303(d) List
Deadline: 10/20/06 5pm

772

O'Laughlin & Paris LLP

Attorneys at Law

October 18, 2006

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SWRCB
Executive Ofc.

Tam Doduc
State Water Resources Control Board
1001 I St.
Sacramento, CA 95814

Re: Comment Letter – 2006 Federal CWA §303(d) List

Dear Chairwoman Doduc,

Please accept the attached comments of the San Joaquin River Group Authority on the proposed 2006 Clean Water Act §303(d) List of Water Quality Limited Segments for California. Please contact me if you have any questions.

Very truly yours,

O'LAUGHLIN & PARIS LLP

By: Kenneth Petruzzelli

Enclosures

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Proposed 2006 Federal Clean Water Act §303(d) List of Water Quality Limited Segments for California

Comments of the

SAN JOAQUIN RIVER GROUP AUTHORITY

South San Joaquin Irrigation District	Modesto Irrigation District
Oakdale Irrigation District	Turlock Irrigation District
Merced Irrigation District	City and County of San Francisco
Friant Water Users Authority and its member agencies:	
Lower Tule River Irrigation District	Shafter-Wasco Irrigation District
Arvin-Edison Water Storage District	Southern San Joaquin Municipal Utility District
Orange Cove Irrigation District	Stone Corral Irrigation District
Pixley Irrigation District	Ivanhoe Irrigation District
Chowchilla Water District	Teapot Dome Water District
Porterville Irrigation District	Kern-Tulare Water District
Delano-Earlimart Irrigation District	Terra Bella Irrigation District
Rag Gulch Water District	Lindmore Irrigation District
Exeter Irrigation District	Tulare Irrigation District
Saucelito Irrigation District	Lindsay-Strathmore Irrigation District
Fresno Irrigation District	Madera Irrigation District
San Joaquin River Exchange Contractors Water Authority and its members:	
Central California Irrigation District	Firebaugh Canal Water District
San Luis Canal Company	Columbia Canal Company

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I. Introduction.

The San Joaquin River Group Authority ("SJRGA") submitted extensive comments for the 2006 revision to the Clean Water Act ("CWA") §303(d) List of Water Quality Limited Segments for California ("§303(d) List"). In its comments, the SJRGA recommended de-listing the Lower San Joaquin River ("LSJR"), from Mendota Pool to Vernalis, as a water quality limited segment for Electrical Conductivity ("EC") and boron. The proposed 2006 §303(d) List recommends no changes in the LSJR's status. (State Water Resources Control Board ("SRWCB"), Revision of the Clean Water Act §303(d) List of Water Quality Limited Segments (Vol. 1, September 2006) ("Staff Report"), p88 Table 11 (available at http://www.waterboards.ca.gov/tmdl/docs/303dlists2006/v1sr_all.pdf, accessed 9.27.06.).) The Responses to Comments however, are contradictory and inconsistent with themselves, the law, and the facts and fail to address the legal inadequacies of continued listing of the LSJR for EC based on exceedances of non-existent Water Quality Objectives ("WQOs").

II. The Lower San Joaquin River Cannot Be Classified as a Water Quality Limited Segment for Salinity, Because No Applicable Water Quality Objectives Have Been Established.

A. No Applicable Water Quality Objectives Have Been Established for the Lower San Joaquin River.

The authority for the CVRWQCB to regulate water quality derives from the Porter-Cologne Act, which in turn delegates powers to SWRCB and regional water quality control boards for the purposes of implementing the Federal Water Pollution Control Act ("Clean Water Act"). (33 U.S.C. §1251 et seq.) Therefore, the basin planning process, including the development of water quality objectives and TMDLs, must comply with Porter-Cologne and the CWA.

WQOs[1] are "the limits or levels of water quality constituents or characteristics" established to reasonably protect beneficial uses or prevent nuisance within a specific area. (Water Code §13050(h).) The CWA provides the statutory basis for defining water quality limited segments and, by its explicit language, makes WQOs are an integral element and prerequisite for listing a water body:

> Each State shall identify those waters within its boundaries for which the effluent limitations required by section 1311(b)(1)(A) and section 1311(b)(1)(B) of this title are not stringent enough to implement any **water quality standard** applicable to such waters.

(33 USCA 1313(d)(1)(A) (emphasis added); *see* also San Francisco Baykeeper v. Whitman (2002) 297 F.3d 877, 885.) Federal regulations, consistent with the CWA, make WQOs an integral element of the definition of "water quality limited segment":

> "Any segment where it is known that water quality does not meet **applicable water quality standards**, and/or is not expected to meet **applicable water quality standards**..."

(40 CFR §130.2 (emphasis added).)

It therefore follows, based on the federal statutory and regulatory definition of "water quality limited segment," adopted and implemented through the Water Quality Control Policy for Developing California's §303(d) List of Water Quality Limited Segments ("Listing Policy"), that a water body cannot be classified as a "water quality limited segment" unless applicable WQOs for the pollutant are first established. (SWRCB Resolution No. 2004-0063, Water Quality Control Policy for Developing

[1] The term "water quality objective" as used in Porter-Cologne is equivalent to the term "water quality standard" in the Clean Water Act. (Water Code §13050(h); 40 CFR 130.3; SWRCB Cases (2004) 136 Cal.App.4th 674, 697 fn11.)

California's §303(d) List of Water Quality Limited Segments (September 30, 2004), p1; 23 Cal. Code Regs. §2917.)

It is undisputed that no WQOs for EC have been established for the LSJR upstream of Vernalis. (SWRCB, Revision of the Clean Water Act §303(d) List of Water Quality Limited Segments: Responses to Comments (Vol. 4, September 2006) ("2006 §303(d) List Responses to Comments"), p180 (available at http://www.waterboards.ca.gov/tmdl/docs/303dlists2006/v4sr_all.pdf, accessed 9.27.06).) Until such WQOs are properly established and sufficient exceedances demonstrated, the LSJR, by definition, cannot be classified as a water quality limited segment and must be de-listed.

B. The Vernalis EC Objective Does Not Apply to the Lower San Joaquin River.

Currently, the only EC objective on the LSJR is the Southern Delta Water Quality Objective for Agricultural Beneficial Uses compliance location at Airport Way Bridge, near Vernalis ("Vernalis EC Objective"). (1995 Water Quality Control Plan ("WQCP") for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary ("1995 WQCP"), p17 Table 2 (available at http://www.waterrights.ca.gov/baydelta/1995WQCPB.pdf, accessed October 17, 2006.) The Vernalis EC Objective requires a maximum 30-day running average mean daily EC of 0.7 deciSiemens/meter ("dS/m") from April 1 through August 31 and 1.0 dS/m from September 1 through March 31. (Id.) It was adopted from the earlier 1991 Water Quality Control Plan for Salinity for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary ("1991 WQCP") for the purpose of protecting South Delta agricultural beneficial uses.[2] (SWRCB Resolution No. 95-24, Adoption of the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (May 1995), p1.) It was neither developed nor adopted to protect the LSJR upstream of Vernalis.

CVRWQCB Staff, in comments supporting continued listing of the LSJR, acknowledge that the Vernalis EC Objective does not represent upstream EC:

> The San Joaquin River at Vernalis, as a result of its location downstream of the Stanislaus River, does not necessarily represent the water quality conditions present in the rest of the upstream reaches of the river. As mentioned before, releases from New Melones Reservoir for water quality and fisheries compliance provides a large amount of dilution water for the San Joaquin River. Proposed compliance sites upstream of this confluence present a starkly different view of the water quality conditions.

(Grober, L., CVRWQCB, Report on San Joaquin River Salinity (2006) ("Grober 2006").)

The Responses to Comments also acknowledge the inapplicability of the Vernalis EC Objective upstream, as the "WQO's for the listings in question apply only to the LSJR at Vernalis." (SWRCB, Revision of the Clean Water Act §303(d) List of Water Quality Limited Segments: Responses to Comments (Vol. 4, September 2006) ("Responses to Comments"), p180 (available at http://www.waterboards.ca.gov/tmdl/docs/303dlists2006/v4sr_all.pdf, accessed 9.27.06).) The response contradicts itself, as the "listings in question" are for segments of the LSJR

[2] The Vernalis EC Objective in the 1991 WQCP was, in turn, adopted from the terms and conditions established in Water Rights Decision 1422. (1991 WQCP, p[5-10].) D-1422 required "releases of conserved water from New Melones Reservoir for water quality control purposes… to maintain a mean monthly total dissolved solids concentration in the San Joaquin River at Vernalis of 500 parts per million." (SWRCB Water Rights Decision 1422, New Melones Project Water Rights Decision (April 4, 1973), p31 (available at http://www.waterrights.ca.gov/hearings/decisions/WRD1422.PDF, accessed October 17, 2006.) "Interim Stage 2" of the 1991 WQCP revised the Vernalis EC Objective from 500 ppm total dissolved solids to the current irrigation and non-irrigation season objectives of 0.7 and 1.0 dS/m, respectively.

from Mendota Pool to Vernalis that admittedly lack WQOs for EC. (Id. at 181.) The Responses to Comments and the CVRWQCB Staff report on SJR salinity further contradict themselves by relying on exceedances of the Vernalis EC Objective as a line of evidence supporting impairment of the LSJR from Mendota Pool to Vernalis while simultaneously arguing that the Vernalis EC Objective is not representative of the LSJR upstream of Vernalis. (Responses to Comments, p178-180; Grober 2006.)

Finally, the Responses to Comments attempt to argue that the Listing Policy provides latitude in determining the spatial representativeness of data used to list a water body or consider water quality during critical drought periods. (Id.) Irrespective of whether the data adequately represents LSJR EC, the Vernalis EC Objective only applies to the South Delta and compliance only indicates whether South Delta agricultural beneficial uses are protected. The Vernalis EC Objective does not indicate whether agricultural beneficial uses elsewhere, including the LSJR upstream of Vernalis, are protected.

C. The Vernalis EC Objective Cannot Apply to the LSJR.

The basin planning process must be conducted in compliance with applicable requirements of the Porter-Cologne Water Quality Control Act ("Porter-Cologne") (Water Code § 13000 et seq.) and the CWA. (Government Code §11353(b)(7).) WQOs are contained in regional water quality control plans ("basin plans"). (Water Code §13241.) Regional boards cannot adopt basin plans without first holding a public hearing and giving notice by publication. (Water Code §13244.) No water quality control plan or any revision thereof, including any addition or alteration of WQOs, becomes effective until approved by the SWRCB. (Water Code §13245.) All such revisions must be subsequently approved by the Office of Administrative Law ("OAL"). (Government Code §11353(b)(5).) The OAL must reject all basin plans and basin plan amendments that fail to comply with the public participation requirements of the CWA. (Government Code §11353(b)(4).)

The CVRWQCB is still in the early stages of developing WQOs for EC for the LSJR upstream of Vernalis. No draft public review staff report has been issued and no Basin Plan amendment adopting such objectives has been approved by the SWRCB or adopted by the OAL. No workshop presenting a public review draft staff report is planned until at least Summer 2007. (*See* Attachment 2: CVRWQCB electronic notice (October 16, 2006).) By applying the Vernalis EC Objective upstream, the SWRCB and CVRWQCB would circumvent the public participation process mandated by Porter-Cologne and the CWA and effectively impose new WQOs on the LSJR without amending the Basin Plan. The proper procedure dictated by the CWA and Water Code is to develop WQOs and incorporate them into the Basin Plan via a basin plan amendment. Only after developing WQOs can a water body classified as a "water quality limited segment" and, based on the frequency and severity of water quality exceedances of WQOs, allocated a priority for a TMDL.[3]

The continuing scientific validity of the Vernalis EC Objective itself has also become questionable, so much so that the Draft 2006 WQCP calls for an updated independent scientific investigation of the irrigation salinity needs of the South Delta,

[3] The CVRWQCB Staff report on SJR salinity relies on data contained in Attachment 3, which calculates running 30-day average flow-weighted EC. (Grober 2006, Attachment 3, p2.) The Vernalis EC Objective however, is not a flow-weighted average, but an average of mean daily EC. (1995 WQCP, p17 Table 2.) By weighting flow, CVRWQCB Staff change the criteria and thereby change the objective. Salinity data contained in Attachment 3 of the CVRWQCB Staff report on SJR salinity therefore does not and cannot indicate whether compliance with the Vernalis EC Objective has occurred.

similar to the investigation on which the current objective is based. (Draft 2006 WQCP, p30.) To that end, the SWRCB has scheduled a public workshop for January 2007 to solicit further information on the irrigation salinity needs of the South Delta, in addition to recommendations and proposals for study plans. (*See* Attachment 1: Notice of Public Workshop in re Consideration of Southern Delta Water Quality Objectives for Salinity in the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (October 13, 2006).)

The only investigation of irrigation salinity needs upstream was in the Technical Committee Report drafted in response to SWRCB's Order No. WQ 85-1 ("WQO 85-1"). (CVRWQCB, Amendments to the Water Quality Control Plan For the Sacramento River and San Joaquin River Basins for the Control Of Salt And Boron Discharges Into the Lower San Joaquin River, Final Staff Report, Appendix 1: Technical TMDL Report (September 10, 2004) ("SJR Salt & Boron TMDL Appendix 1"), p[1-21] (available at http://www.waterboards.ca.gov/centralvalley/programs/tmdl/vernalis-salt-boron/appendix1.pdf, accessed October 17, 2006); Technical Committee Report for Regulation of Agricultural Drainage to the San Joaquin River ("WQO 85-1 Technical Report").) In developing WQO's for agricultural beneficial uses, the Technical Committee adopted recommendations previously developed by the University of California Consultants in 1974. (WQO 85-1 Technical Report, p[IV-4].) With respect to salinity, the Technical Committee first observed that a criterion of 0.7 dS/m would fully protect all crops in the LSJR Basin and in the South Delta:

> "An EC of 0.7 mmhos/cm permits production of all crops on all soils with adequate drainage in the San Joaquin River Basin and downstream in the southern Delta. Salinity levels above this require special cropping or water management techniques. Above

> an EC of 3.0 mmhos/cm (about 2,000 mg/l TDS) water quality is generally too poor to support agriculture."

(WQO 85-1 Technical Report, p[IV-9].) The Technical Committee also made specific recommendations for different segments of the LSJR, based on prevalent soil types and cropping patterns. For the segment from Lander Avenue on the LSJR down to Hills Ferry Road Bridge, just above the Merced River, the Technical Committee recommended an EC objective of 3.0 dS/m:

> "In Salt Slough and areas of the San Joaquin River downstream to Hills Ferry there are only a few agricultural diversions. These diversions are for the irrigation of pasture which is very salt tolerant. Historical maximum salinity concentrations in Salt Slough are typically as high as or higher than 3.0 mmhos/cm EC. An objective of 3.0 mmhos/cm EC supports the existing uses in Salt Slough and areas downstream to Hills Ferry consistent with the historic water quality and present agricultural practices. Therefore, an objective of 3.0 mmhos/cm EC is recommended as the water quality objective for this limited area."

(WQO 85-1 Technical Report, p[VIII-16].) For the segment below Hills Ferry, the Technical Committee recommended an objective of 1.0 dS/m:

> "The Regional Board staff has evaluated the soil types and crops that are grown using diversions from the San Joaquin River in the areas immediately downstream of Hills Ferry. They have determined that a water quality objective of 1.0 mmhos/cm EC (about 620 mg/l TDS) would provide reasonable protection to these crops on the soils in this area."

(WQO 85-1 Technical Report, p[VIII-15].) Based on the WQO 85-1 Technical Report, applying the Vernalis EC Objective upstream would lack any scientific basis. Even if application of the Vernalis EC Objective upstream did have a scientific basis, the Draft 2006 WQCP now acknowledges that any such scientific basis could now be outdated.

While blind application of the Vernalis EC Objective upstream might be easy, it would also be improper.

III. Compliance with the Vernalis EC Objective Refutes the Propriety of Continued Listing.

A. Courts have Concluded that the Vernalis EC Objective Will Be Met.

Central Valley Project Improvement Act ("CVPIA") §3406(b) requires that the Central Valley Project ("CVP") meet all of its obligations under State and Federal law, including decisions by the SWRCB. (Pub.L. 102-575 Stat. 4600.) D-1641 made the USBR solely responsible for maintaining the Vernalis EC Objective. (SWRCB, Revised Water Right Decision 1641 (March 15, 2000), p159-161.) Before D-1641, the USBR was not required to maintain the Vernalis EC Objective. It is undisputed that the Vernalis EC Objective has been met, without fail, since 1995. (Grober 2006, Attachment 1, p18.) Under the Listing Policy such a compliance rate would require de-listing. (Listing Policy, §4.2.) Arguments supporting continued listing depend on prior exceedances and the potential for future exceedances, particularly those occurring in Dry and Critically Dry year types. (Grober 2006.)

In developing the SJR Salt & Boron TMDL, the CVRWQCB acknowledged that, due to changes in facilities, regulations, and operations, historical data did not represent current conditions. (CVRWQCB, Amendments to the Water Quality Control Plan For the Sacramento River and San Joaquin River Basins for the Control Of Salt And Boron Discharges Into the Lower San Joaquin River, Final Staff Report, Appendix 5: Technical Evaluation of Alternatives (September 10, 2004) ("SJR Salt & Boron TMDL Appendix 5"), p[A5-3].) Much of the historical data, particularly from before 1995, preceded the New Melones Interim Plan of Operations ("IPO"), the protocol used by the USBR to operate New Melones in compliance with all of its obligations, including maintaining the Vernalis EC Objective. Since historical data poorly represented current and future conditions, modeling was required in order to compare various project alternatives to one another and to No Project conditions, which represented current conditions. (SJR Salt & Boron TMDL Appendix 5, p[A5-1].) Under No Project conditions, the CVRWQCB modeling predicted that exceedances would occur in approximately 13% of months. (Grober 2006 Attachment 1, p19; SJR Salt & Boron TMDL Appendix 5, p[A5-21]; *see* Table 1, below.)

