas for future management actions
- Identify studies needed to address
  - key geographic information gaps
  - key species or taxa information gaps
  - inconsistent information

Lake Pleasant Shoreline, Phoenix, AZ
Photo Credit Arizona Game & Fish

Where are we going with this?

EnWaP Roadmap

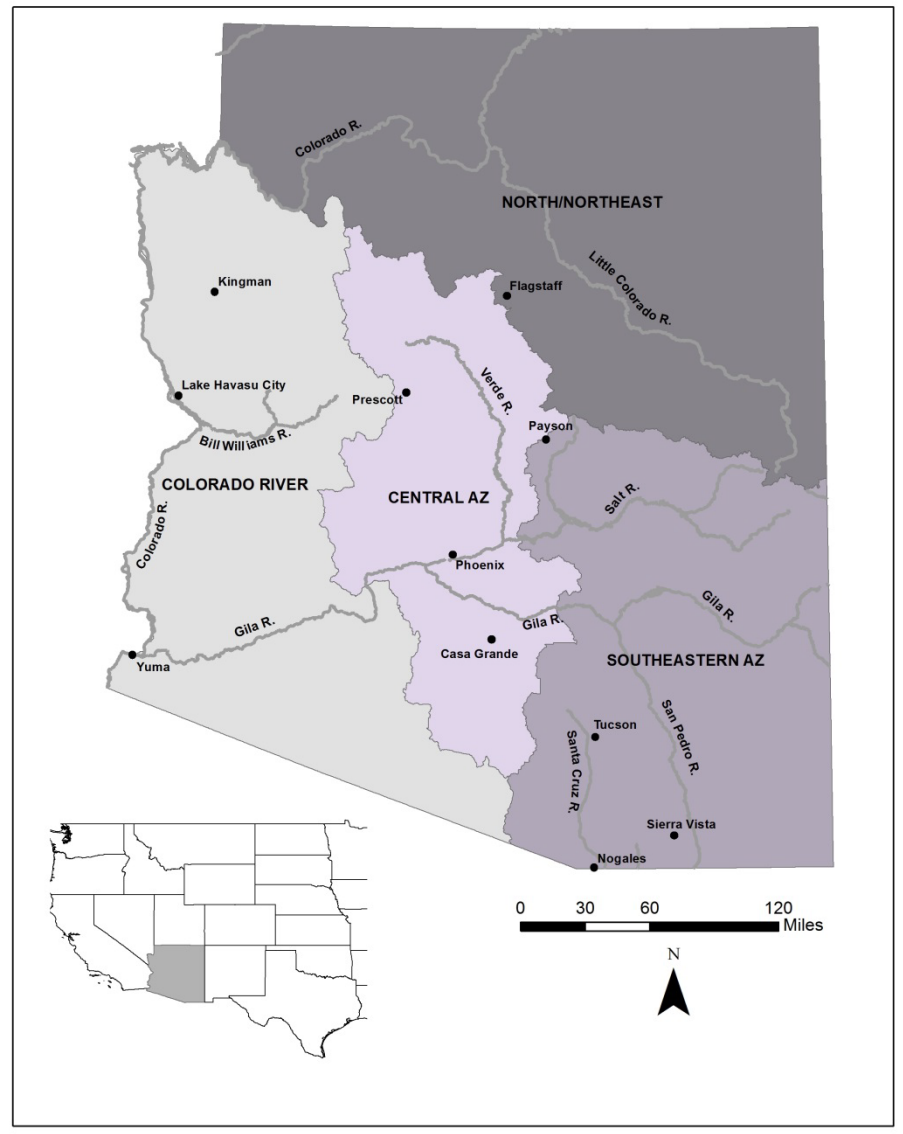
- Building **first-ever** roadmap for considering the environment in AZ water planning
  - What are the opportunities for considering the environment in water decision making?
  - What is the decision space or common ground for considering the environment?
- Guided by Steering Committee
- Focus group meetings fall 2013
  - Contact us to participate

