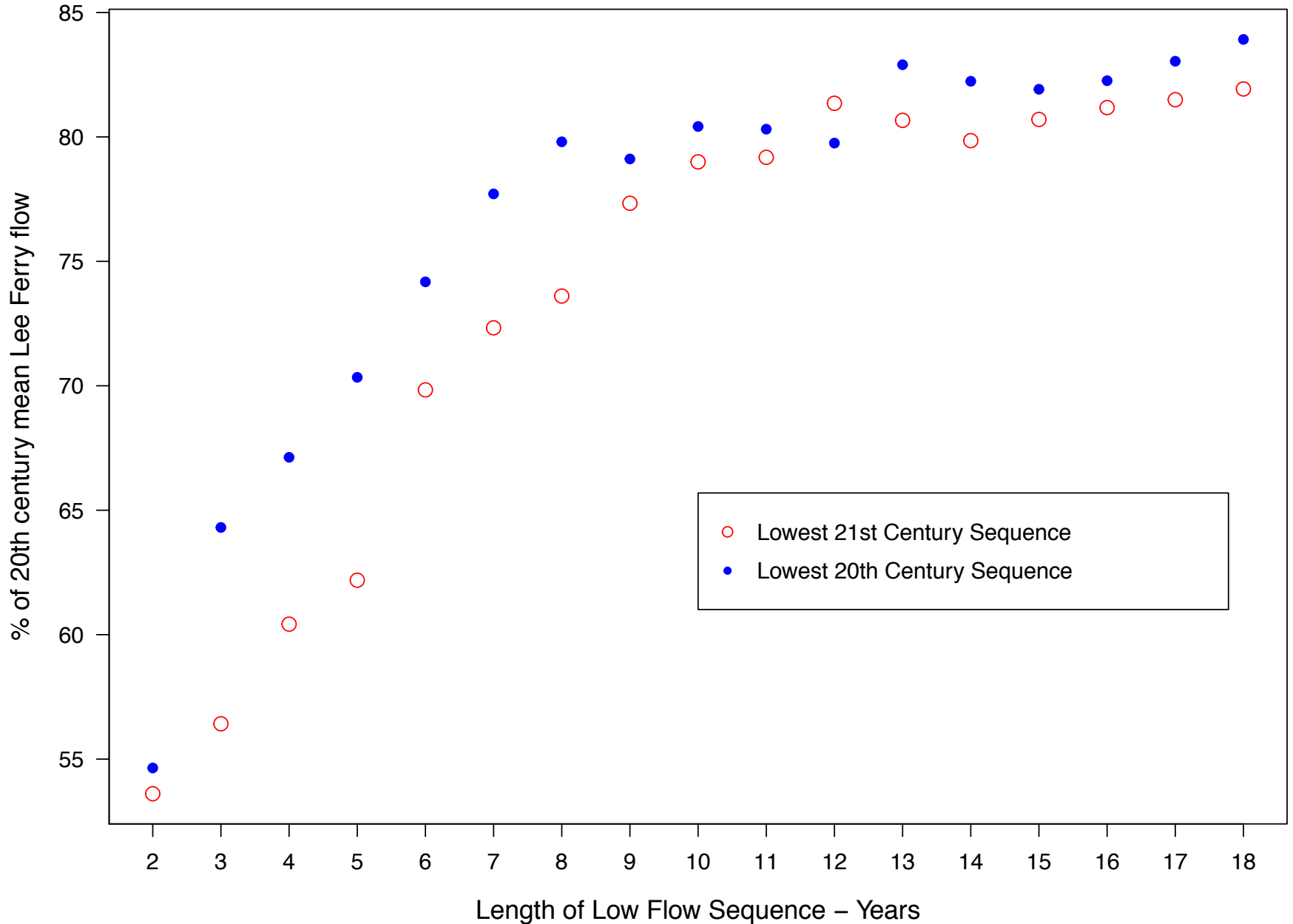


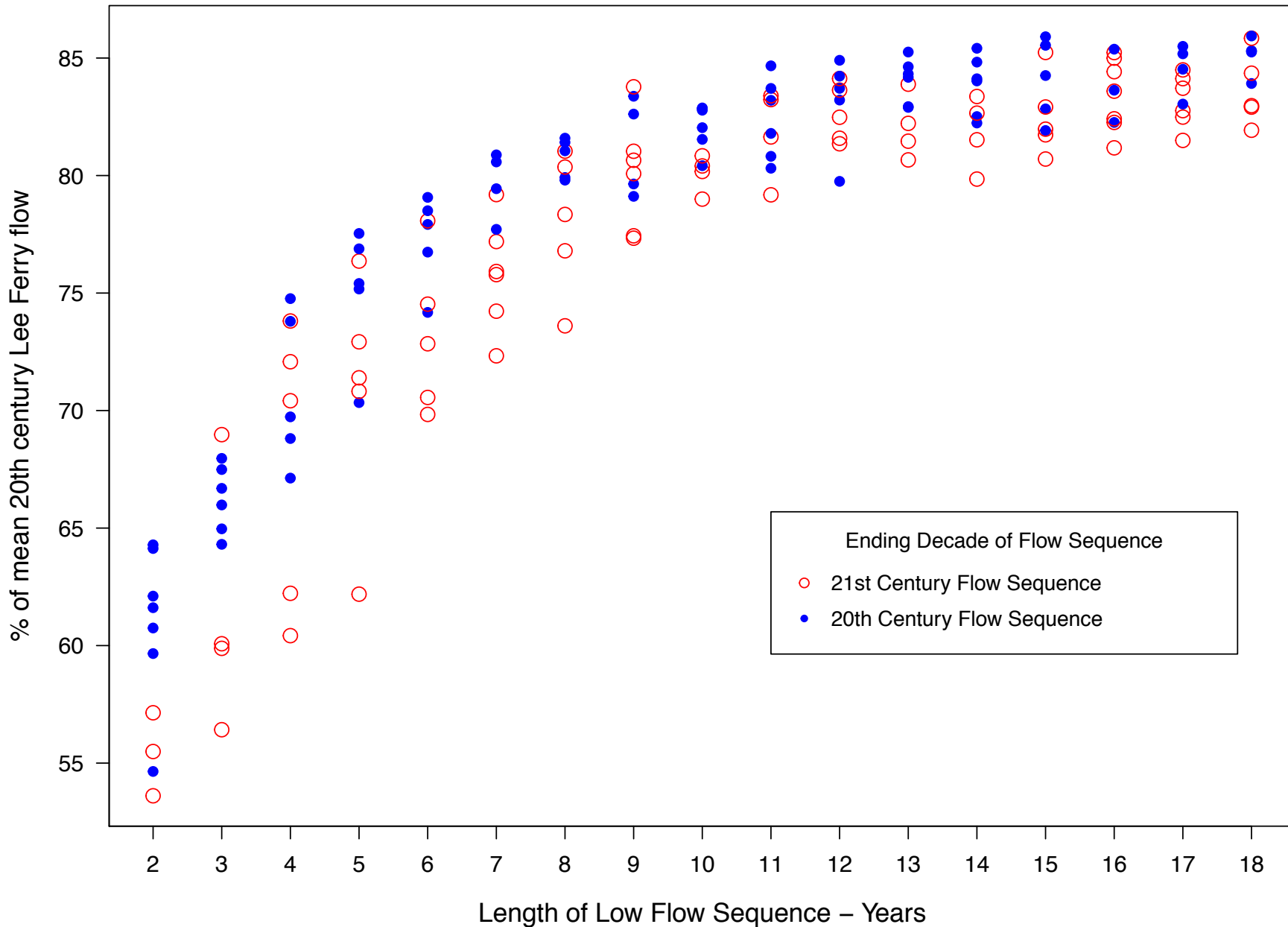
Most Severe Colorado River Low Flow Sequences