Table 1. Projected Number and Rate of Exceedances Predicted by CVRWQCB.[4]

		Irrigation Season			Non-Irrigation Season		
Year Type	Years	Months	Exceedance Rate (%)	Exceedances	Months	Exceedance Rate (%)	Exceedances
CD	17	85	40	34	119	34	40
D	15	75	18	14	105	14	15
BN	17	85	13	11	119	15	18
AN	21	105	9	9	147	7	10
W	34	170	2	3	238	1	2
Total	104	520	14	71	728	12	86
		Total Exceedances: 157			Exceedance Rate (%): 13		

When the USBR adopted the IPO for New Melones in 1997, it used modeling that showed exceedances would occur in approximately 10% of months. (Central Delta Water Agency v. Bureau of Reclamation ("CDWA v USBR") (2006) 452 F.3d 1021, 1024-5.) The IPO was developed using the now-outdated STANMOD model. Since then, the United States Bureau of Reclamation ("USBR") and Department of Water Resources have adopted the new, state-of-the-art CALSIM II model as their official planning model.

[4] The CVRWQCB did not provide overall rates and numbers of exceedances in either its SJR Salt & Boron TMDL or its 2006 §303(d) List submission. Numbers and rates of exceedances were calculated based on the number of year types in the period from 1901 through 2004 cited in the CVRWQCB 2006 §303(d) List comments. (Grober 2006 Attachment 1, p19.) Exceedance rates were based on "No Project" conditions modeled for the SJR Salt & Boron TMDL. (SJR Salt & Boron TMDL Appendix 5, p[A5-21].) The numbers of months were based on having five months each year in an irrigation season (April through August) and seven months for the non-irrigation season. Numbers were rounded to whole numbers.

(CALFED Science Program, Review Panel Report: San Joaquin River Valley CALSIM II Model Review ("CALSIM II Peer Review") (January 12, 2006), p4 (available at http://science.calwater.ca.gov/pdf/calsim/calsim_II_final_report_011206.pdf, accessed October 10, 2006).) The CVRWQCB used modeling to develop the SJR Salt & Boron TMDL that is also now outdated. The CVRWQCB would have used CALSIM II had the model been available. (Salt & Boron TMDL: Appendix 5, p2.) Modeling by CALSIM II clearly demonstrates that, even if the USBR strictly operates pursuant to the IPO and only uses New Melones releases to maintain the Vernalis EC Objective, exceedances would occur in less than 2% of months. (*see* SJRGA Comments, p57-58; *see* also Table 2, below.)

Table 2: Exceedances of the Vernalis EC Objective simulated by CALSIM II-Revised with Current LSJR hydrology.[5]

Average Monthly Water Quality at Vernalis - Simulated (uS/cm)

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1935	C	C	C	C	1080	C	C	C	C	C	C	C
1961	C	C	C	C	1058	C	C	C	C	C	717	C
1977	C	C	C	C	C	C	C	C	C	C	710	C
1988	C	C	C	C	C	C	C	C	C	C	708	C
1989	C	C	C	C	1207	C	C	C	C	C	C	C
1990	C	C	C	C	1139	C	C	C	C	C	C	C
1991	C	C	C	C	1253	C	C	C	C	C	C	C
1992	C	C	C	C	C	C	749	1011	723	C	737	C
1994	C	C	C	C	C	C	C	C	735	718	725	C

Notes: "C" means water quality was within compliance for month. Exceedence during April or May is during non-pulse flow period.

Water Quality Objective - uS/cm

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	1000	1000	1000	1000	1000	1000	700	700	700	700	700	1000

Estimated Additional New Melones Release Needed to Provided Water Quality Compliance - 1,000 acre-feet

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1935					10							
1961					7						2	
1977											1	
1988											1	
1989					20							
1990					15							
1991					22							
1992							6	21	1		3	
1994									4	1	2	

End of Month New Melones Storage - 1,000 acre-feet

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1935	584	580	583	616	640	690	820	1012	1127	1074	1001	958
1961	1201	1216	1231	1239	1243	1224	1186	1132	1079	1023	966	934
1977	1448	1444	1436	1428	1400	1339	1273	1209	1181	1124	1069	1047
1988	1443	1424	1410	1414	1404	1361	1298	1222	1182	1145	1109	1081
1989	1045	1029	1022	1020	1029	1079	1047	1002	984	932	882	886
1990	906	908	923	936	952	920	856	786	733	676	633	609
1991	598	580	589	587	584	626	594	558	521	461	404	385
1992	382	371	386	400	450	467	441	361	308	252	194	166
1994	716	738	772	802	825	775	723	675	619	552	490	455

Even more important, whenever CALSIM II predicts an exceedance, New Melones has more than enough storage available to maintain the Vernalis EC Objective. (*See* Table 2, above.) Exceedances only occur if the USBR strictly adheres to the IPO. However, the USBR does not blindly adhere to the IPO and deviates when necessary in order to meet its various obligations, including compliance with the Vernalis EC Objective. (CDWA v USBR, *supra* F.3d at 1025.)

CVRWQCB Staff cite inaccuracy of the CALSIM II model as reason to dismiss findings that the Vernalis EC Objective will be met in the future. (Grober 2006.) The

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[5] *See* Bay-Delta Periodic Review SJRG 13. Only violations of the Objective are shown. Violations are shaded pink. For purposes of conversion, 1000 uS/cm = 1 dS/m.

CALSIM II Peer Review Panel included Mr. Les Grober, then of the CVRWQCB Staff. (CALSIM II Peer Review, p1.) In its January 2006 report, the panel expressed concern that, although CALSIM II represented a significant advance over the older "Kratzer equation" representation, the CALSIM II model could underestimate salinity in Dry and Critical years and thereby overestimate the ability of New Melones to meet water quality objectives. (Id., p9.) However, the panel also noted that its finding was based on a narrowly constructed analysis and only identified a "potential additional need" for additional releases from New Melones. (Id., p54.)

CVRWQCB Staff submitted comments authored by Mr. Grober regarding SJR salinity for the 2006 §303(d) List revisions to SWRCB Staff in March 2006. (Grober 2006.)

In April 2006, the SWRCB held a workshop on the new CALSIM II model. (*See* Notice of Public Hearing, at http://www.waterboards.ca.gov/wksmtgs/2006/docs/0424_calsim.pdf.) At the workshop, this "potential additional need" was quantified and illustrated by the SJRGA presenter, with results indicating that conclusions drawn by the SJRGA from the CALSIM II results regarding the ability of New Melones to meet water quality objectives remain valid. (SWRCB CALSIM II Workshop (April 24, 2006).) Mr. Grober stated that the panel's concerns regarding CALSIM II's underestimation of salinity in Dry and Critical years had been addressed and, although CALSIM II could still underestimate salinity, such underestimates were insignificant. (Id.) CALSIM II, like any other model is imperfect, but still represents the best modeling available. (CALSIM II Peer Review, p8.)

The accuracy of CALSIM II and the USBR's ability to respond to actual hydrologic conditions has been confirmed by twelve years of consistent compliance. Although there has been no recurrence of the 1987 through 1992 drought, Dry years have occurred since then. Between 1995 and 2004, there have been four Wet years, two Above Normal years, one Below Normal year, and three Dry years. (Grober 2006, Attachment 1, p19 Table 4; Bay-Delta SJRG-7: Statement, Presentation of Daniel B. Steiner Concerning San Joaquin River Hydrology and Alternative Flow and Quality Objectives at Vernalis (March 2005), p32 Table 15 (available at http://www.waterrights.ca.gov/baydelta/docs/exhibits/SJRG-EXH-07.pdf, accessed October 16, 2006); *See* Table 3, below.)

Table 3. Comparison of Water Year Types for Historical 1995 to 2004 Periods.

Time Period		**Year Type**						**Mean Index**
		Wet	**Above Normal**	**Below Normal**	**Dry**	**Critically Dry**	**Total**	
1901 to 2004	No. years	34	21	17	15	17	104	3.34
	%	33%	20%	16%	14%	16%	100%	
1995 to 2004	No. years	4	2	1	3	0	10	3.64
	%	40%	20%	10%	30%	0%	100%	

While no Critical years have occurred since 1995, Dry years have occurred. In fact, Dry years have occurred twice as frequently as during the historical period since 1901. Furthermore, all of the drier years in the historical period since 1995 occurred consecutively, with two Dry years, a Below Normal year, and then another Dry year occurring from 2001 to 2004. (*See* Table 4, below.)

Table 4. Year Types for Historical Period 1995 to 2004.[6]

Year	Year Type	Year	Year Type
1995	W	2000	AN
1996	W	2001	D
1997	W	2002	D
1998	W	2003	BN
1999	AN	2004	D

CVRWQCB Staff continually cite the need to meet EC objectives under "all conditions," but the conditions in the historical record not only occurred as a result of year types, but also due to the sequence, quantity, and frequency of year types. (CVRWQCB Responses to Written Public Comments on the November 2003 Draft Staff Report for Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Salt and Boron Discharges into the LSJR (July 2004) ("SJR Salt & Boron TMDL Responses to Comments on November 2003 Draft Staff Report"), p12 (available at http://www.waterboards.ca.gov/centralvalley/programs/tmdl/vernalis-salt-boron/responsetocoms.pdf, accessed October 16, 2006.) The 1987 through 1992 drought, consisting of six consecutive Critical years, has an estimated 400-year rate of reoccurrence. (Bay-Delta SJRG-7, p32 Table 15; *See also* Attachment 3: New Melones Revised Plan of Operations Brekke Drought Reoccurrence Presentation, p30 (available at http://www.usbr.gov/mp/ccao/nmrpo/news_info/3-23-06_mtg/brekke_drought_presentation.pdf, accessed October 16, 2006); *See* also Attachment 4: New Melones Revised Plan of Operations Brekke Drought Reoccurrence Analysis (available at http://www.usbr.gov/mp/ccao/nmrpo/news_info/3-23-06_mtg/dft_drought_recurrence_analysis.pdf, accessed October 16, 2006.) By the

[6] *See* Bay-Delta SJRG-7, p32 Table 15, included with SJRG Comments and Recommendations Regarding California's 2006 Clean Water Act § 303(d) List of Water Quality Limited Segments (January 30, 2006).

reasoning of CVRWQCB Staff, the USBR would have to comply with the Vernalis EC Objective until the next 1987 through 1992 drought occurs, which could be another 400 years, before concluding an adequately representative historical record existed and the USBR can maintain and comply with the Vernalis EC Objective under all conditions.

Completely disregarding modeling projections and speculative future events, the Ninth U.S. Circuit Court of Appeals concluded that the USBR's demonstrated ability to maintain the Vernalis EC Objective and its willingness to deviate from the IPO if and when necessary to comply with its legal obligations were sufficient to preclude any "reasonable scientific certainty" that the USBR would violate the Vernalis EC Objective. (CDWA v USBR, *supra* F.3d at 1025.) Models are based on hypothetical conditions, but actual hydrologic conditions undoubtedly and frequently change. (Id.) As the USBR had maintained the Vernalis EC Objective, without fail, since 1995, the USBR demonstrated it could modify the IPO to account for changes in conditions. (Id.)

The holding in CDWA v. USBR was consistent with the SWRCB Cases, (2006) 136 Cal. App.4th 674, 734, wherein it was noted that there was no showing that the USBR could not meet the Vernalis EC Objectives. If such a showing had been made, then the allocation of responsibility to the USBR by the SWRCB would have been "illusory" and the SWRCB would have failed to comply with its statutory obligation to implement its own water quality control plan.[7] (Id.)

There has been no showing that the USBR cannot maintain the Vernalis EC Objective or exceedances "will" occur, only assertions exceedances are "likely" or "may"

[7] If the USBR fails to maintain the Vernalis EC Objective as required by its permit terms and conditions, the SWRCB, consistent with its statutory obligations, can use its enforcement authority, pursuant to Water Code §1831, to enforce compliance.

occur. As the courts concluded in both CDWA v. USBR and the SWRCB Cases however, a petitioner must show that the USBR cannot maintain the Vernalis EC Objective and that exceedances will occur. Merely alleging harm that may occur is insufficient.

If New Melones lacks sufficient supply for the USBR to meet its obligations, including the Vernalis EC Objective, then the USBR can and will find other ways to meet its obligations. How the USBR chooses to comply, whether through New Melones releases or other means is irrelevant, so long as the USBR complies. (SWRCB Cases, *supra* 136 Cal.4th at 734; CDWA v. USBR, *supra* F.3d at 1026.) The CVPIA gives the USBR discretion in choosing how to comply with its obligations. (CDWA v. USBR, *supra* F.3d at 1026.) Additionally, the SWRCB, in D-1641, by directing the USBR to meet the Vernalis EC Objective by "flows or other means" similarly left the USBR discretion in choosing how to maintain the Vernalis EC Objective.[8] (D-1641, p159-161.)

The Responses to Comments recommend that the SWRCB wait and reevaluate current hydrologic conditions in the next listing cycle, but the courts have already spoken. The regulatory landscape created by the IPO, the 1995 WQCP, and D-1641 and validated by the USBR's record of consistent compliance since 1995, precludes any conclusion that the USBR would fail to meet its obligations and, as a result, that the Vernalis EC Objective would not be maintained.

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[8] Although the USBR has discretion to continue using flow and can meet the Vernalis EC Objective solely by using flow from New Melones, it has opted for an additional method with the San Luis Unit Feature Reevaluation Project, which would reduce saline discharges to the LSJR by retiring land and treating drain water by reverse osmosis and selenium biotreatment before disposal in evaporation basins. (Draft 2006 WQCP, p29.)

B. Trends in Salinity at Vernalis are only Relevant if and to the Extent Exceedances of the Vernalis EC Objective Occur.

According to the Listing Policy, one condition requiring removal of water segments or pollutants from the §303(d) list is an unsubstantiated trend in declining water quality, as described in steps 1 through 4 of §3.10 of the Listing Policy **or** if impacts are no longer observed. (Listing Policy, §4 and §4.10 (emphasis added).) As the Listing Policy uses the disjunctive, rather than the conjunctive, a water body must be de-listed if either criterion is not observed.[9] (Listing Policy, §4.10.)

In support of continued listing, CVRWQCB Staff cite a steady increase in mean annual EC at Vernalis since the 1930's. (Grober 2006, Attachment 1, p17.) However, CVRWQCB Staff have acknowledged that historical conditions are neither representative of current conditions nor indicative of future conditions. (SJR Salt & Boron TMDL Appendix 5, p[A5-3].) CVRWQCB data even shows that 15-year moving average EC has leveled out since about 1990.[10] (Grober 2006, Attachment 1, p17 Figure 5.)

Regardless, trends in EC do not necessarily indicate whether South Delta agricultural beneficial uses are protected. The Vernalis EC Objective is a concentration-based threshold. (1995 WQCP, p17 Table 2.) Agricultural beneficial uses are only

[9] By comparison, §3.10 of the Listing Policy uses the conjunctive and only permits listing if trends in declining water quality are substantiated **and** impacts are observed. A line of evidence based on trends in water quality, pursuant to §3.10 of the Listing Policy therefore requires documented, quantitative evidence of beneficial use impact. If the Vernalis EC Objective is valid, as the Responses to Comments assume, whether at Vernalis or for upstream application, and exceedances have occurred, then evidence of agricultural beneficial use impacts will exist. Regardless of whether any evidence of beneficial use is required, none has been submitted.

[10] The Draft 2006 WQCP discusses several projects that "may assist in meeting the [Vernalis EC Objective] by reducing drainage to the [SJR]; improving circulation in the southern Delta; and supplementing flows through recirculation." (Draft 2006 WQCP, p28.) "If successful, these projects and the actions they contain could make additional regulatory measures by the [SWRCB] and [CVRWQCB] unnecessary." (Id.) Such projects include the Grasslands Bypass Project, the West Side Regional Drainage Plan, the San Luis Unit Feature Reevaluation Project, the CVPIA Land Retirement Program, the South Delta Improvements Program, and Delta-Mendota Canal Recirculation. (Id. at 28-29.)

harmed if and to the extent that exceedances occur. (1991 WQCP, p[5-11] Table [5-1].) If exceedances do not occur, agricultural beneficial uses are protected. CVRWQCB Staff acknowledge that no exceedances have occurred since 1995. (Grober 2006, Attachment 1, p18.) There is no showing that exceedances will occur, only a claim that exceedances may occur in the future. (Grober 2006, Attachment 1, p18.)

No quantitative data documenting actual impacts to agricultural beneficial uses has been submitted by the CVRWQCB, South Delta Water Agency, or any other party in support of continued listing. There are no declarations from farmers in the LSJR Basin stating that their crops have been harmed by high salt concentrations. No data or analysis has been submitted showing which lands are irrigated with water from the LSJR and, of those lands, which have suffered crop impacts due to high salt concentrations. The conclusion by the Responses to Comments that beneficial uses are not met is based solely on the failure to achieve WQOs, but such a conclusion is arbitrary and contradictory, because there are no WQOs for EC on the LSJR.

IV. If the Lower San Joaquin River Remains Listed for Electrical Conductivity and Boron, the Proposed Total Maximum Daily Load Should Be Re-Scheduled.

No draft report for a Basin Plan amendment for EC objectives upstream of Vernalis or for the SJR EC and Boron Upstream of Stanislaus Confluence TMDL has been released and no workshop to present a public review draft staff report is planned until at least Summer 2007. (*See* Attachment 2: CVRWQCB electronic notice (October 16, 2006).) Not even CVRWQCB Staff anticipates compliance with the proposed TMDL schedule.