Colorado River at Black Canyon.
Source: ADWR, 2010

***If* and *when* should environmental water demands be considered in water management and planning.**

For more information…

- Statewide and Regional Bulletins



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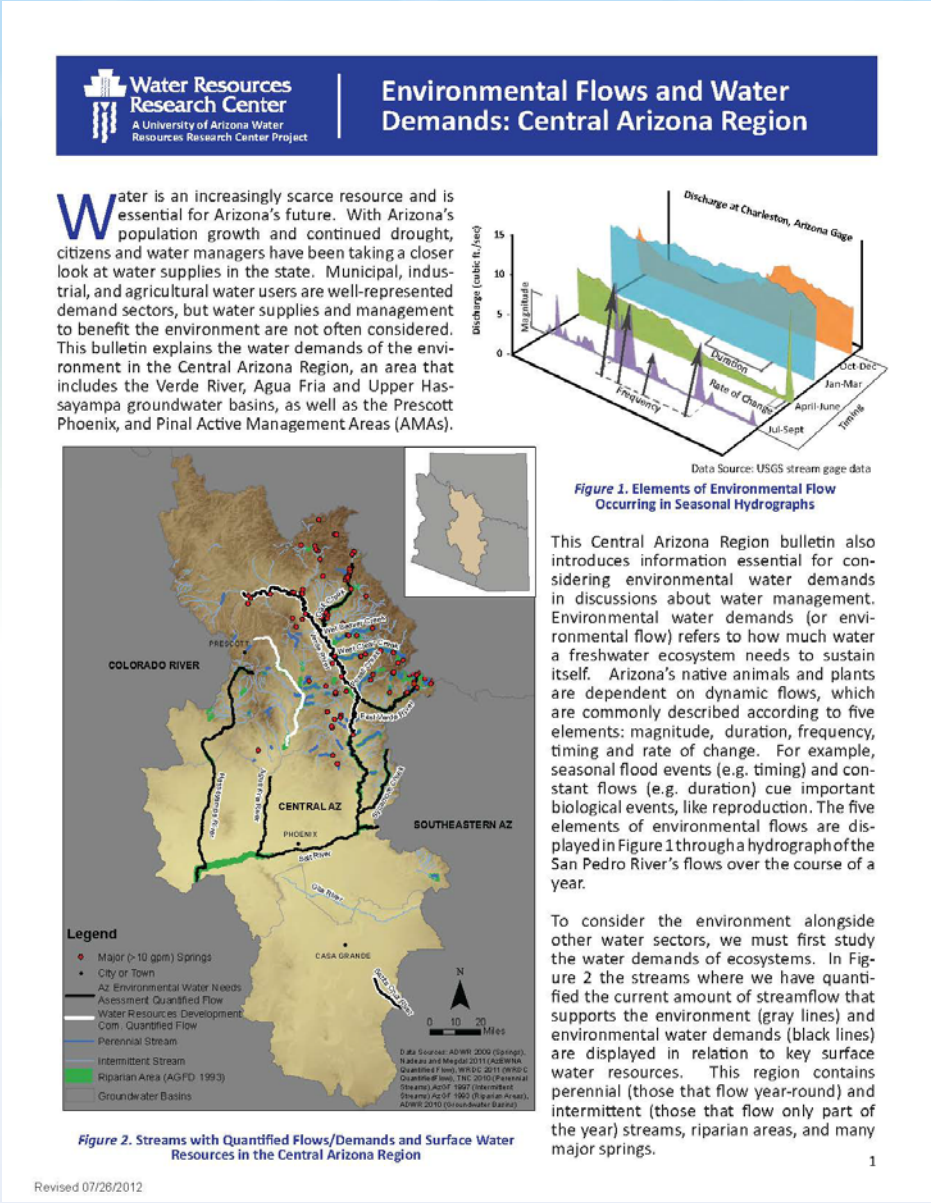


Water Resources Research Center
A University of Arizona Water Resources Research Center Project

Environmental Flows and Water Demands: Central Arizona Region

Water is an increasingly scarce resource and is essential for Arizona's future. With Arizona's population growth and continued drought, citizens and water managers have been taking a closer look at water supplies in the state. Municipal, industrial, and agricultural water users are well-represented demand sectors, but water supplies and management to benefit the environment are not often considered. This bulletin explains the water demands of the environment in the Central Arizona Region, an area that includes the Verde River, Agua Fria and Upper Hassayampa groundwater basins, as well as the Prescott Phoenix, and Pinal Active Management Areas (AMAs).