Worst Sequence from each century



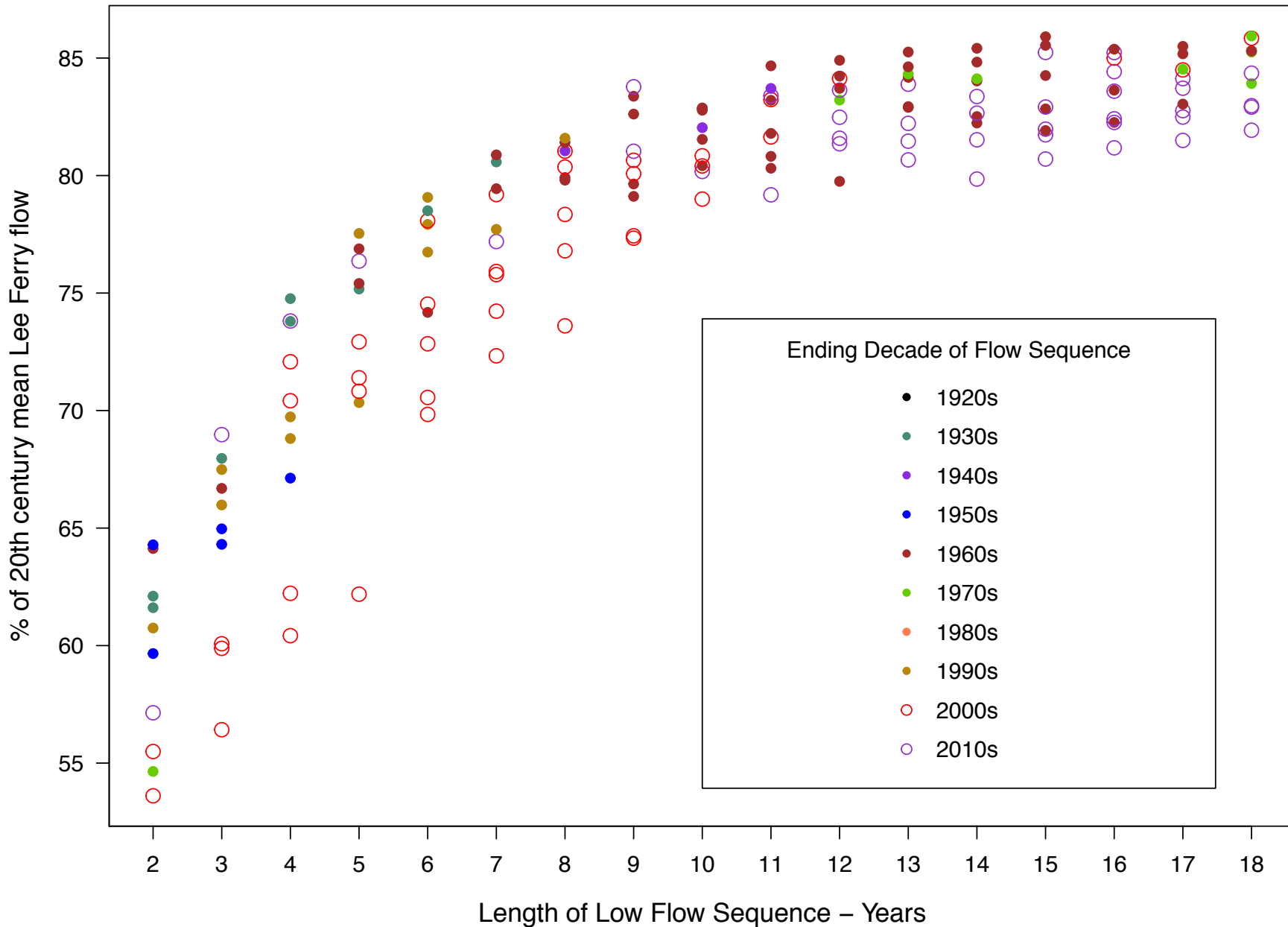
Most Severe Colorado River Low Flow Sequences