The SJR EC and Boron Upstream of Stanislaus Confluence TMDL will require draft basin plan amendments, public comment periods for each draft, and peer review. As a result, it is highly unlikely that the CVRWQCB can comply with the proposed schedule and with the CWA public participation requirements, much less involve the public in any meaningful way. (33 USCA §2151(e); 40 CFR §25.) Furthermore, the Draft 2006 WQCP recognizes the need for an updated scientific investigation of irrigation salinity needs in the south Delta. (Draft 2006 WQCP, p30.) The irrigation salinity needs of the LSJR upstream of the Delta have never been evaluated, independently or otherwise, and it is unlikely one could be completed in the time required by the §303(d) List TMDL schedule. Such a study would likely require one to two years, at a minimum.

The CVRWQCB and SWRCB should not feel compelled to complete a TMDL solely because the §303(d) List TMDL schedule calls for it. The SJR EC and Boron Upstream of Stanislaus Confluence TMDL should therefore be rescheduled to when the TMDL can be completed with adequate public participation, peer review, and consideration by the CVRWQCB, which would perhaps be 2008.

V. Staff Recommended Deferring Analysis Because the Listing is Unjustified.

A. Deferring Analysis Will Waste Public Resources.

The SJRGA comments were fully analyzed, yet no fact sheet was prepared. (Responses to Comments, p177.) Information provided by the SJRGA would have required de-listing the LSJR for EC and boron. (Responses to Comments, p176.) Federal regulations prohibit the development of TMDLs for unlisted water bodies if any TMDLs are required for any other water bodies, thereby insuring that public resources are allocated toward redressing actual, existing water quality problems. (40 CFR §130.7(e).)

If the LSJR from Mendota Pool to Vernalis is de-listed for EC, the CVRWQCB cannot continue developing the SJR EC and Boron Upstream of Stanislaus Confluence TMDL until TMDLs are developed for all other listed water bodies and pollutants.

If the LSJR from Mendota Pool to Vernalis remains listed for EC, considerable additional Staff time will be utilized developing the SJR EC and Boron Upstream of Stanislaus Confluence TMDL and, once adopted, the public will incur significant compliance costs, in addition to the SJR Salt & Boron TMDL, which alone will cost an estimated $27 to $38 million per year. (SWRCB Resolution No. 2005-0087: Amending the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Salt and Boron into the Lower San Joaquin River, Attachment 2: CVRWQCB Resolution No. R5-2005-108, Attachment 2, p13 (November 16, 2005.) (available at http://www.waterboards.ca.gov/resdec/resltn/2005/rs2005-0087attach2.pdf, accessed October 16, 2006.) If a deferred analysis for 2008 shows the LSJR should have been de-listed, public resources that could have been used redressing actual water quality problems will be wasted on an unnecessary regulatory program andthe public will continue bearing significant additional and unnecessary regulatory costs. (Staff Report, p4.)

No public review draft staff report for the SJR EC and Boron Upstream of Stanislaus Confluence TMDL is anticipated until at least Summer 2007. (*See* Attachment 2: CVRWQCB electronic notice (October 16, 2006).) If completing the SJR EC and Boron Upstream of Stanislaus Confluence TMDL before the next listing cycle is unlikely, then nothing is lost by de-listing the LSJR for EC. In the interim, irrigation salinity needs for the LSJR upstream of Vernalis can be independently researched and evaluated. EC objectives for the LSJR upstream of Vernalis can be developed and adopted into the Basin Plan. Then, if was monitoring data shows the LSJR from Mendota Pool to Vernalis is indeed a water quality limited segment, it can again be listed and scheduled for a TMDL, consistent with the procedures established by Porter-Cologne and the CWA.

B. Review Must Occur Before Project Momentum Becomes Irresistible.

Environmental assessments cannot be deferred until after project approval. At some point, "project momentum" reduces or completely eliminates an agency's flexibility to subsequently change its course of action. (Sacramento Old City Association v. City Council of Sacramento (1991) 229 Cal.App.3d 1011, 1028; Residents Ad Hoc Stadium Committee v. Trustees of the California State University and Colleges (1979) 89 Cal.App.3d 274, 292.) In the public participation process for the SJR Salt & Boron TMDL, the §303(d) listing for the LSJR was a significant and oft-cited justification for the TMDL. (SJR Salt & Boron TMDL Final Staff Report, p3 (available at http://www.waterboards.ca.gov/centralvalley/programs/tmdl/vernalis-salt-boron/StaffRptDec04.pdf, accessed October 17, 2006); SJR Salt & Boron TMDL Appendix 1, p[1-10]; SJR Salt & Boron TMDL Responses to Comments on November 2003 Draft Staff Report, p12.)

During the public process, nothing was submitted by the CVRWQCB. After the comment period closed and SWRCB Staff had an opportunity to review the SJRGA's comments, SWRCB Staff requested further information from the CVRWQCB Staff. (Grober 2006.) Although fact sheets for LSJR EC were not prepared due to the need "avoid further delay" in the 2006 §303(d) List, SWRCB Staff were able to analyze the

CVRWQCB report. (Grober 2006; Responses to Comments, p176.) The CVRWQCB report on SJR salinity relies heavily on unpublished draft documents prepared by CVRWQCB Staff for the SJR EC and Boron Upstream of Stanislaus Confluence TMDL that have never been part of the public record, never subject to public or peer review, and its findings have never been adopted by resolution of the CVRWQCB.[11] (Grober 2006.) The CVRWQCB Staff report on SJR salinity represents not the position of the CVRWQCB, but that of certain members of CVRWQCB Staff.[12]

CVRWQCB Staff were already in the process of developing the SJR EC and Boron Upstream of Stanislaus Confluence TMDL. (Grober 2006, Attachment 1 and Attachment 3.) The SWRCB had only recently adopted the SJR Salt & Boron TMDL. (SWRCB Resolution No. 2005-0087 (November 16, 2005).) With one project established and another in development, SWRCB and CVRWQCB Staffs surrendered to the temptation of project momentum and now desperately rely on a report replete with legal and factual contradictions. The purpose of Porter-Cologne and the CWA is to improve water quality, not to feed project momentum.

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[11] The lack of public and peer review is particularly important, as the salinity data used to develop the CVRWQCB report on SJR salinity is based on flow-weighted average EC. (Grober 2006, Attachment 3, p2.) While such a method may prove a useful measure of loading, no EC objective for agricultural beneficial uses a flow-weighted average and none has been proposed. (1995 WQCP, p17 Table 2.) Except for Clifton Court Forebay and the Delta Mendota Canal, which use a maximum monthly average mean daily EC, all EC compliance locations use maximum running 14 or 30-day running averages of mean daily EC. (Id.) The CVP, State Water Project, and many other agencies have carefully developed their operations to meet the EC objectives now in place, as they are written. Changing EC objectives from maximum daily average EC to flow-weighted monthly average EC would amount to a change in the WQO and significantly impact operational planning.

[12] Mr. Grober, the CVRWQCB Staff person who sent the report, is now a member of the SWRCB Staff. Most of the supporting documents and the citations therein were prepared by him. (Grober 2006.)

C. The Resolution Adopting the 2006 §303(d) List Should Address the SJRGA's Petition to De-List.

Early in the §303(d) process, the SJRGA filed a separate petition to de-list the LSJR. (SWRCB, In re: Revision to Federal Clean Water Act §303(d) List of Water Quality Limited Segments for California, Hearing Transcript (December 6, 2005), p95.) At the December 6, 2006 workshop, the SJRGA agreed with SWRCB Staff that it would incorporate its petition into the §303(d) process and make its comments and suggestions within that process. (Id.) The SJRGA subsequently submitted extensive comments and supporting data recommending the SWRCB de-list the LSJR, from Mendota Pool to Vernalis, for impairment by EC, and boron. (Responses to Comments, p177.) While the SJRGA comments were fully analyzed, no fact sheet was prepared, and consideration of current conditions was deferred until the next listing cycle. (Id.)

When the SWRCB adopts a resolution approving the 2006 §303(d) List, it should include in that resolution an order, or at least acknowledgment, that the SJRGA petition to de-list the LSJR for EC and boron was included as a comment on the draft 2006 §303(d) List and considered, regardless of whether the LSJR remains listed for EC and boron.

VI. Conclusion.

The LSJR from Mendota Pool to Vernalis must be de-listed for EC and boron. The question is not whether water in the LSJR contains salt. The question is whether the LSJR is a "water quality limited segment" due to EC, as defined by the CWA. The CWA and Porter-Cologne establish a step-by-step process in basin planning, starting with the designation of beneficial uses, adoption of WQOs, the incorporation of WQOs into a basin plan with a basin plan amendment, and, finally, a determination of whether WQOs are sufficiently met. Only then, if WQOs are insufficiently met, is a water body listed and, based on the degree and frequency of exceedances as compared to other listed water bodies, scheduled for a TMDL. The SWRCB skipped the second and third steps and now cannot effectively schedule a TMDL, because, without applicable WQOs, the frequency and extent of impairment cannot objectively be determined. In order to comply with Porter-Cologne and the CWA, the LSJR must be de-listed for EC and boron. Then, the SWRCB can start at the beginning of the basin planning process, by first designating beneficial uses and developing applicable WQOs for the LSJR above the Stanislaus River, as required by Porter-Cologne and the CWA.

ATTACHMENT 1

State Water Resources Control Board

Division of Water Rights
1001 I Street, 14th Floor ♦ Sacramento, California 95814 ♦ 916.341.5300
P.O. Box 2000 ♦ Sacramento, California 95812-2000
Fax: 916.341.5400 ♦ www.waterrights.ca.gov

Linda S. Adams
Secretary for Environmental Protection

Arnold Schwarzenegger
Governor

NOTICE OF PUBLIC WORKSHOP

Consideration of the Southern Delta Water Quality Objectives for Salinity in the Water Quality Control Plan for the San Francisco Bay/ Sacramento-San Joaquin Delta Estuary

Commencing on Tuesday, January 16, 2007, and continuing on Friday, January 19, 2007, if necessary
All sessions will commence at 10:00 a.m. unless announced otherwise

Joe Serna, Jr./Cal-EPA Building
Sierra Hearing Room
1001 I Street
Sacramento, California

Additional hearing dates, times, and locations will be announced as necessary.

SUBJECT OF WORKSHOP
The purpose of this workshop is to commence a proceeding regarding the southern Delta salinity objectives for agriculture that are contained in the current Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary adopted in 1995 (1995 Plan or Plan). At the workshop, the State Water Resources Control Board (State Water Board)[1] will receive information and conduct detailed discussions on the southern Delta salinity objectives. As a result of this workshop, the State Water Board will, if there is adequate justification, develop and manage a thorough study or studies of the sources, concentrations, loads, and effects of salinity, and methods for its control in the southern Delta.

BACKGROUND
On October 11, 2006, the State Water Board considered a proposed order amending State Water Board Decision 1641 to comply with a writ of mandate that requires the State Water Board either to assign responsibility for meeting the southern Delta salinity 0.7 Electrical Conductivity (EC) objective in the 1995 Plan or to amend the Plan.[2] The State Water Board did not approve the water right order, but directed staff to commence a proceeding regarding southern Delta salinity objectives in the 1995 Plan.

[1] A quorum of the members of the State Water Board may be present at the workshop.
[2] On February 9, 2006, the Court of Appeal, Third District of California, issued its opinion in the appeals of a trial court decision regarding Decision 1641. The Court of Appeal generally upheld D-1641, but with regard to the salinity objectives at three compliance stations in the southern Delta, the Court of Appeal held that the State Water Board acted without authorization when it included footnote 5 of Table 3 on page 182 of D-1641. Footnote 5 would replace the 0.7 mmhos/cm Electrical Conductivity (EC) with the 1.0 EC objective under certain conditions after April 1, 2005. The court held that the Board must either fully implement the southern Delta salinity objectives as set forth in the 1995 Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary or must duly amend the Plan.

The State Water Board adopted the southern Delta salinity objectives for agriculture, with compliance measurement points at Interagency Station Nos. C-6, C-8, and P-12 (respectively San Joaquin River at Brandt Bridge, Old River near Middle River, and Old River at Tracy Road Bridge) in the 1978 Water Quality Control Plan for the Sacramento-San Joaquin Delta (1978 Plan). The objectives are based on conditions, crops, and irrigation practices in the interior southern Delta at the time when the objectives were adopted. These objectives remain unchanged in the 1995 Plan.

The State Water Board adopts and implements water quality control plans under its authority to protect the beneficial uses of water. Water Code section 13240 provides the authority to revise water quality control plans. The federal Clean Water Act, at section 303(c) (33 U.S.C., § 1313(c)) requires approval by the United States Environmental Protection Agency of State water quality "standards," as defined in the Act.

The State Water Board conducted a periodic review of the 1995 Plan in 2004. Subsequently, the State Water Board conducted a multi-day workshop to receive additional information on selected issues[3], one of which addressed the objectives that are the subject of this workshop. During that workshop, participants provided enough information to support the need to conduct additional review of the salinity objectives, including research as to the sources, concentrations, loads, and effects of salinity, and methods for its control in the southern Delta.

MATTERS FOR DISCUSSION IN THE WORKSHOP

The State Water Board is seeking to obtain information in addition to the information it received in the 2004-2005 workshop regarding the southern Delta salinity objectives. The additional information should focus on salinity objectives for the southern Delta, including a corresponding program of implementation. At this salinity workshop, the State Water Board specifically requests that the Department of Water Resources (DWR) and any other participants present detailed current information they have on southern Delta salinity objectives, including: 1) spatial and temporal variability of salinity in southern Delta channels, compliance measurement points (Interagency Station Nos. C-6, C-8, and P-12), and salinity sources; 2) spatial and temporal variability of irrigation practices and cropping patterns; 3) actions taken to control salinity and the effects of these actions; and 4) the reasonableness of the existing salinity objectives.

The State Water Board also requests that participants recommend the scope of work for studies they believe are needed regarding salinity in the southern Delta. The State Water Board requests that participants who recommend studies provide a reasonably detailed study plan for consideration, including completion dates for studies and other actions. The study plans, completion dates, and potential actions will be discussed at the workshop.

If it is evident that information is available which supports embarking on a study, this salinity workshop will be the starting point for the State Water Board to develop and manage a thorough study or studies of salinity issues in the southern Delta. The State Water Board expects that the study or studies and other efforts may result in a Plan amendment. If the State Water Board amends the 1995 Plan, it may implement the Plan amendments through a

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[3] On September 29, 2006, as a result of the workshop in 2004-2005, the State Water Board released a draft amended Bay-Delta Plan and gave notice of a hearing on November 13, 2006, to consider amending the 1995 Bay-Delta Plan in accordance with the draft amended Bay-Delta Plan. The proceeding noticed on September 29, 2006, is separate and distinct from the proceeding commenced by this notice.

water right and/or water quality proceeding. This overall process may require two or more years to complete.[4]

PROCEDURAL MATTERS

At least ten days in advance of the workshop, the participants must submit documents satisfying the above requests for information, including scopes of work and study plans. At the workshop, participants will be given an opportunity to summarize and supplement their written materials with oral presentations.

To ensure a productive and efficient workshop, and to ensure that all participants have an opportunity to participate, oral presentations may be given time limits. Participants with similar comments are requested to make joint presentations.

The workshop will be informal. There will be no sworn testimony or cross-examination of participants, but the State Water Board and its staff may ask clarifying questions.

After the workshop, the State Water Board staff will advise the participants of the next steps in reviewing the salinity issues for the interior southern Delta.

Participants are required to provide their written materials by January 5, 2007. The State Water Board requests that ten copies of written comments be sent to:

Ms. Gita Kapahi, Chief
Bay Delta/Special Projects Unit
P.O. Box 2000
Sacramento, CA 95812-2000

Hand and special deliveries can be dropped at:

Division of Water Rights - Records Unit
1001 "I" Street, 2nd floor
Sacramento, CA 95814

Participants are encouraged to also submit their comments electronically. Any documents submitted electronically must be in Adobe™ Portable Document Format (PDF). Electronic submittals to the State Water Board of documents less than 15 megabytes in total size (incoming mail server attachment limitation) may be sent via electronic mail to: gwilson@waterboards.ca.gov, with a subject of "Southern Delta Salinity Workshop". Electronic submittals to the State Water Board of documents greater than 15 megabytes in total size should be sent by regular mail in PDF format on compact disk (CD™) media.

Each participant is requested to bring additional copies of any written submittals to the workshop for the use of the other participants.

[4] The State Water Board will consider changing the agricultural salinity objectives for the southern Delta or the program of implementation for these objectives upon the submission of adequate information, including data and modeling studies, to support a change.

INFORMATION REGARDING WORKSHOP
Questions concerning this notice may be directed to Gita Kapahi, Chief, Bay-Delta Unit, at (916) 341-5289 or Barbara Leidigh, Staff Counsel IV, at (916) 341-5190.