Data Source: USGS stream gage data

Figure 1. **Elements of Environmental Flow Occurring in Seasonal Hydrographs**

Figure 2. **Streams with Quantified Flows/Demands and Surface Water Resources in the Central Arizona Region**

This Central Arizona Region bulletin also introduces information essential for considering environmental water demands in discussions about water management. Environmental water demands (or environmental flow) refers to how much water a freshwater ecosystem needs to sustain itself. Arizona's native animals and plants are dependent on dynamic flows, which are commonly described according to five elements: magnitude, duration, frequency, timing and rate of change. For example, seasonal flood events (e.g. timing) and constant flows (e.g. duration) cue important biological events, like reproduction. The five elements of environmental flows are displayed in Figure 1 through a hydrograph of the San Pedro River's flows over the course of a year.

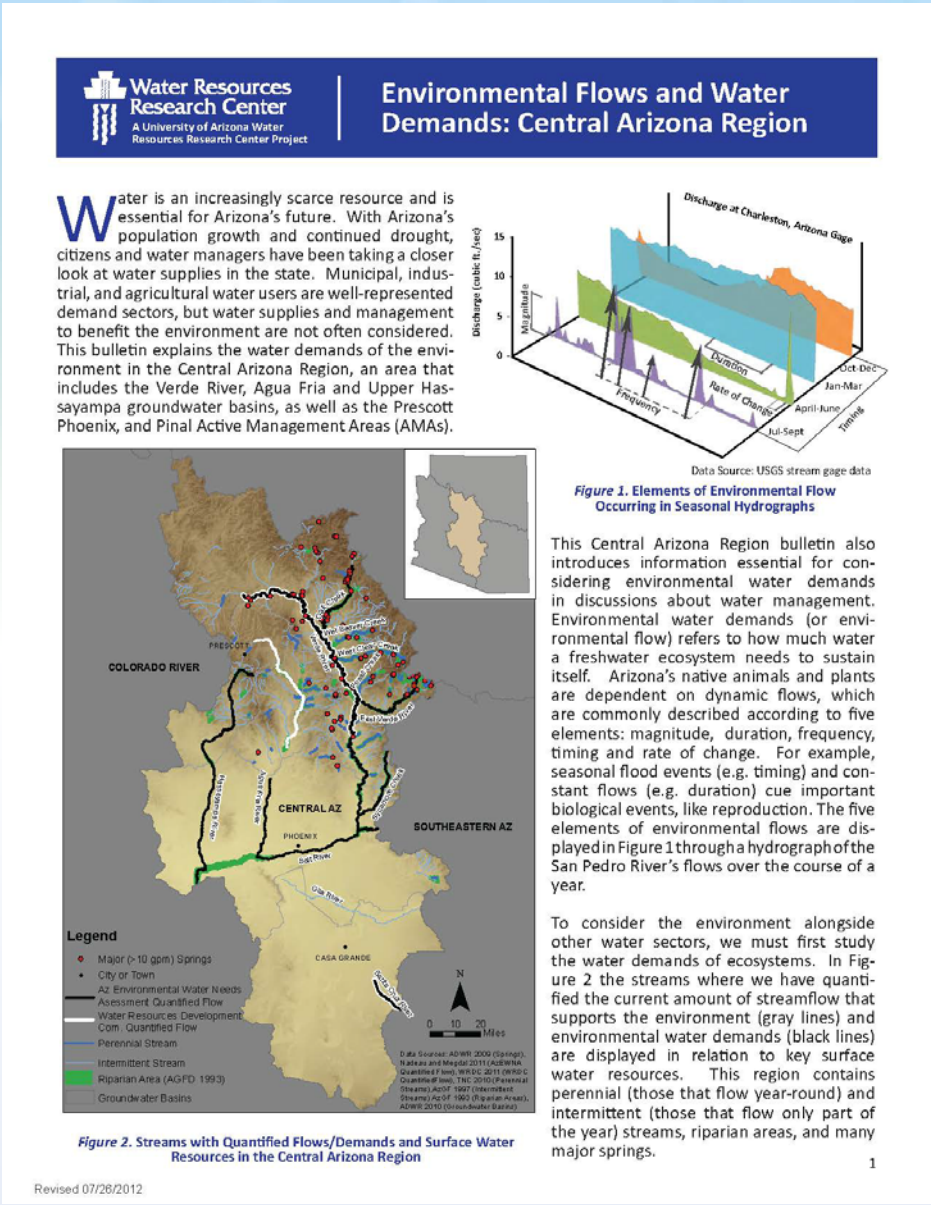
To consider the environment alongside other water sectors, we must first study the water demands of ecosystems. In Figure 2 the streams where we have quantified the current amount of streamflow that supports the environment (gray lines) and environmental water demands (black lines) are displayed in relation to key surface water resources. This region contains perennial (those that flow year-round) and intermittent (those that flow only part of the year) streams, riparian areas, and many major springs.