10 Worst Sequences



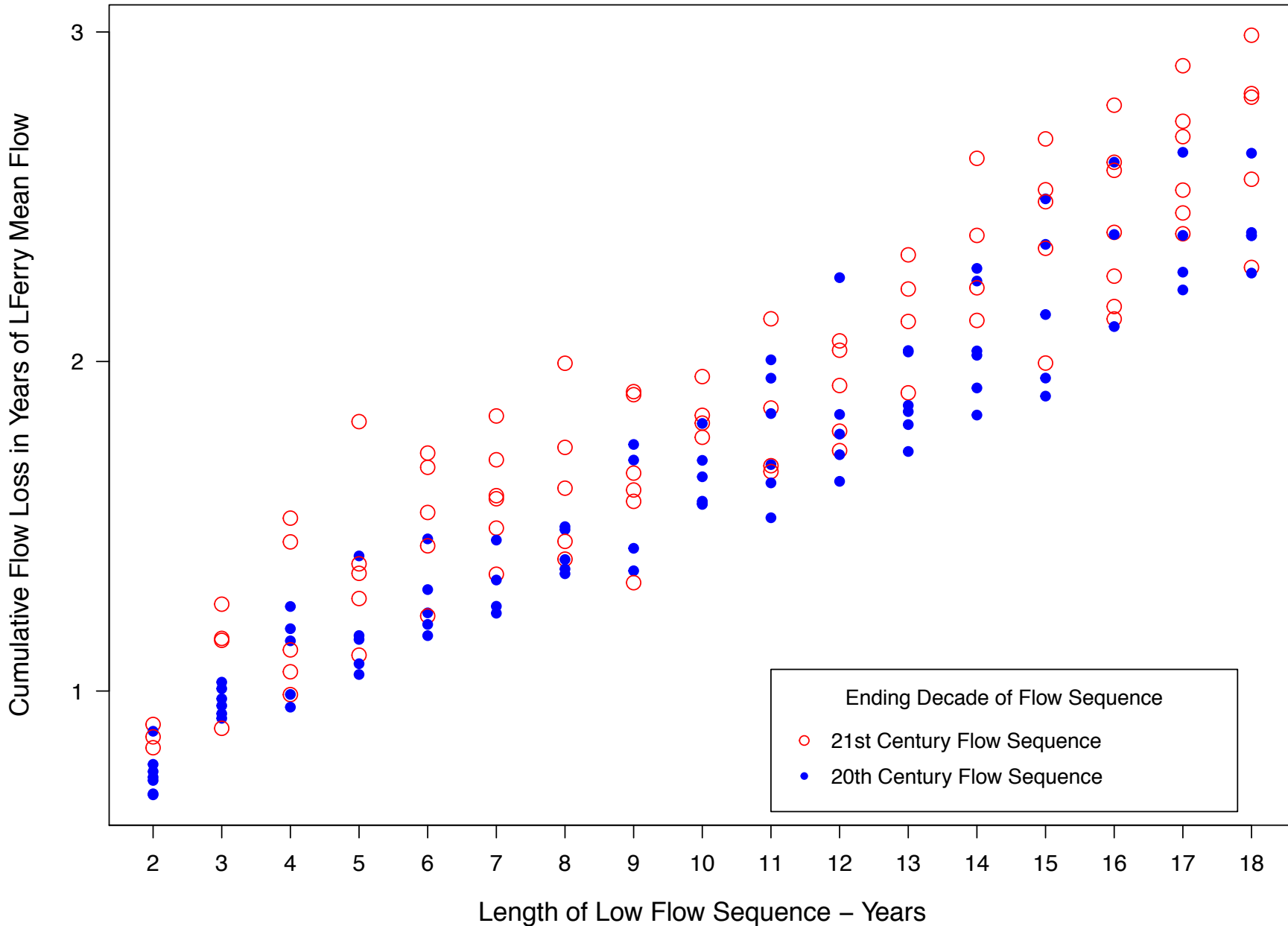
Most Severe Colorado River Low Flow Sequences