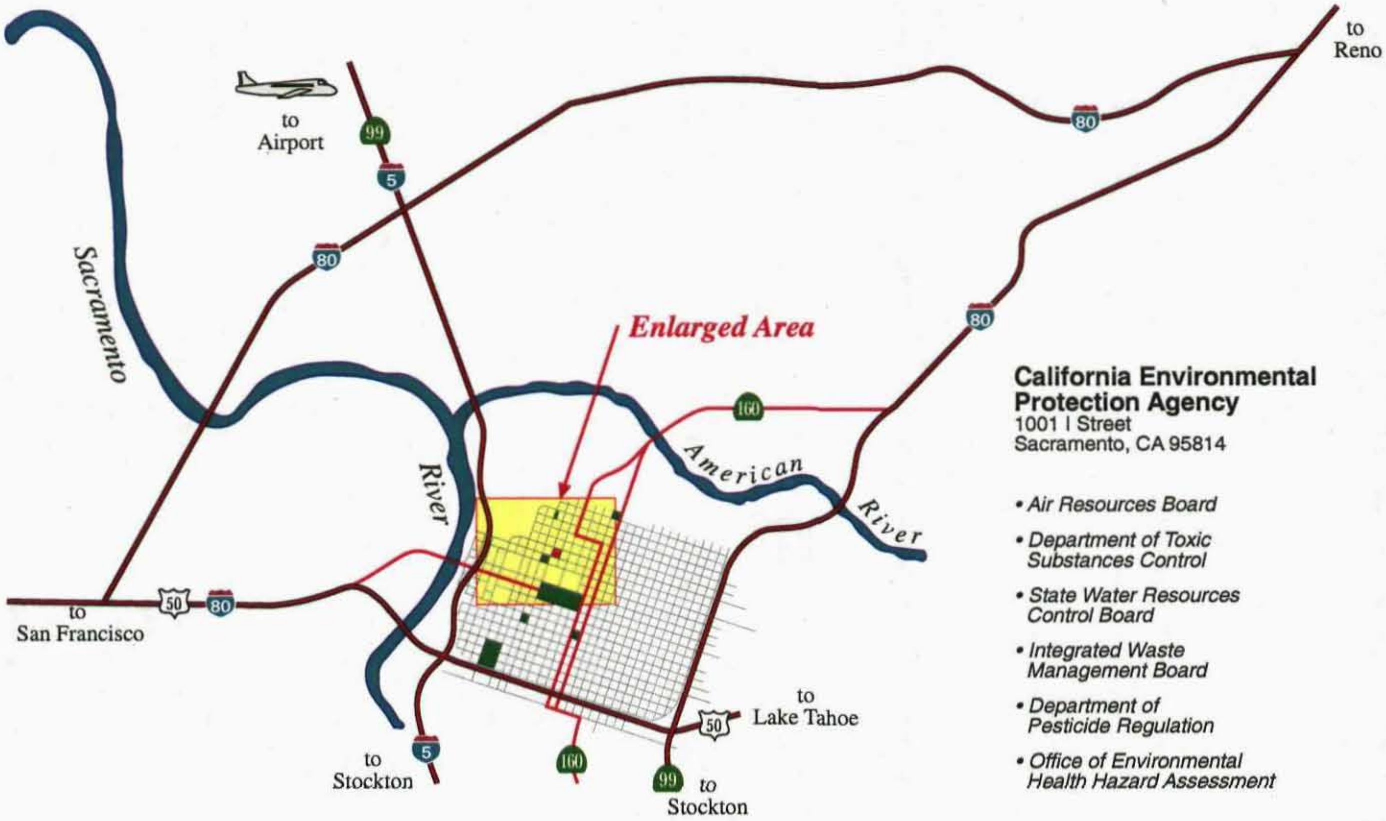
PARKING AND ACCESSIBILITY
The enclosed map shows the location of the Joe Serna, Jr. (Cal EPA) Building and public parking sites in Sacramento. The Joe Serna, Jr. (Cal EPA) Building, Sierra Hearing Room, is accessible to persons with disabilities.

Due to enhanced security precautions at the Joe Serna, Jr. (Cal EPA) Building, all visitors are required to sign in prior to attending any meeting. Visitors can sign in and obtain badges in the Visitor and Environmental Services Center, which is just inside and to the left of the building's public entrance. Visitors may be asked to show valid picture identification. Valid identification can take the form of a current driver's license, military identification card, or state and federal identification cards. Depending on the size and number of meetings scheduled on any given day, the security check-in could take from three to fifteen minutes. Please allow adequate time to sign in before being directed to your meeting.

Song Her
Clerk to the Board

Date: October 13, 2006

Enclosure



California Environmental Protection Agency
1001 I Street
Sacramento, CA 95814

- *Air Resources Board*
- *Department of Toxic Substances Control*
- *State Water Resources Control Board*
- *Integrated Waste Management Board*
- *Department of Pesticide Regulation*
- *Office of Environmental Health Hazard Assessment*

Parking Lot Locations

Lot 1 - (7th & G St.)

Lot 2 - (7th & G St.)

Lot A - (7th & Capitol)

Lot C - (14th & H St.)

Lot G - (3rd & L)

Lot H - (10th & L)

Lot I - (10th & I, 11th & I)

Lot K - (6th & J/L, 7th & K)

Lot P - (2nd & I)

Lot U - (5th & J)

Lot W - (2nd & I St.)

ATTACHMENT 2

From: lyris@swrcb18.waterboards.ca.gov
Sent: Monday, October 16, 2006 8:34 AM
To: Kenneth Petruzzelli
Subject: San Joaquin River Salt and Boron Upstream Objectives

This is a message from the California Regional Water Quality Control Board, Central Valley Region(5).

The Central Valley Water Board continues to develop water quality objectives for the lower San Joaquin River Upstream of Vernalis.

Staff is planning to have a public workshop to present a public review draft report by Summer 2007. Current information on the development of the objectives is available at http://www.waterboards.ca.gov/centralvalley/programs/tmdl/upstream-salt-boron/index.html.

New developments on the subject will be disseminated on this email listserv. If you know of anyone who may be interested in these updates, please direct them to http://www.waterboards.ca.gov/lyrisforms/reg5_subscribe.html.

For more information, please contact Matthew McCarthy at mmccarthy@waterboards.ca.gov or 916-464-4658.

ATTACHMENT 3

RECLAMATION

Managing Water in the West

Drought Reoccurrence Analysis for the Stanislaus River Basin

Levi Brekke, D-8520

Acknowledgements: MP-700, CVO

U.S. Department of the Interior
Bureau of Reclamation

Outline

1. Questions on Drought Reoccurrence
2. Analysis Methods
3. Repeating Analysis on Different Datasets
4. Results
5. Critical Assumptions of the Analysis
6. Summary

RECLAMATION

Questions

1. Apparent reoccurrence of 6-year droughts in the Stanislaus River Basin?

2. Change in apparent reoccurrence given records prior to New Melones operation?

3. Change in apparent reoccurrence given precipitation- vs. runoff-defined drought?

RECLAMATION

Preview

- Drought reoccurrence analysis was conducted for the Stanislaus River Basin region and 6-year droughts.

- Apparent reoccurrence varies with period of observed record, hydrologic variable, and monitoring location.

- Apparent reoccurrence of the 1987-1992 drought based on synthetic modeling appears to exceed "observed" reoccurrence in the hydrologic record. The synthetic and observed reoccurrence of the 1929-1934 appear to be similar.

RECLAMATION

Outline

1. Questions on Drought Reoccurrence
2. Analysis Methods
3. Repeating Analysis on Different Datasets
4. Results
5. Critical Assumptions of the Analysis
6. Summary

RECLAMATION

Methodology

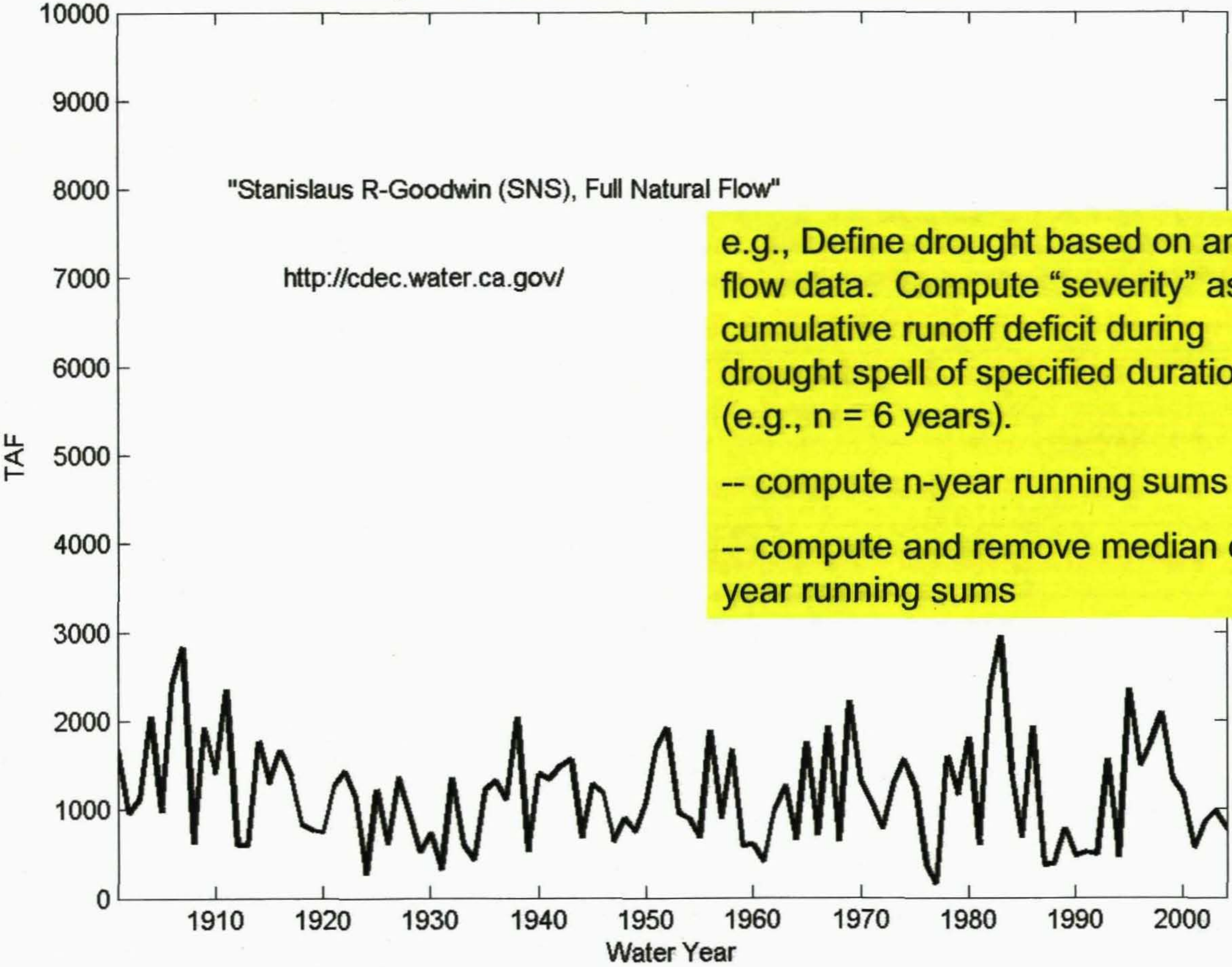
1. Define Drought

2. Analyze reoccurrence based on observed data record

3. Analyze apparent reoccurrence based on synthetic data record

RECLAMATION

Fig.A1-Observed Annual Flow: Stanislaus 1901-2004



e.g., Define drought based on annual flow data. Compute "severity" as cumulative runoff deficit during drought spell of specified duration (e.g., n = 6 years).

-- compute n-year running sums

-- compute and remove median of n-year running sums

Methodology

1. Define Drought

2. Analyze reoccurrence based on observed data record

3. Analyze apparent reoccurrence based on synthetic data record

RECLAMATION

Information from Step #2

1. Relative severity of experienced droughts.

2. Observed reoccurrence estimates of experienced droughts.

RECLAMATION

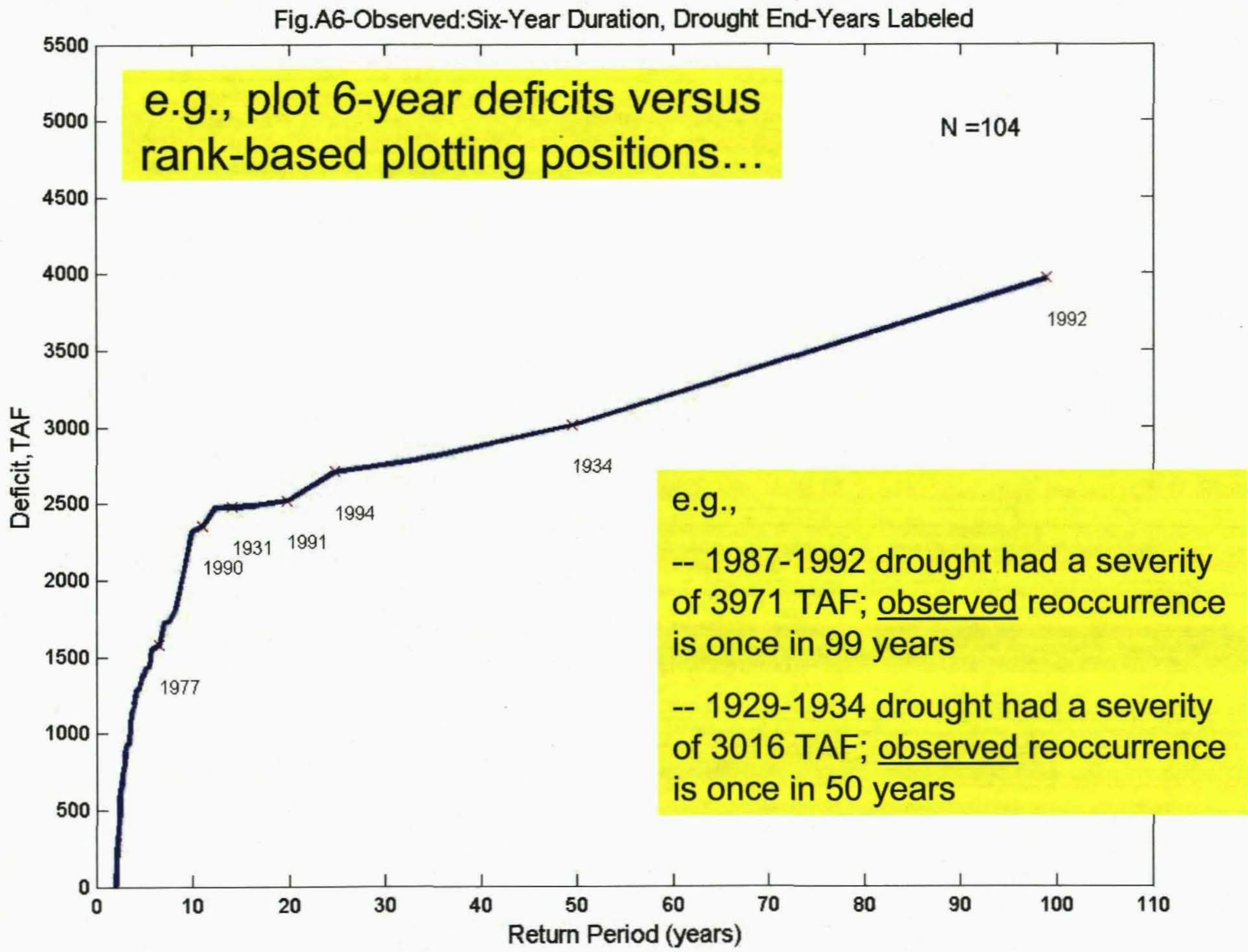


Fig.A6-Observed:Six-Year Duration, Drought End-Years Labeled
e.g., plot 6-year deficits versus rank-based plotting positions…
N =104
1992
1934
1994
1931
1991
1990
1977
e.g.,
-- 1987-1992 drought had a severity of 3971 TAF; observed reoccurrence is once in 99 years
-- 1929-1934 drought had a severity of 3016 TAF; observed reoccurrence is once in 50 years
Deficit, TAF
Return Period (years)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
0
10
20
30
40
50
60
70
80
90
100
110

Do the *observations* represent the *actual* distribution of potential conditions?

RECLAMATION

Impossible to know.

But we can explore this question using synthetic analysis.

RECLAMATION

Methodology

1. Define Drought

2. Analyze reoccurrence based on observed data record

3. Analyze apparent reoccurrence based on synthetic data record

RECLAMATION

Modeling Observed Conditions

- What are we trying to do?
  - Model a our drought-defining condition (flow or precip)
- Why build a model?
  - Simulate a <u>longer</u> time series, providing a more robust basis for estimating drought reoccurrence.
- Can we believe the model?
  - Yes, if it preserves statistical properties of observations.

RECLAMATION

Step 3 – Part (a): Define Conceptual Model

- Properties to preserve:
  - persistence (auto-correlation)
  - distribution of random variations

- Initial Model:

  Synthetic Condition =

  Persistence Term + Random Term

RECLAMATION

About the Persistence Term

- Meant to address phenomena controlling persistence of multi-year dry/wet conditions.

- Potential phenomena are not understood, but we can test for their presence.

Use lag-n-year autocorrelation analysis.