1

Revised 07/26/2012

For more information…

- Statewide and Regional Bulletins
- White Paper
- Quarterly Environmental Water Program Newsletter
- Website: wrrc.arizona.edu/Water-for-the-Environment



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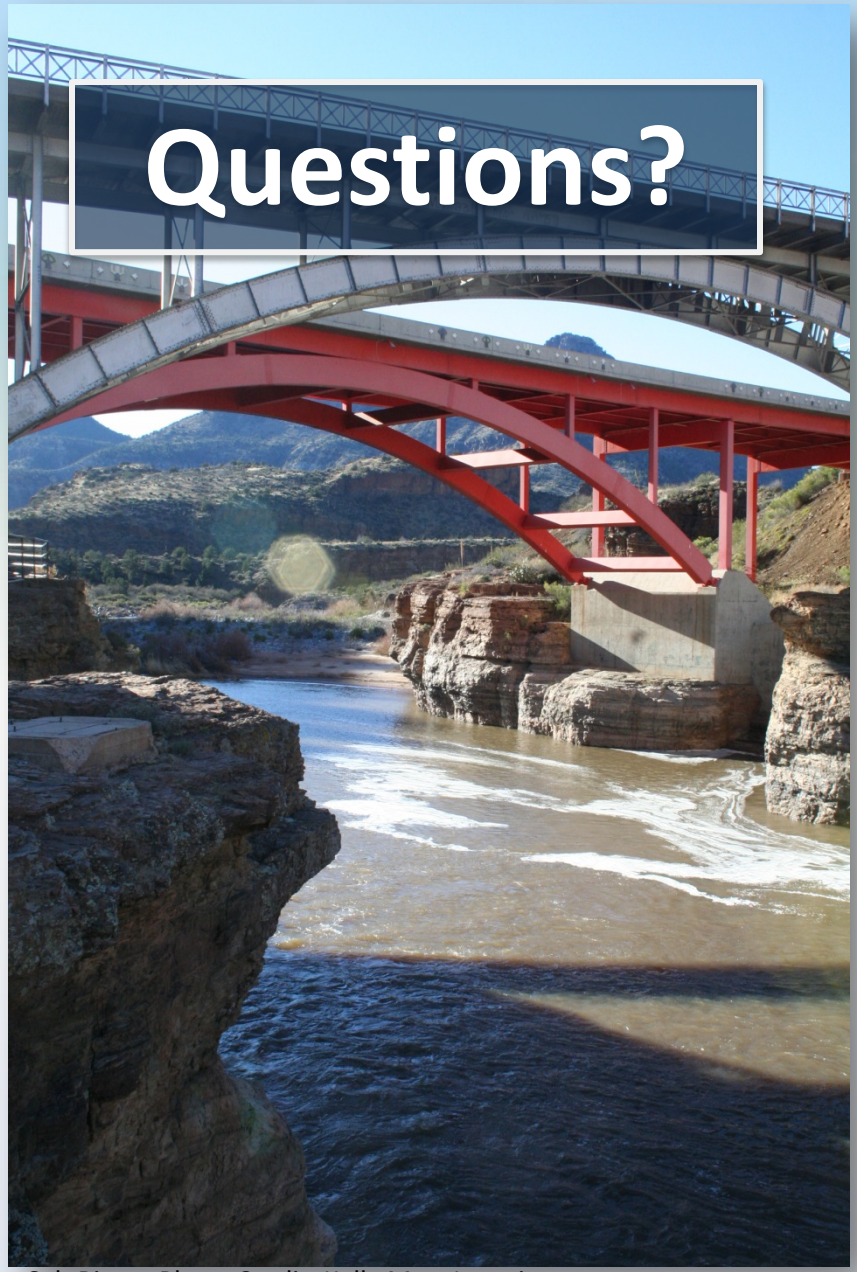
Questions?



Salt River. Photo Credit: Kelly Mott Lacroix

Kelly Mott Lacroix
Research Analyst
klacroix@cals.arizona.edu

University of Arizona
Water Resources Research Center
520-621-9591

wrrc.arizona.edu