10 Worst Sequences



Most Severe Colorado River Low Flow Sequences

10 Worst Sequences

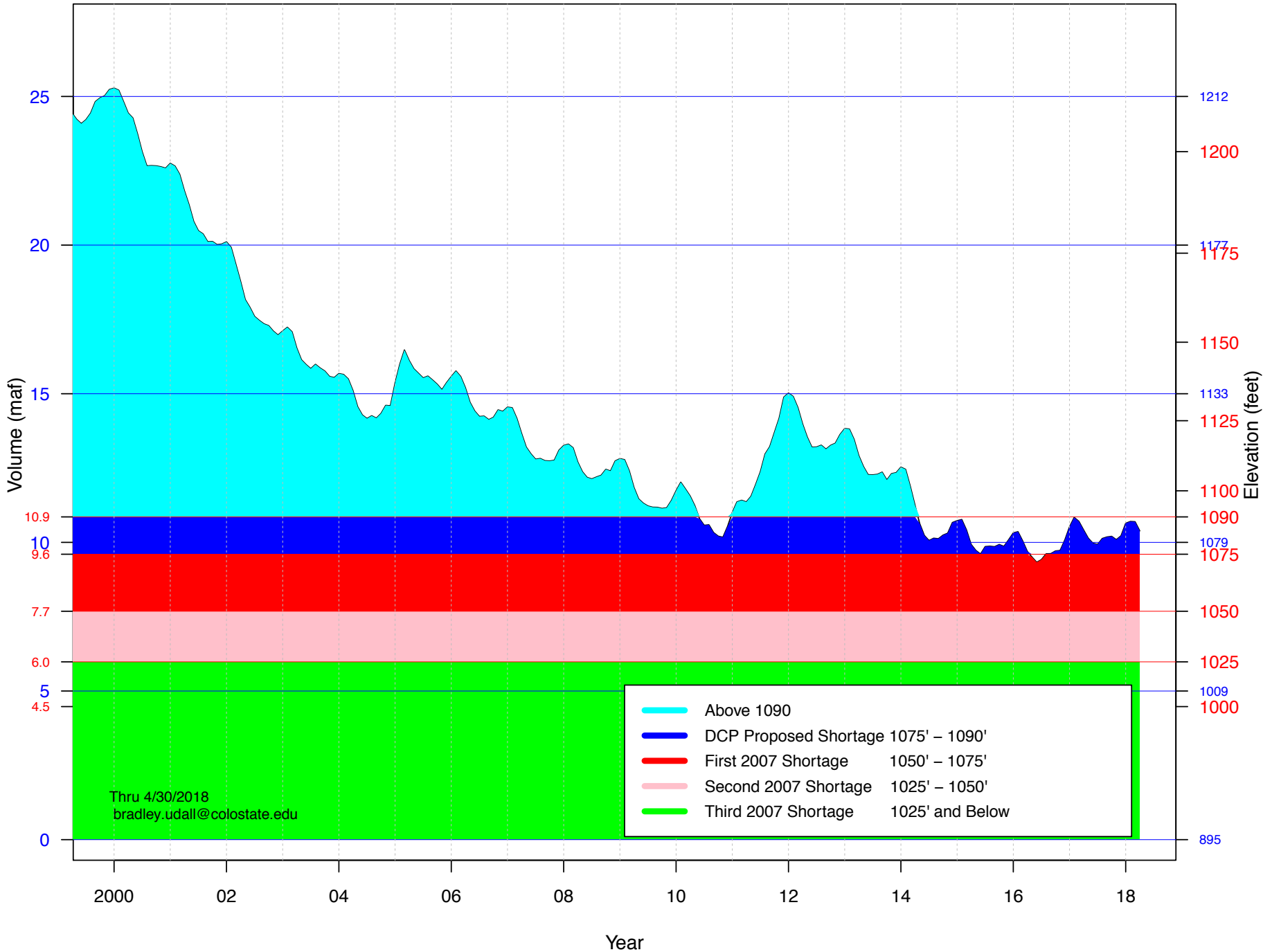


Notes on these slides

- Plots were produced in R by Brad Udall, Bradley.udall@colostate.edu. Code is available on request.
- Raw Data is the Lee Ferry Natural Flows from Reclamation.
- I calculate as many n-year overlapping averages as I can for a given n, with n ranging from 2 years to 18 years. (Imagine in Excel doing a two-year moving average on a column of all years of flow data and copying that formula for the entire period of record.) With 113 years of data, I calculate 112 2-year sequences, 111 3-year sequences, etc.
- 2018 is estimated at 53% of normal.
- I sort the calculated moving averages from lowest to highest and take the 10 worst to graph for Plots 2,3, and 4. Some of the plotted sequences may be overlapping. For example, 2002-2003 and 2001-2002 are the 1st and 3rd worst two-year sequences.
- For Plot 1 showing only 2 dots per sequence, I plot the worst 21st century sequence, and the worst 20th century sequence. In many cases, I skip intervening 21st century sequences that are worse than the worst 20th century sequence. (See Plots 2 and 3 for the missing sequences.)
- For the cumulative flow loss plot (#4), I multiply the per year average flow loss by the number of years in the sequence to arrive at the total flow loss if average flows had occurred during the n-year flow sequence.
- Plot 3 showing the ending decades by individual decade can be used to ascertain the approximate position of the n-year sequence in the historical record. An attached CSV file shows the 10 worst sequences including average flow, ending year, and missing flow volume. The 10 worst flow sequences for each n-year period are also shown on the next slide.