RECLAMATION

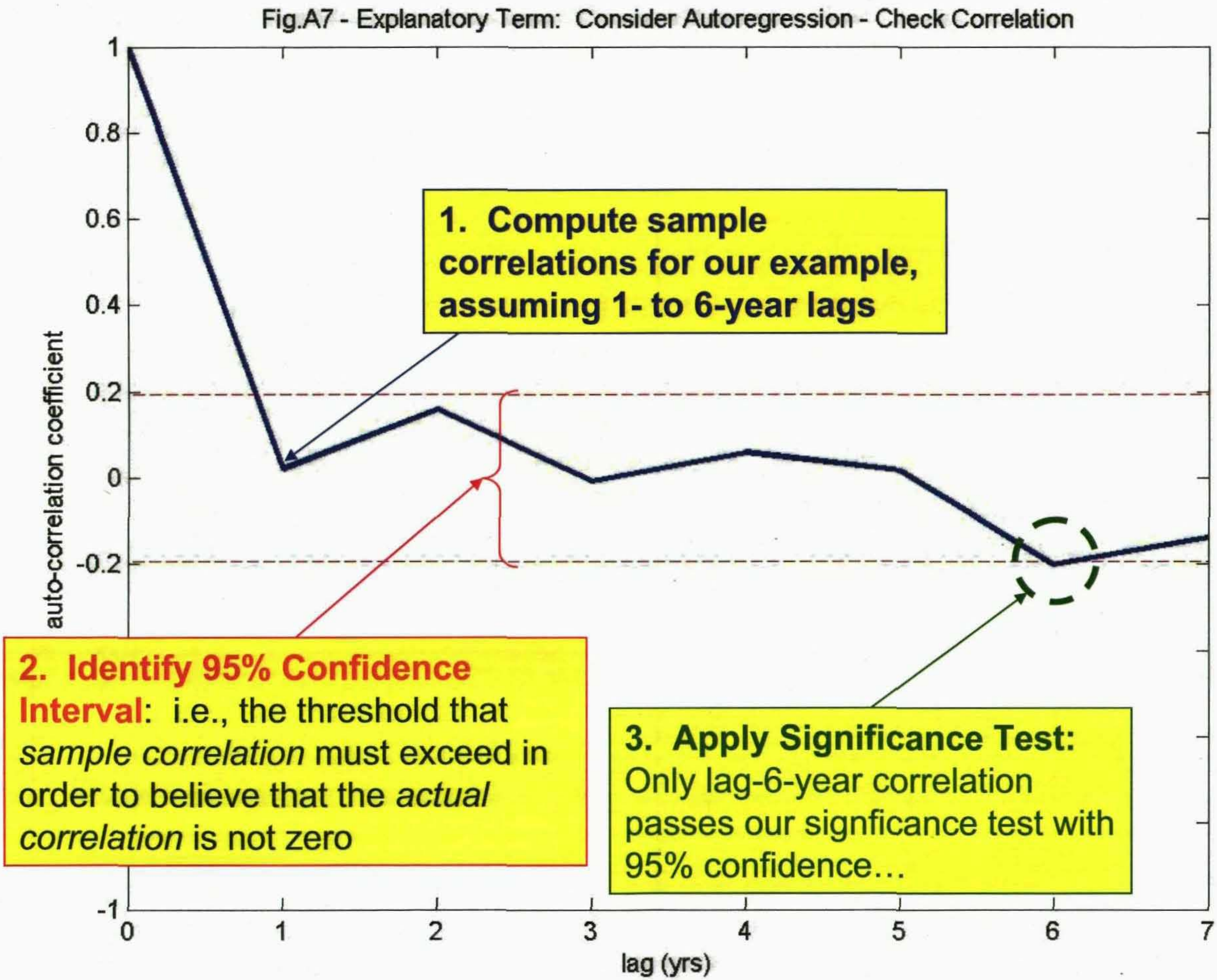


Fig.A7 - Explanatory Term: Consider Autoregression - Check Correlation
1
0.8
0.6
0.4
0.2
0
-0.2
-1
auto-correlation coefficient
0
1
2
3
4
5
6
7
lag (yrs)
1. Compute sample correlations for our example, assuming 1- to 6-year lags
2. Identify 95% Confidence Interval: i.e., the threshold that sample correlation must exceed in order to believe that the actual correlation is not zero
3. Apply Significance Test: Only lag-6-year correlation passes our signficance test with 95% confidence…

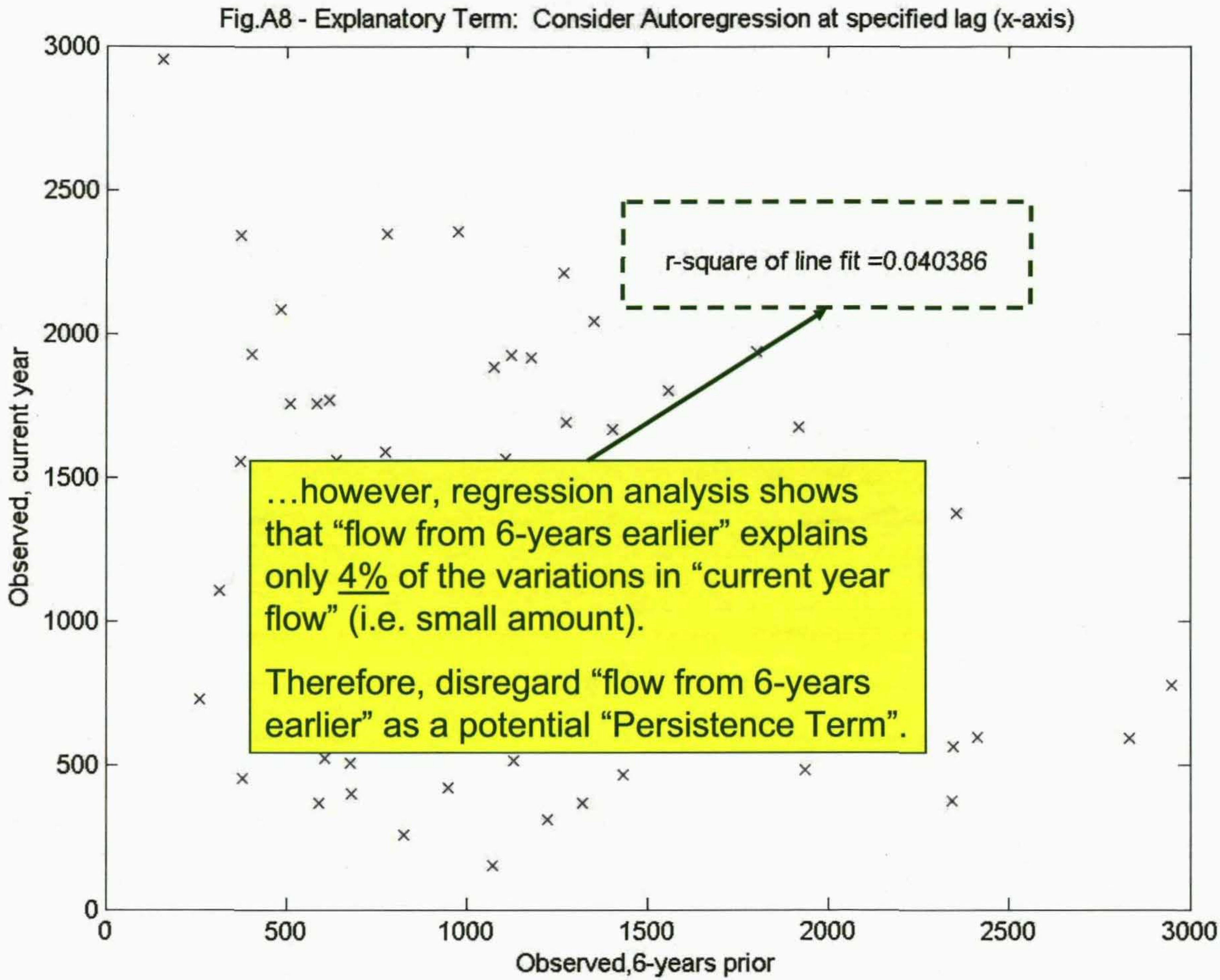


Fig.A8 - Explanatory Term: Consider Autoregression at specified lag (x-axis)
r-square of line fit =0.040386
...however, regression analysis shows that "flow from 6-years earlier" explains only 4% of the variations in "current year flow" (i.e. small amount).
Therefore, disregard "flow from 6-years earlier" as a potential "Persistence Term".
Observed, current year
Observed,6-years prior
0
500
1000
1500
2000
2500
3000

Persistence Term unnecessary...

Simplify our Model:

Synthetic Condition = Random Term

RECLAMATION

Defining our Random Term

- Fit a probability distribution to the observations
- Choose technique
  - Parametric? ← *explored*
  - Nonparametric? ← *ultimately used in this analysis*

RECLAMATION

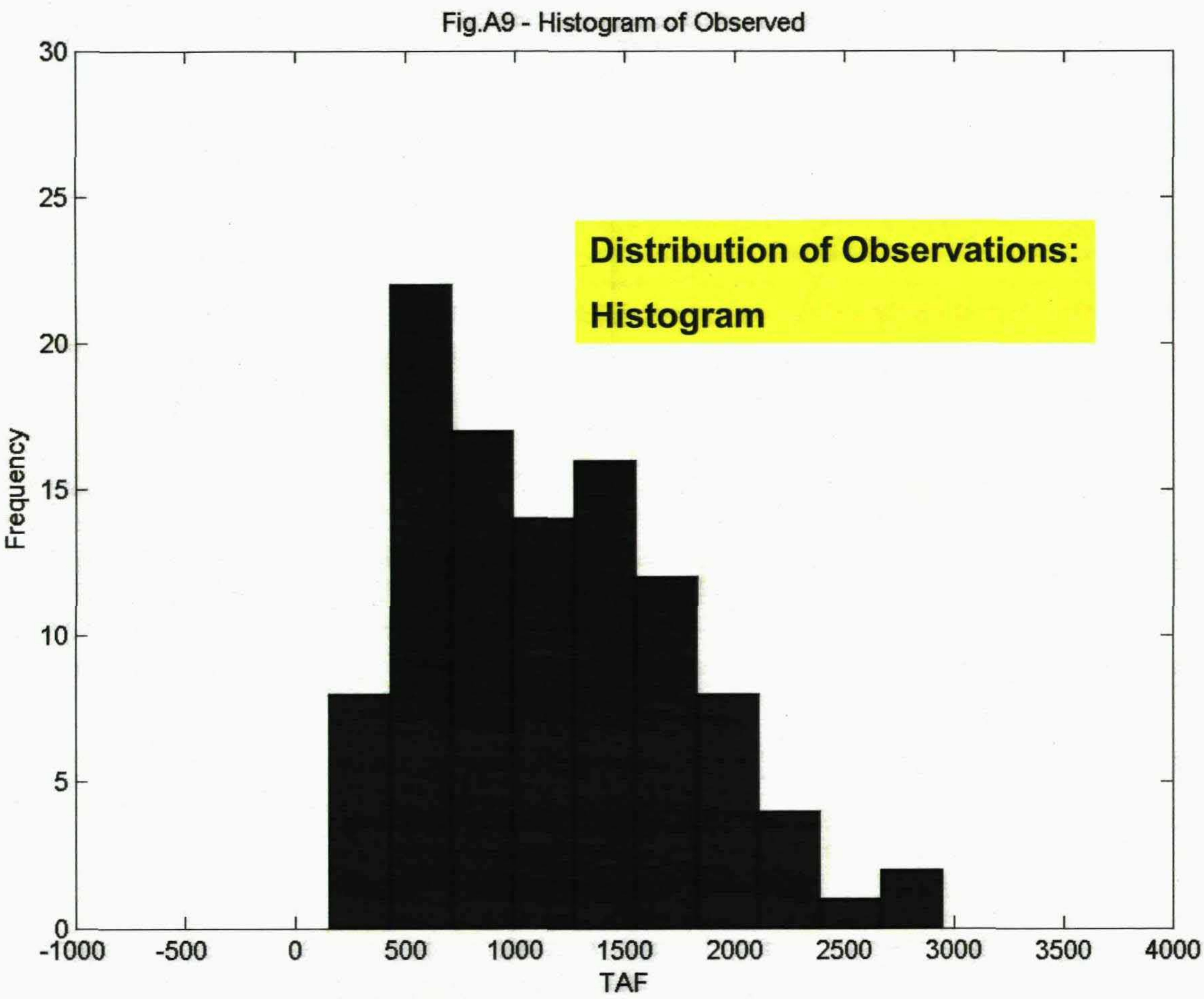


Fig.A9 - Histogram of Observed
Distribution of Observations:
Histogram
Frequency
TAF
30
25
20
15
10
5
0
-1000
-500
0
500
1000
1500
2000
2500
3000
3500
4000

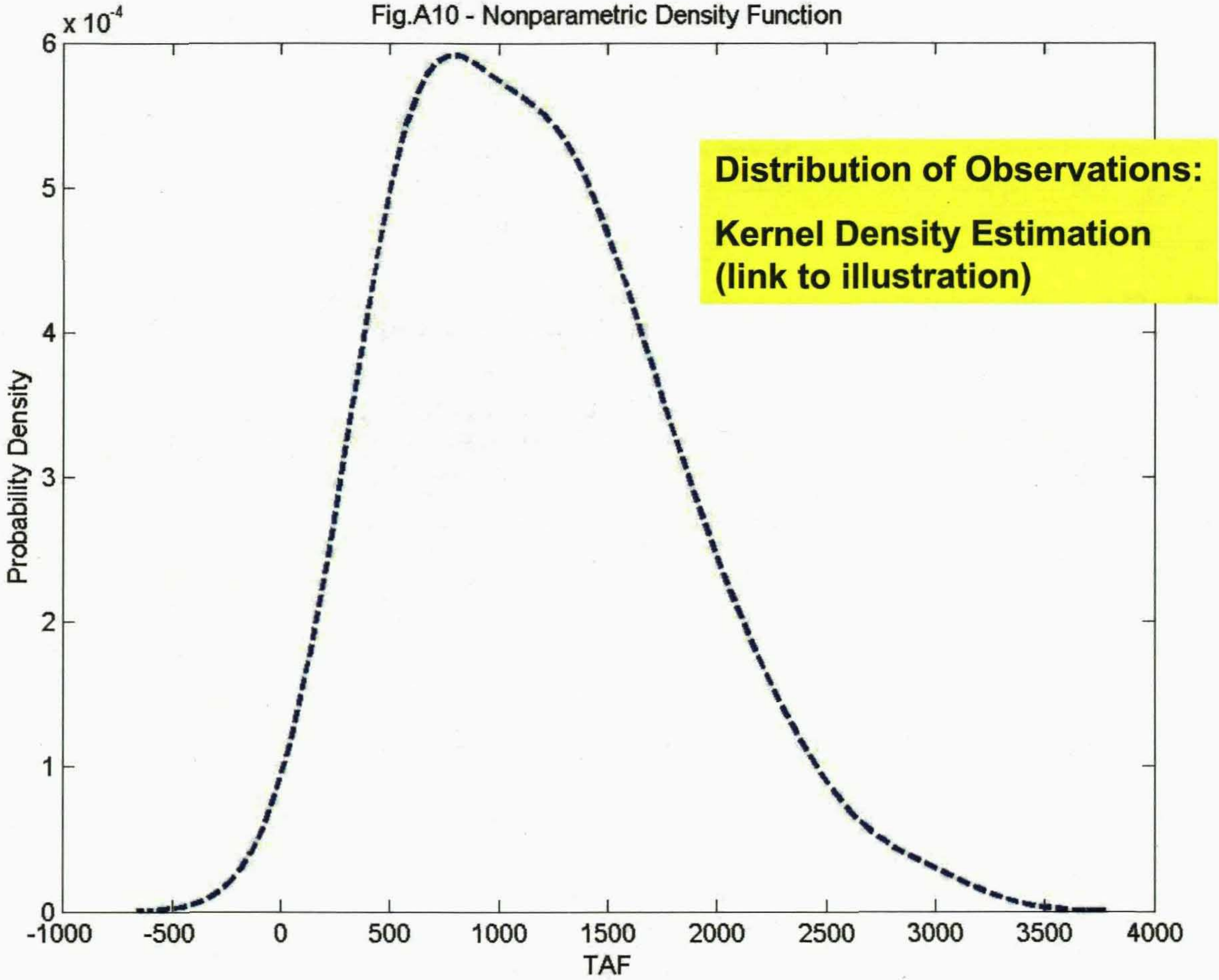


Fig.A10 - Nonparametric Density Function
x 10^-4
6
5
4
3
2
1
0
Probability Density
-1000
-500
0
500
1000
1500
2000
2500
3000
3500
4000
TAF
Distribution of Observations:
Kernel Density Estimation
(link to illustration)

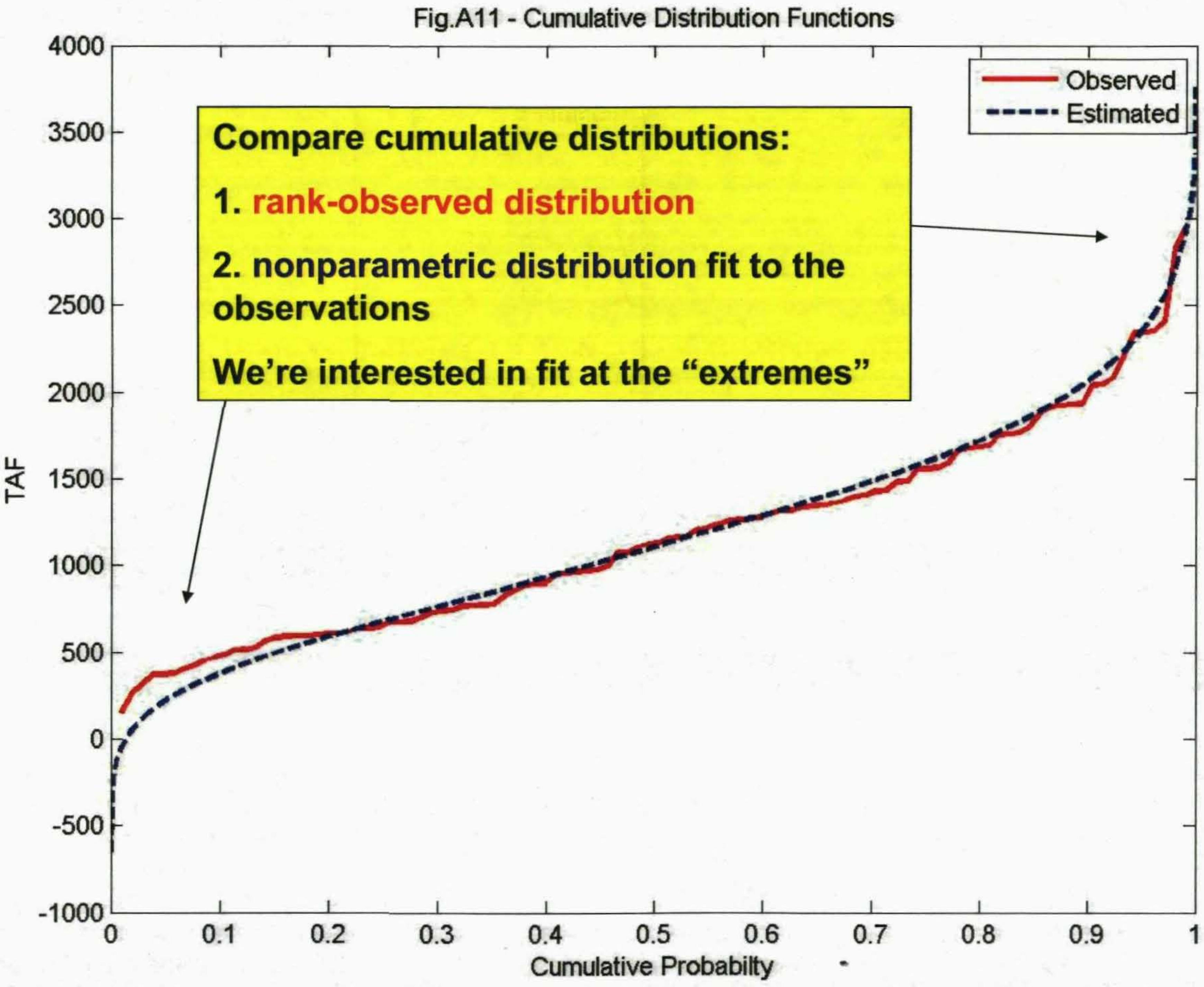


Fig.A11 - Cumulative Distribution Functions
Observed
Estimated
Compare cumulative distributions:
1. rank-observed distribution
2. nonparametric distribution fit to the observations
We're interested in fit at the "extremes"
TAF
4000
3500
3000
2500
2000
1500
1000
500
0
-500
-1000
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Cumulative Probabilty

Step 3 – Part (b): Apply Model

- Generate M-year sequence of Synthetic Data
  - M = 100,000 years
  - Get sampling probabilities
    - randomly selected from uniform distribution between 0 and 1,
    - constrained to be within 0.01 to 0.99.
  - Sample M values from the nonparametric CDF fit to observations, at the M sampling probabilities.

RECLAMATION

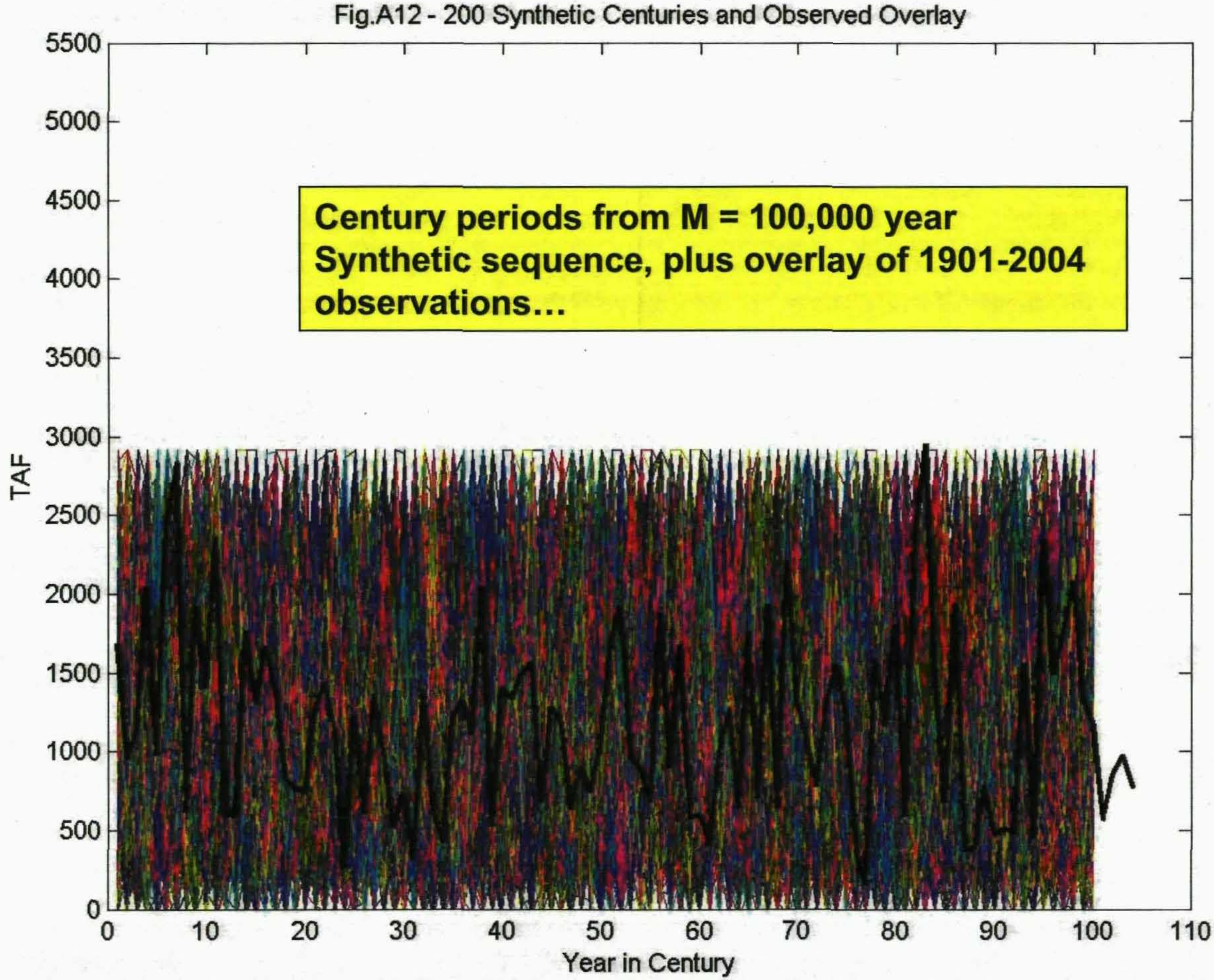
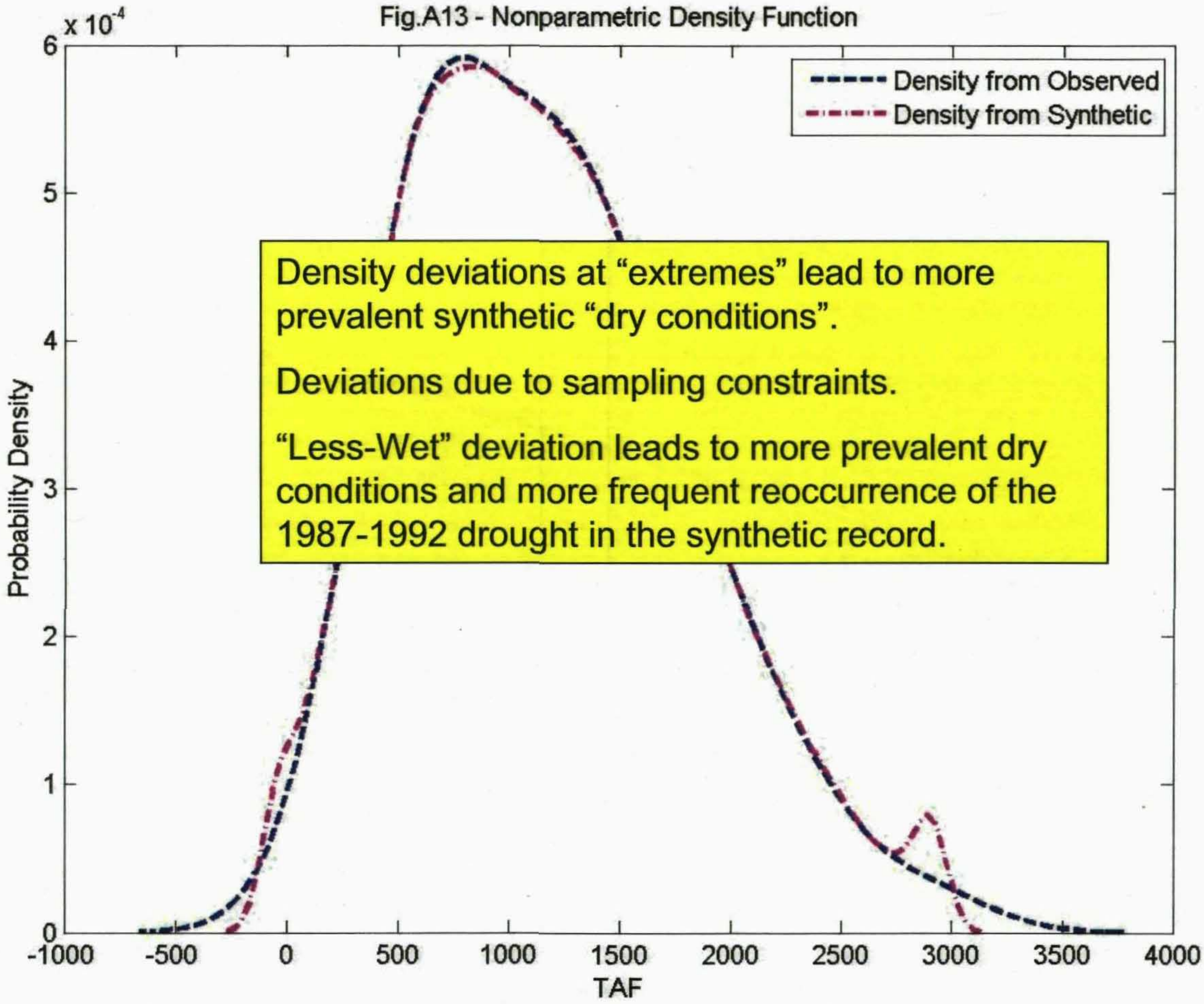


Fig.A12 - 200 Synthetic Centuries and Observed Overlay
Century periods from M = 100,000 year
Synthetic sequence, plus overlay of 1901-2004
observations...
TAF
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
10
20
30
40
50
60
70
80
90
100
110
Year in Century

Step 3 – Part (c): Check Synthetic Distribution

- Compare:
  - Nonparametric distribution of Synthetic conditions
  - Nonparametric distribution of Observed conditions
  - They should be similar…

RECLAMATION



Density deviations at “extremes” lead to more prevalent synthetic “dry conditions”.

Deviations due to sampling constraints.

“Less-Wet” deviation leads to more prevalent dry conditions and more frequent reoccurrence of the 1987-1992 drought in the synthetic record.

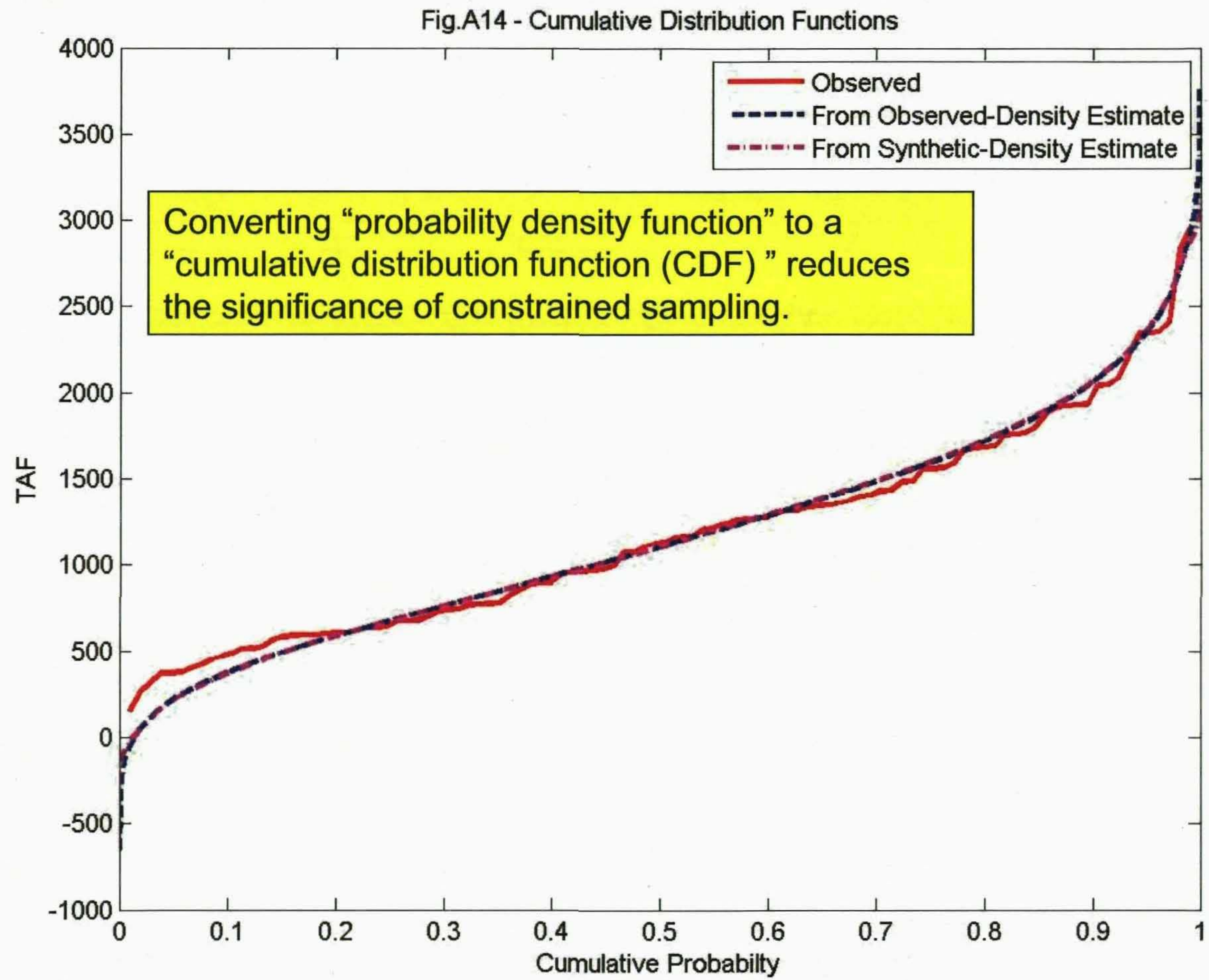


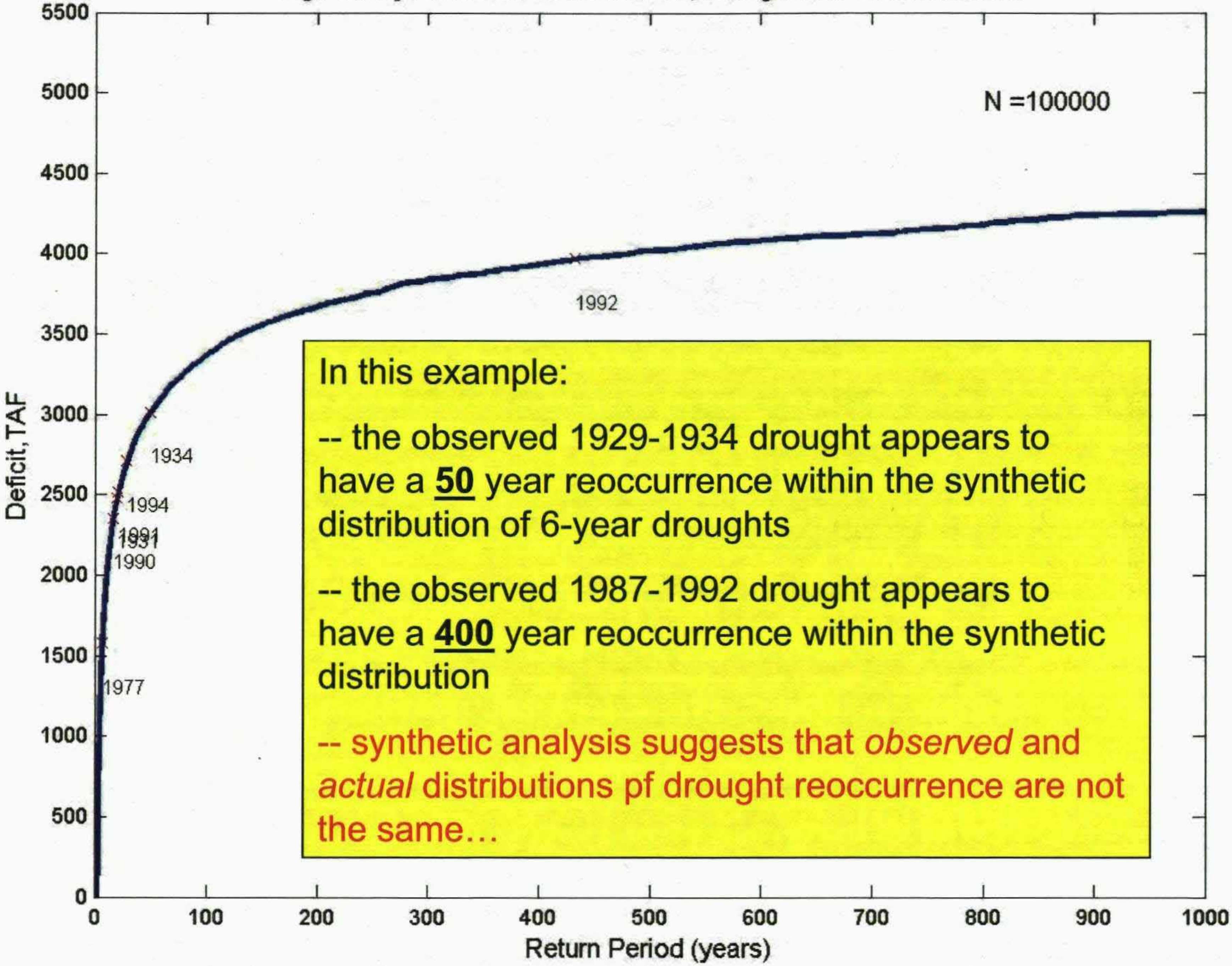
Fig.A14 - Cumulative Distribution Functions
Observed
From Observed-Density Estimate
From Synthetic-Density Estimate
Converting "probability density function" to a "cumulative distribution function (CDF) " reduces the significance of constrained sampling.
TAF
Cumulative Probabilty
4000
3500
3000
2500
2000
1500
1000
500
0
-500
-1000
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Step 3 – Part (d): Perform Drought Analysis

- Apply drought analysis procedure discussed in Step 2 to the Synthetic time series.
- Construct n-year reoccurrence distributions.
- Plot historically observed droughts on these synthetic distributions.