Ending Year	Average Flow	N-Year Sequence	Missing_Flow	Ending Year	Average Flow	N-Year Sequence	Missing_Flow	Ending Year	Average Flow	N-Year Sequence	Missing_Flow	Ending Year	Average Flow	N-Year Sequence	Missing_Flow
2003	8160550	2	13678901	2006	11010173	7	27928788	1964	12140122	12	34318537	2016	12405487	17	44106720
1977	8318137	2	13363727	2007	11299290	7	25904970	2013	12383592	12	31396896	2018	12556413	17	41540976
2002	8447306	2	13105388	2004	11536115	7	24247192	2010	12419568	12	30965184	2015	12598126	17	40831851
2013	8698284	2	12603433	2005	11556491	7	24104563	2012	12555425	12	29334903	1969	12640744	17	40107349
1955	9081806	2	11836389	2018	11750355	7	22747513	1970	12666758	12	27998904	2017	12743423	17	38361814
1990	9247321	2	11505358	1994	11829295	7	22194935	2011	12731108	12	27226707	2014	12805474	17	37306939
1934	9378789	2	11242423	2008	12054536	7	20618251	1965	12742594	12	27088867	2004	12862044	17	36345252
1935	9453768	2	11092464	1964	12092707	7	20351049	2009	12806084	12	26326998	1970	12866444	17	36270456
1964	9762251	2	10475498	1937	12265996	7	19138025	1969	12821678	12	26139861	1967	12966339	17	34572236
1954	9786071	2	10427858	1965	12311812	7	18817315	1961	12924284	12	24908592	1968	13014660	17	33750782
2004	8588530	3	19234411	2007	11204542	8	30363667	2013	12279120	13	35371443	2018	12471360	18	45515523
2003	9115517	3	17653448	2006	11690388	8	26476895	2012	12400492	13	33793600	2017	12621083	18	42820511
2002	9145305	3	17564085	2008	11925900	8	24592798	2014	12515834	13	32294158	2016	12630287	18	42654827
1955	9789204	3	15632388	1961	12147951	8	22816390	1966	12619300	13	30949104	1970	12774086	18	40066455
1956	9889569	3	15331292	1966	12165306	8	22677552	1965	12624241	13	30884866	2015	12840929	18	38863281
1990	10044288	3	14867136	2005	12233001	8	22135993	2010	12769491	13	28996614	1971	12977606	18	36403084
1961	10151721	3	14544838	2009	12335723	8	21314217	1964	12813962	13	28418494	1968	12985281	18	36264949
1991	10273698	3	14178906	1940	12337892	8	21296867	1971	12836036	13	28131532	1967	12985871	18	36254315
1935	10345866	3	13962401	1960	12392479	8	20860167	1967	12882288	13	27530254	2004	13067192	18	34790552
2014	10499768	3	13500695	1994	12419971	8	20640235	1963	12977838	13	26288111	1977	13081695	18	34529482
2004	9197761	4	23208958	2008	11772056	9	29051495	2013	12154990	14	39830140				
2003	9471964	4	22112145	2007	11787581	9	28911774	2014	12409378	14	36268705				