RECLAMATION

Fig.A19-Synthetic:Six-Year Duration, Drought End-Years Labeled



Outline

1. Questions on Drought Reoccurrence
2. Analysis Methods
3. Repeating Analysis on Different Datasets
4. Results
5. Critical Assumptions of the Analysis
6. Summary

RECLAMATION

Purpose

- We want to explore apparent reoccurrence of the 1987-1992 and 1928-1934 droughts, varying by:
  - Hydrologic Variable
  - Period of Record
  - Site-specific versus Regional Condition

RECLAMATION

Cases

Case	Name	Variable	Period
A	Flow1	Stanislaus River, annual full natural flow	1901-2004
B	Flow2	Stanislaus River, annual full natural flow	1901-1980
C	Flow3	Stanislaus River, annual full natural flow	1906-2003
D	PrecipSOR	Annual Precipitation, "Sonora RS" CDEC I.D. SOR	1906-2003
E	PrecipYSV	Annual Precipitation, "Yosemite Valley" CDEC I.D. YSV	1906-2003
F	PrecipNFR	Annual Precipitation, "North Fork R.S." CDEC I.D. NFR	1906-2003
G	PrecipIndex1	Annual Precip Index for American-to-UpperSJ region	1906-2003
H	PrecipIndex2	Annual Precip Index for Stanislaus-to-UpperSJ region	1906-2003

RECLAMATION

Outline

1. Questions on Drought Reoccurrence
2. Analysis Methods
3. Repeating Analysis on Different Datasets
4. Results
5. Critical Assumptions of the Analysis
6. Summary

RECLAMATION

Results: Observed Reoccurrence (yrs)

Case	Name	1929-1934 Drought	1987-1992 Drought
A	Flow1	50	99
B	Flow2	75	n/a
C	Flow3	50	93
D	PrecipSOR	31	93
E	PrecipYSV	47	93
F	PrecipNFR	31	47
G	PrecipIndex1	47	93
H	PrecipIndex2	47	93

RECLAMATION

Results: Synthetic Reoccurrence (yrs)

Case	Name	1929-1934 Drought	1987-1992 Drought
A	Flow1	50	433
B	Flow2 (note)	67	719
C	Flow3	36	258
D	PrecipSOR	25	199
E	PrecipYSV	53	68
F	PrecipNFR	20	23
G	PrecipIndex1	49	56
H	PrecipIndex2	46	108

Note: Case A observed droughts were assessed relative to the Case B synthetic reoccurrence distribution.

Response to Questions

- The 1987-1992 drought has apparent 250- to 400-year reoccurrence; 1929-1934 drought has apparent 30- to 50-year reoccurrence.

- Pre-1980 information would have suggested a 700-year apparent reoccurence for the 1987-1992 drought.

- The 1987-1992 drought seems more rare in the Stanislaus-based cases compared to regionally-representative cases.

RECLAMATION

Outline

1. Questions on Drought Reoccurrence
2. Analysis Methods
3. Repeating Analysis on Different Datasets
4. Results
5. Critical Assumptions of the Analysis
6. Summary

RECLAMATION

Critical Assumptions

- Drought definition & measurement
- Assumptions in building and applying the synthetic flow & precipitation models
  - omitting persistence
  - distribution fitting for random variations
  - constrained probabilities for distribution sampling
- Quality of observations

RECLAMATION

Summary

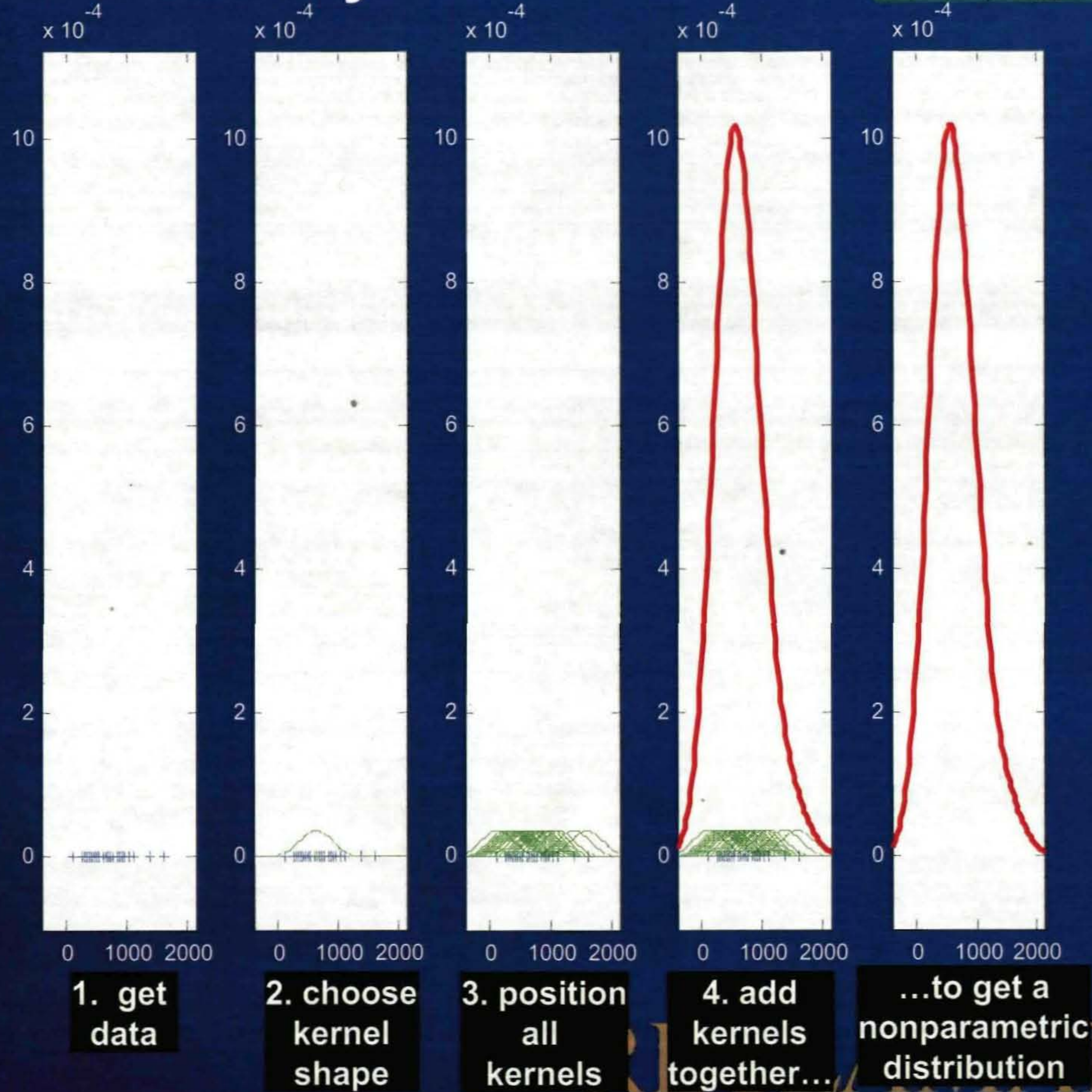
- Drought reoccurrence analysis was conducted for the Stanislaus River Basin region and 6-year droughts.
- Apparent reoccurrence varies with period of observed record, hydrologic variable, and monitoring location.
- Apparent reoccurrence of the 1987-1992 drought based on synthetic modeling appears to exceed "observed" reoccurrence in the hydrologic record. The synthetic and observed reoccurrence of the 1929-1934 appear to be similar.

RECLAMATION

Extras

RECLAMATION

Kernel Density Estimation used ...(back)



ATTACHMENT 4

MEMORANDUM

11 January 2006

Submitted To: Michelle Light, MP-700

By: Levi Brekke, D-8520

Subject: **Drought Reoccurrence Analysis for the Stanislaus River**

1.0 INTRODUCTION

Reclamation's Stanislaus Policy Group has expressed an interest in understanding the reoccurrence intervals of critical droughts in the Stanislaus Basin. Such information is expected to support a decision on whether a New Melones Revised Plan of Operation should be based on the critical drought observed during 1928-1934 or 1987-1992.

Framing questions:

1. What are the reoccurrence intervals of 6-year droughts of varying severity in the Stanislaus Basin?
2. How do these reoccurrence intervals change if the analysis is based on an earlier period of record (e.g., pre-operations hydrologic record)?
3. How do these reoccurrence intervals change if the analysis is based on a precipitation- rather than a runoff-defined drought?

For question 1, the focus is on 6-year drought reoccurrence rather than 7-year drought reoccurrence (i.e. similar in duration to the 1928-1934 "drought"). The 6-year duration was selected mainly because it coincides with the 1987-1992 duration. Also, review of 1928-1934 annual Stanislaus runoff sequence (**Figure 1**) shows that the 1928-1934 drought might actually be described as back-to-back droughts (i.e. a 4-year drought and a 2-year interrupted by a wetter year in 1932), rather than as a 7-year drought.

For question 2, it reasoned that when New Melones construction was being completed, an original plan of operations was still being developed. Planning at that time was informed by hydrologic observations that did not include the severe 1987-1992 drought. It is of interest to understand the severity of the 1987-1992 relative to this pre-operations understanding of hydrology.

For question 3, it is reasoned that as multi-year droughts persist, the runoff response to precipitation may decay as basin infiltration potential increases. Thus, a normal precipitation year might produce less runoff if the given year follows multiple dry years rather than a wet year.

The remainder of this memorandum is organized as follows:

- Section 2.0 – methodology for assessing drought reoccurrence.

- Section 3.0 – description of cases that were studied, varying by basis period and whether the drought is defined relative to precipitation or runoff observations.
- Section 4.0 – results and discussion on the framing questions.
- Section 5.0 – analysis limitations.
- Section 6.0 – summary.

Supplemental details on the methodology are provided in Appendices A and B. Supplemental results graphics for each of the case studies are provided in Appendix C.

2.0 METHODOLOGY

The methodology is designed to reveal observed and theoretical probabilities of drought reoccurrence, given either a runoff- or precipitation-basis for defining drought. The methodology includes three primary steps:

- Define drought.
- Analyze drought reoccurrence based on observed flow data.
- Analyze drought reoccurrence based on synthetic flow data modeled during a longer period, where the flow model is designed to produce a synthetic flow time series exhibiting statistical consistency with the observed flow time series.

2.1 Drought Definition

Droughts can be described as meteorological or hydrological phenomena. They are often measured relative to median conditions, and can be expressed in terms of spell (i.e. duration of below-median conditions), severity (i.e. cumulative deficit during spell), or intensity (i.e. severity divided by spell) (**Frick et al. 1990**). Both meteorological and hydrologic droughts are considered in this analysis, with each consistently defined as severity during several predetermined durations: 2-, 3-, 4-, 5- and 6-year spells. Grant it, only the results from studying 6-year droughts are used to address the framing questions. However, additional context for the 6-year drought reoccurrence is provided by also studying 2- to 5-year droughts.

To illustrated subsequent methodology steps, consider *hydrologic* drought defined as *severity* relative observed annual "full-natural" flow in the Stanislaus River at Goodwin (**Figure 1**). These data are reported by the California Data Exchange Center (http://cdec.water.ca.gov/, station I.D: SNS). Flow data from water years 1901-2004 are shown (N = 104).

2.2 Drought Analysis based on Observed Data

The methodology to compute reoccurrence distributions for the various assumed drought spells is as follows:

- from the observed time series with N years of data, compute running n-year sums of observed annual flow, where n = 2, 3 … 6 years. The reporting year for the n-year sum is the end-year of the sum.
- compute running n-year deficits relative to respective median n-year sums.
- compute rank-based return-period (RP) plotting positions, where:

$$\textbf{(1)}\quad \begin{aligned} rank &= 1\ldots(N-n+1) \\ RP &= (N-n+1)/rank \end{aligned}$$

- Sort running n-year deficits from largest surplus (i.e. most negative "deficit") to largest deficit (i.e. most positive deficit) and plot versus return-period (**Figures 2-6**). The plots show drought reoccurrence distributions illustrating the "observed" return periods of the assumed n-year drought severity.
- On each n-year curve, plot several notable observed droughts to provide a sense for how historical droughts rate within the observed distribution. In the case of this example, notable observed droughts include those of n-year duration ending on 1931, 1934, 1977, 1990, 1991, 1992, and 1994.

Since the analysis is based on N=104 years of observations, the worst drought of record for each n-year duration would have an observed return-period of (104-n+1) years. For example, **Figure 6** might be used to support the statements:

- The 6-year drought ending on 1992 has a severity of 3971 TAF and might be expected to occur once in every 99 years.
- The 6-year drought ending on 1934 has a severity of 3016 TAF and might be expected to occur once in every 50 years.

These statements are only true if we can assume that the observed flows from 1901-2004 represent the *true* distribution of Stanislaus annual flow. This assumption is challenged in the next analysis step.

2.3 Drought Analysis based on Synthetic Data

In the example of Section 2.2, it is difficult to assess droughts having return periods of 50 to 100 years because such episodes would only have infrequent or singular occurrence in the observed record (i.e. N=104 years). Given this, it is assumed that the reoccurrence distributions of **Figures 2-6** and observed return periods of the notable droughts may be inaccurate. To test this assumption, the preceding methodology was re-applied using a synthetic time series of Stanislaus annual flow, modeled to be statistically consistent with the observed data.

To do this analysis, a synthetic flow model must be developed. The initial model concept was as follows:

(2) Modeled flow = Explanatory Term(s) + Error, where "Explanatory Term(s)" accounts for non-random flow variations and "Error" accounts for the random component of the flow.

2.3.1 Synthetic Model Development – Explanatory Term:

It is common in hydrologic time series data to find observations that are correlated with their own values from previous time periods (Haan 1977). Such a phenomenon is referred to as auto-correlation, and varies with the "lag" between time periods. Given significant auto-correlation, one might say that "persistence" exists in the hydrologic time series, or that the time series has "memory".

Using the example of Section 2.2, auto-correlation was analyzed in the Stanislaus annual flow time series at p-year lags, where p = 1, 2 ... 6 **(Figure 7).** The correlations were tested for statistical significance. The hypothesis for these tests is that the true p-year lag correlation is zero despite the computed correlation. This hypothesis can be rejected at a specified level of confidence. A 95% level of confidence was used in this analysis, and in this example leads to rejection of the hypothesis for only the 6-year lag condition. Thus, only a lag-6 year auto-regressive variable was retained for further consideration in flow model development.

The next step was to graphically and statistically analyze the lag-6 relationship (**Figure 8**). Statistically, the annual flow from 6-years ago explains very little of the current year's flow variability (r-square = 0.04). Based on this result, it appears that the basis for including a lag-6 auto-regressive Explanatory Term in the model is weak. Consequently, model development proceeds in this example with omission of the Explanatory Term.

2.3.2 Synthetic Model Development – Error Term:

Given results from the preceding discussion, the synthetic flow model can be simplified:

(3) Modeled flow = Error,

In this case, there is no need to isolate the random component of the observed time series; the entire time series is treated as the random component. The model is then constructed and applied as follows, understanding the flow time series to be a random variable:

(a) treat the flow time series as a "data pool" and fit a probability density function (PDF) to the data. Convert the PDF into a cumulative distribution function (CDF).

(b) construct an M-period time series of randomly sampled values from a uniform distribution between 0 and 1. Treat these values as sampling probabilities.

(c) construct an M-period time-series of synthetic flow values by sampling from the cumulative distribution function from (a) at the sampling probabilities from (b).

The synthetic flow period (M) should be far greater than the observed flow period (N). Specifying the distribution fit in (a) and applying it in (c) requires some judgment (see Appendix A for details).

Continuing with the example from Section 2.3.1, the approach for Error modeling was implemented with M=100,000 years and with a nonparametric approach to assuming the

PDF (see Appendix A). The observed data's distribution (i.e. a histogram), the fitted PDF, and the PDF converted into a CDF are shown, respectively, on **Figures 9-11**.

The reasonability of the synthetic flow time series was then judged by plotting century time-slices from the synthetic series with an overlay of the observed series. Doing this with our example shows that the synthetic data spread and variability is comparable to observed (**Figure 12**). Also, a re-generation of the PDF and CDF based on the synthetic rather than observed data suggests that the sampling procedure produces a synthetic flow distribution that is comparable to observed (**Figures 13 and 14**).

2.3.3 Drought Analysis on the Modeled Synthetic Flow:

The drought-analysis methodology of Section 2.2 was applied to the synthetic flow data to reveal synthetic reoccurrence distributions for n-year droughts (**Figures 15-19**). On each n-year curve, the notable *observed* n-year droughts from **Figures 2-6** are also shown as an overlay. These results support the following types of statements:

- The 6-year drought ending on 1992 has a severity of 3971 TAF and might be expected to occur once in approximately 450 years.
- The 6-year drought ending on 1934 has a severity of 3016 TAF and might be expected to occur once in approximately 50 years.

In general, the most extreme, observed, 5- and 6-year droughts appear to have larger return periods according to the synthetic reoccurrence distributions (**Figures 18-19**) compared to return periods according to the observed reoccurrence distributions (**Figures 5-6**).