1956	10218177	4	19127291	1961	12043068	9	26612389	1966	12518207	14	34745103				
1992	10474643	4	18101429	1967	12123271	9	25890561	1967	12559849	14	34162113				
1991	10614829	4	17540684	2009	12190137	9	25288764	2015	12582107	14	33850500				
2005	10719197	4	17123212	2006	12276853	9	24508325	2012	12689878	14	32341707				
2002	10971952	4	16112192	2010	12335130	9	23983833	1964	12790524	14	30932661				
1934	11233705	4	15065182	1968	12576021	9	21815811	1972	12804776	14	30733132				
2015	11235741	4	15057037	1966	12691376	9	20777615	1968	12912645	14	29222967				
1936	11380745	4	14477019	2018	12752582	9	20226759	1963	13002129	14	27970190				
2004	9466469	5	27667655	2009	12025254	10	29747461	2014	12284840	15	40727402				
1992	10707359	5	21463207	2010	12204162	10	27958380	2013	12441450	15	38378247				
2005	10780448	5	21097759	2008	12240040	10	27599602	1967	12469459	15	37958112				
2003	10867950	5	20660252	1968	12241673	10	27583274	2015	12478330	15	37825047				
2006	11100891	5	19495544	2007	12305680	10	26943204	1968	12609678	15	35854826				
1935	11442968	5	17785160	1963	12412201	10	25877988	2016	12621768	15	35673476				
1963	11478713	5	17606436	1940	12488037	10	25119626	1964	12825684	15	32614740				
2016	11623997	5	16880013	1967	12609938	10	23990624	2012	12975124	15	30373137				
1964	11703295	5	16483523	1964	12610932	10	23890679	1969	13021367	15	29679491				
1991	11802803	5	15985984	1962	12615696	10	23843039	1966	13076996	15	28845060				
2004	10630706	6	26215762	2010	12052993	11	32417077	2015	12357266	16	42283744				
2005	10740591	6	25556456	1964	12225224	11	30522538	1968	12521823	16	39650825				
2006	11088318	6	23470091	1963	12302365	11	29673987	2016	12521999	16	39648023				
1964	11291502	6	22250986	2009	12427676	11	28295568	2014	12545281	16	39275509				
2007	11344930	6	21930423	1969	12450927	11	28039798	2013	12724395	16	36409677				
1992	11681916	6	19908507	1968	12665151	11	25683337	1969	12730541	16	36311350				
1994	11861141	6	18833157	2008	12669906	11	25631032	2017	12850796	16	34387267				
2003	11884720	6	18691682	2012	12694513	11	25360356	2004	12938533	16	32983474				
1936	11950037	6	18299778	1940	12742171	11	24836121	2018	12974367	16	32410135				
1993	12036435	6	17781393	1961	12888499	11	23226513	1967	12996371	16	32058069				

Mead Volume/Elevation 2000–2018



Powell Volume/Elevation 2000–2018