3.0 APPLICATION

The methodology was applied for several cases varying by drought definition and period of observed record:

- Case A - Flow1: Based on annual full-natural flow in the Stanislaus River during WY1901-2004 (**Figure 1**) (data i.d. SNS on the California Data Exchange Center (CDEC) at http://cdec.water.ca.gov).
- Case B - Flow2: Based on annual full-natural flow in the Stanislaus River during WY1901-1980.
- Case C - Flow3: Based on annual full-natural flow in the Stanislaus River during WY1906-2003.
- Case D - PrecipSOR: Based on annual precipitation amount at station "Sonora RS" (CDEC i.d. SOR) during WY1906-2003.
- Case E - PrecipYSV: Based on annual precipitation amount at station "Yosemite Headquarters" (CDEC i.d. YSV) during WY1906-2003.
- Case F - PrecipNFR: Based on annual precipitation amount at station "North Fork R.S." (Upper San Joaquin Basin, CDEC i.d. NFR) during WY1906-2003.

- Case G – PrecipIndex1: Based on annual precipitation index (Appendix B) representing stations spanning the American to Upper San Joaquin basins during WY1906-2003 (CDEC i.d. CLF, AUB, PCV, FLD, SOR, NFR, YSV).
- Case H – PrecipIndex2: Based on annual precipitation index (Appendix B) representing stations spanning the Stanislaus to Upper San Joaquin basins during WY1906-2003 (CDEC i.d. SOR, NFR, YSV).

The framing questions are addressed by considering results from the following cases: question 1 – collectively consider results from Cases A and C; question 2 – compare results between Cases A and B; question 3 – compare results between Case C and the collective of Cases D-H. For each case, a standard set graphics was produced (i.e. **Figures 1-19**). Case A results are depicted by **Figures 1-19**. Graphics for Cases B-H are provided in Appendix C

4.0 RESULTS

Tables 1 and 2 summarize case-specific results on observed and synthetic reoccurrence of the historical 6-year droughts ending on 1934 and 1992.

Table 1: Observed Reoccurrence Interval of 6-Year Droughts (Years)

Case	Description	1929-1934 Drought	1987-1992 Drought
A	Flow1	50	99
B	Flow2	75	n/a [(1)]
C	Flow3	50	93
D	PrecipSOR	31	93
E	PrecipNFR	47	93
F	PrecipYSV	31	47
G	PrecipIndex1	47	93
H	PrecipIndex2	47	93

Notes:
(1) Period of observed record was WY1901-1980 and did not include this drought.

Table 2: Synthetic Reoccurrence Intervals of 6-Year Droughts (Years)

Case	Description	1929-1934 Drought	1987-1992 Drought
A	Flow1	50	433
B	Flow2	67 [(1)]	719 [(1)]
C	Flow3	36	258
D	PrecipSOR	25	199
E	PrecipNFR	53	68
F	PrecipYSV	20	23
G	PrecipIndex1	49	56
H	PrecipIndex2	46	108

Notes:
(1) The 1929-1934 and 1987-1992 droughts defined in Case A were overlaid on the synthetic reoccurrence distributions of Case B to arrive at these synthetic reoccurrence intervals.

Discussion of results in relation to the framing questions:

- Question 1: based on a hydrologic drought definition, the apparent reoccurrence of the 1987-1992 drought appears to be approximately once in every 250 to 450 years. In contrast, the apparent reoccurrence of the 1929-1934 drought appears to be once in every 30 to 50 years.
- Question 2: staying with the hydrologic drought definition, truncation of the period of observed record from WY1901-2004 to WY1901-1980 leads to a greater apparent reoccurrence interval for both the 1929-1934 and 1987-1992 droughts. The apparent reoccurrence of the 1987-1992 drought increases to as much as once in approximately 700 years.
- Question 3: switching to the precipitation drought definition, the apparent reoccurrence of the 1987-1992 drought is less than the reoccurrence based on runoff-drought (Case C). For example, the station-based precipitation definitions led to reoccurrence estimates of once in every 199 years at Sonora, once in every 68 years at North Fork San Joaquin, and once in every 23 years at Yosemite Valley. The region-based precipitation definitions led to reoccurrence estimates of once in every 56 to 108 years, with the reoccurrence appearing greater as the index reflected relatively more influence from the Sonora station.

For precipitation-based drought, it is interesting to note how the results depended on station locations (i.e. Cases D-F in Table 2). A rank-percentile analysis of annual precipitation amounts from these stations during 1906-2003 (shown on Figures D1, E1 and F1 in Appendix C) reveals that the dryness relative to station-specific variability was more persistent at the Sonora gage than at the other two (**Table 4**).

Table 4: Rank-Percentile of Annual Precipitation Amounts relative to 1906-2003 Record

Water	Station Name (I.D.) (1)		
Year	Sonora R S (SOR)	North Fork R S (NFR)	Yosemite Headquarters (YSV)
1987	3	4	4
1988	6	18	16
1989	27	28	33
1990	20	15	29
1991	8	27	43
1992	25	38	35

Notes:
(1) California Data Exchange Center (http://cdec.water.ca.gov)

5.0 LIMITATIONS

The synthetic return periods computed in this analysis are sensitive to a number of factors, including:

- choice of drought definition,
- procedure of drought measurement,
- assumptions in synthetic flow and precipitation modeling,
- decision in synthetic flow and precipitation modeling to constrain sampling so that the fitted distribution was not sampled at probabilities less than 0.01
- decision in synthetic flow and precipitation modeling to generate synthetic record of 100,000 years rather than a longer period of some other duration.
- quality of underlying flow and precipitation data

The first two limitations can be regarded as caveats for this analysis. The analysis could be repeated with a different drought definition and method of measurement.

The third limitation could be explored by a more exhaustive survey of potential synthetic flow models. It is possible that a superior synthetic flow model could be identified. However, it is not expected that another synthetic flow model would affect the conclusion from this analysis that there is significant reoccurrence difference between the 1929-1934 and 1987-1992 droughts.

The fourth limitation leads to a synthetic flow time series that when subjected to nonparametric density fitting, has anomalous probability assignment at the flow associated with the 0.01 cumulative probability (**Figure 13**). However, this effect on the synthetic PDF does not seem to create a synthetic CDF that differs significantly CDF fit to observed data (**Figure 14**). Thus, the results seem benign to this limitation.

To explore sensitivity to the fifth limitation, the random sequence of sampling probabilities used to generate Case C and D was permuted 7 times. The resultant range of synthetic reoccurrence of the 1987-1992 precipitation drought (Case D) was 186 to 212 years with a median of 198 years. For runoff drought (Case C), the range was 232 to 284 with a median of 252 years. Thus, the sampling uncertainty interval is approximately +/- 15 years for the precipitation droughts and +/- 25 years for the runoff droughts.

Finally, it is necessary to acknowledge the sixth limitation that this analysis assumes accurate annual precipitation measurements at the surveyed CDEC stations, and accurate estimates of annual full natural flow at Goodwin (also as reported by CDEC). Quality review of these data was not scoped in this analysis.

6.0 SUMMARY

A drought reoccurrence analysis for the Stanislaus River was conducted. Drought was defined relative to Stanislaus flow and regional precipitation observations. The analysis was repeated for numerous cases: cases A-C using annual flow observations but from different periods of record (i.e. 1901-2004 (information to support modern-day planning), 1901-1980 (information that would have supported New Melones pre-operations planning), and 1906-2003 (the period coinciding with available precipitation data)), and cases D-H using annual precipitation station and index observations.

Drought was measured by severity (i.e. cumulative deficit measured relative to median condition during the period of record). Drought severity was assessed for 2-year to 6-year spells, with framing questions based on results from the 6-year drought analyses. Reoccurrence intervals for droughts were first evaluated against observed data and then again against synthetic data in an effort to analyze a longer period of record The synthetic data were modeled to be statistically consistent with the observed data.

Results from Cases A-H were used to address the three questions from the introduction. If drought is defined by Goodwin flow during 1906-2003 (Case C), then the 1987-1992 drought could be expected to reoccur once in every 233 to 283 years based on results from Section 4 and the estimated sampling uncertainty of Section 5. However, this range of reoccurrence is sensitive to the period of observed record (Cases A, B, and C). For example, ignoring post-1980 observations suggests a reoccurrence interval that is significantly greater.

If drought is defined by Sonora precipitation rather than Goodwin flow, then the 1987-1992 drought could be expected to have a reduced reoccurrence interval (i.e. once in every 184-214 years, based on Case D results from Section 4 and the estimated sampling uncertainty of Section 5. The fact that the precipitation-based reoccurrence estimate is less than the runoff-based estimate supports the reasoning behind framing question 3 (i.e. that runoff response to precipitation might decay as multi-year droughts persist).

Limitations on this analysis include assumptions related to drought definition, drought measurement, synthetic flow modeling, model application, and data.

6.0 REFERENCES

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Appendix A – On Parametric and Nonparametric Distribution Fitting

In this analysis (Memorandum Section 2.3.2), the random variations in synthetic flow are modeled by randomly sampling from the observed flow, assuming that it is a random variable. To accomplish this, a distribution must be identified to describe the range and variation of flow as a random variable. Parametric or nonparametric rules for distribution fitting may be applied. Ultimately, a nonparametric approach was adopted. However several parametric distributions were initially considered, as explained below.

A.1 Parametric Distributions:

In a "parametric" specification, the overall distribution function is assumed to display an expected form (e.g., Normal distribution appearing as a "bell-curve", or Gamma distribution appearing as a skewed "bell-curve"). Parametric distributions can be fully described based on statistics derived from their underlying observations.

The feasibility of fitting the "random" observed flow to a Normal distribution was assessed using (a) a Normal probability plot **(Haan, 1977),** and (b) quantitative tests of Normality (i.e. Komolgorov-Smirnov, Lilliefors **(Wilks, 1995)**, and Jarque-Bera **(Judge et al. 1988)**). On (a), the data on the Normal probability plot should closely plot along the line of Normality.

For our example (results not shown), it was found that the observed annual flow data do not adequately fit to a Normal distribution Normality probability plot, particularly at the extreme flows cases. Also the test of Normality was not successful using the Lilliefors and Jarque-Bera tests. The assessment was repeated using *transformed* observations of annual flow: square-root and natural log. Results from Normal Probability plotting were more encouraging and the three quantitative tests of Normality did not rule out Normality. However, both transformations produced distributions that overestimated annual flow in the low-flow range relative to expected values at low probabilities. This was significant because it would lead to synthetic reoccurrence intervals erring high on return periods associated with key observed droughts. For this reason, the transformed Normal distribution approach to describing the Error term was rejected.

Other parametric distributions were also considered (e.g., Gamma and Log-Normal Error). Similar problems were experienced with distribution fitting at low-flow ranges, and with coincidental distribution fitting at low- and high-flow ranges. For this reason, parametric distribution assumptions for describing the observations' "randomness" were disregarded.

A.2 Nonparametric Distributions:

Nonparametric distributions are not required to exhibit an assumed overall shape or form (e.g., like a Normal distribution depicting a "bell-curve"). Fitting a nonparametric distribution often leads to a more complicated probability density function on appearance. However, once the distribution is fit, the act of sampling values from the distribution at specified probabilities can be completed just as easily as if the distribution had been fit parametrically. Moreover, nonparametric distribution fitting often fares better than parametric distribution fitting when trying to coincidentally fit the distribution to observed high- and low-flow cases.

Fitting a nonparametric distribution requires adopting a kernel function that relates a single case to the overall probability distribution. Mathematically, the following steps occur:

- Begin with the given pool of data to which the distribution will be fit (e.g., the Stanislaus annual flow time series from 1901-2004, illustrated in Figure 1 of the Memorandum).
- Choose an estimation range within which the nonparametric probability distribution will be estimated. The estimation range should at least bracket the given pool of data and ideally include a buffer beyond the data extremes. The buffer is subjective and does not affect distribution fitting within the estimation range.
- Choose a kernel function that defines a single data case's influence on the overall distribution estimate. The kernel has two attributes: (a) *shape* and (b) *bandwidth*. Generally speaking, the kernel function peaks at the value where the estimation range value coincides with the case value, and decays when the estimation range value becomes different from the case value.
- Position N kernel functions within the estimation range. Center each function over a single data case. In our example, there are 104 data cases.
- Compute the overall distribution estimate as the superposition of the N positioned kernel functions.

On the choice of kernel functions, there are several types that may be used (e.g. Gaussian (or Normal), Epanechnikov, Triangular (**Silverman 1986; Scott 1992**)). It has been shown that different kernel choices can be made equivalent by rescaling according to appropriate bandwidths (**Lall et al. 1996**). It has also been suggested that bandwidth selection is the most important consideration when applying kernel density estimation methods (**Lall et al. 1996**). Given these considerations, the following kernel assumptions were made:

- Gaussian kernel function shape
- Optimal Gaussian kernel function bandwith (**Silverman, 1986**).

Equations describing the resultant probability density and "building-block" kernel functions are as follows:

$$p(\hat{x}) = \frac{1}{hN}\sum_i K(a)$$

(4) $$a = \left(\frac{\hat{x} - x_i}{h}\right)$$

$$K(a) = (2\pi)^{-0.5}\exp(-0.5a^2)$$

where x_i is an annual flow case in the data sample, $\hat{x}$ is a discrete flow coordinate in the flow-range at which density is being estimated, N is the number of sample observations (i.e. 104), and h is the optimal Gaussian kernel-function bandwidth (**Silverman 1986**) computed as follows:

$$h = 0.9AN^{-0.2}$$

(5) $$A = \min\left\{\sigma, \frac{(x_{i,75\%} - x_{i,25\%})}{1.34}\right\}$$

where σ is the sample standard deviation, and $x_{i,75\%}$ and $x_{i,25\%}$ are the 75th and 25th percentile flow values from the data sample.

A.3 Applying the Nonparametric Approach for our Example:

Revisiting the example from A.1, a nonparametric probability distribution function (PDF) was fit to the flow observations (**Figure 10** of the Memorandum). The PDF was then converted into a cumulative distribution function. This function was evaluated relative to the observed, or empirical, frequency distribution (**Figure 11** of the Memorandum). The shapes of the empirical and nonparametric distributions are similar at the extremes, as desired.

One problem with our example application is that the fitted PDF assigns probability to negative flows. Such negative annual flows might imply net annual depletion in the basin measured at Goodwin, which seems unrealistic (but not impossible). In general, it is expected that application of this methodology could produce a distribution function that "tails" at extreme values, assigning small amounts of probability to unrealistic conditions. To avoid the possibility of sampling unrealistically low-value conditions and impairing our ability to model drought reoccurrence, a probability sampling constraint was imposed in the methodology (Memorandum Section 2.3.2) such that the randomly generated sampling probabilities were confined to be within an arbitrary range (i.e. 0.01 to 0.99) even though they're initially sampled from a uniform distribution between 0 and 1. In the example of **Figure 14**, such a constraint on sampling probability is designed to limit the sampled synthetic flow range, but not so much that the sampled range is less than the observed range.

Appendix B – Development of Regional Precipitation Indices

Several factors were considered when selecting stations to describe precipitation in the Stanislaus Basin:

- Location
- Elevation
- Scale of variability (e.g. mean and range of historical data)
- Period of record

On location and elevation, the index would ideally represent station observations that are representative of precipitation in our locale of interest (i.e. in the Stanislaus Basin above Goodwin). On period of record, the index would ideally be based on as many years of observations as possible, and certainly include the observed droughts of 1929-1934 and 1987-1992. On scale of variability, it is recognized that higher elevation stations and more northward stations in the Sierra Nevada (from the American to the Upper San Joaquin Basins) tend to experience greater precipitation amounts than lower elevation and more southward stations, respectively.

Station data available from the California Data Exchange Center were surveyed, revealing a number of stations having a common "maximum" period of record (i.e. WY1906-2003) and being geographically proximate to the Stanislaus Basin. These stations are listed in Table B-1.

Table B-1: Precipitation Stations near the Stanislaus Basin having 1906-2003 data

Station I.D. (1)	Station Name (1)	Elevation (2)	Basin Location
CLF	Colfax	2400	American
AUB	Auburn	1292	American
PCV	Placerville	1850	American
FLD	Folsom Dam	350	American
SOR	Sonora R S	1749	Stanislaus
NFR	North Fork R S	2630	Upper San Joaquin
YSV	Yosemite Headquarters	3966	Merced

Notes:
(1) Station I.D. at the California Data Exchange Center (http://cdec.water.ca.gov)
(2) Units in feet above mean sea level

Table B-1 also indicates which stations are included in the two regional indices mentioned in Memorandum Section 3.0. The thought behind developing two regional indices is that the mix of station selection might affect the resultant index.

For each station, a time series of annual precipitation amounts was computed. Regional index construction then proceeded with the philosophy that the index should reflect common "phase of variability" found among the contributing stations, while paying little regard to the stations' "central tendency" and "range of variability". This ensures that the index is not dominated by stations that experience the most precipitation or the greatest range of precipitation. Instead, then index reveals common relative levels of annual wetness among the stations.

The mechanics of index construction given this philosophy are as follows:

- The annual station time series were converted into standardized station time series, by removing the period mean (based on WY1906-2003) and then dividing by the period standard deviation.
- A principal component analysis (**Haan 1977**) was performed on the collection of standardized time series (first for the collection contributing to PrecipIndex1 and then to the collection contributing to PrecipIndex2). The principal component analysis serves to transform the "dispersion matrix" of station time series (i.e. time periods as rows, stations as columns) into a matrix principal component (PC) "scores" time series. The PC scores exhibit two useful characteristics: (1) each PC scores time series is uncorrelated with the other PC scores time series, and (2) they are hierarchically arranged, with the first PC scores times series (i.e. PC1) explaining the most amount of original data variance in the dispersion matrix, PC2 explaining the next most amount, and so forth. In this application, characteristic (2) is of interest to us, as PC1 is defined as the regional index.

Appendix C – Graphical Results

Memorandum Section 3.0 describes figures generated for each of the analysis cases:

- Case A: Figures A1-A19 (reprint of Figures 1-19 from the memorandum)
- Case B: Figures B1-B19
- Case C: Figures C1-C19
- Case D: Figures D1-D19
- Case E: Figures E1-E19
- Case F: Figures F1-F19
- Case G: Figures G1-G19
- Case H: Figures H1-H19