DROUGHT-RELATED EFFECTS ON RIVER SALINITY:

HISTORICAL RECORDS

A. IBWC Monthly Flow and Salinity Data

B. Supplemented by the Data Compiled by NM.WRRI

C. Data from the automated gauging stations are not yet available

(Focusing on El Paso)

Briefing to NM/TX Water Commission

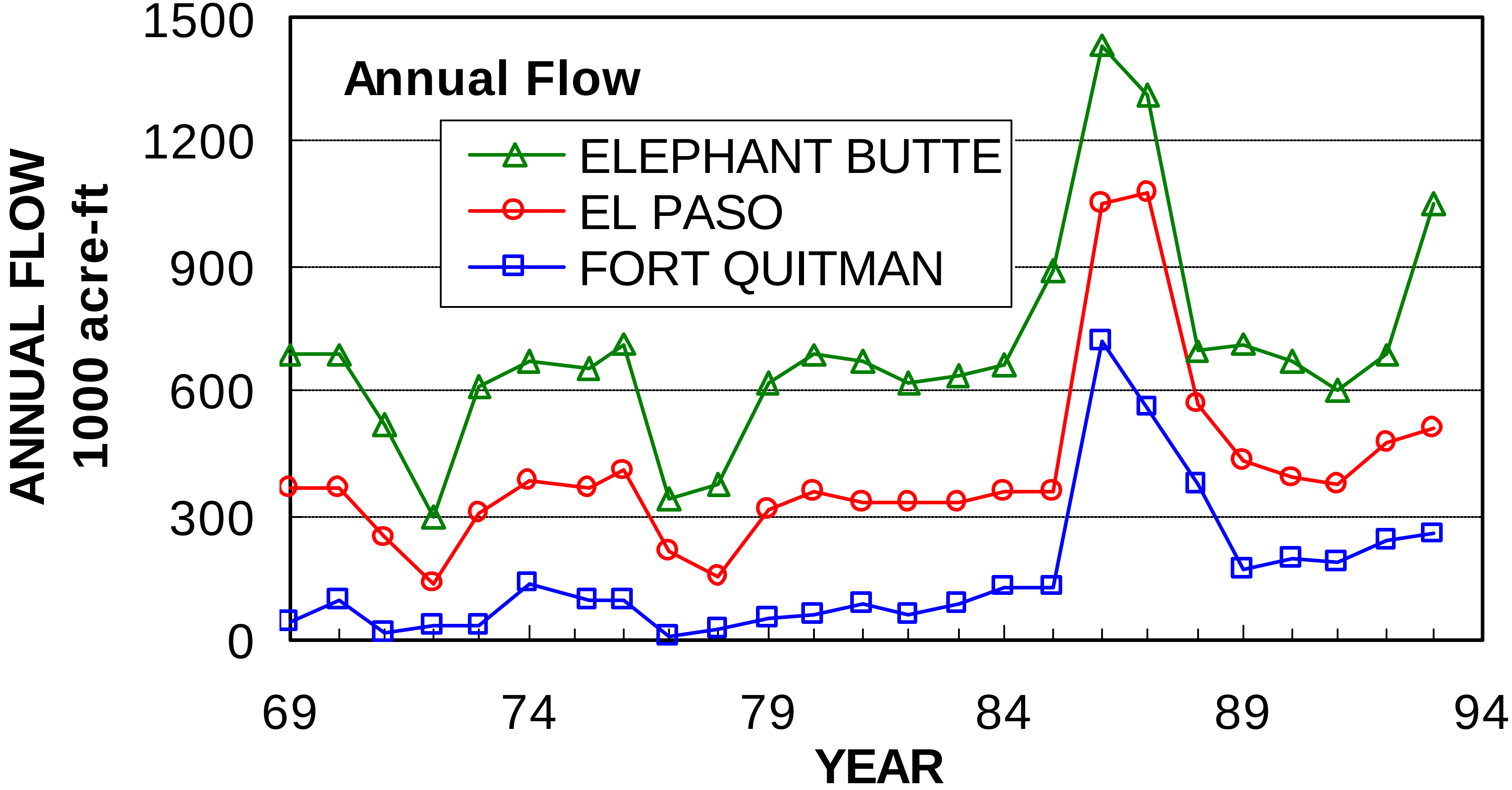
Texas A & M Univ. Agr. Res. Ctr.

Nov. 15, 2002

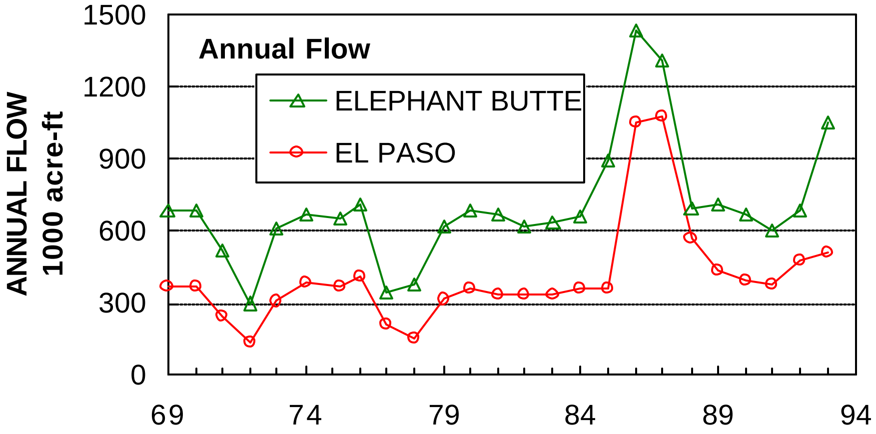
Droughts of the 70's

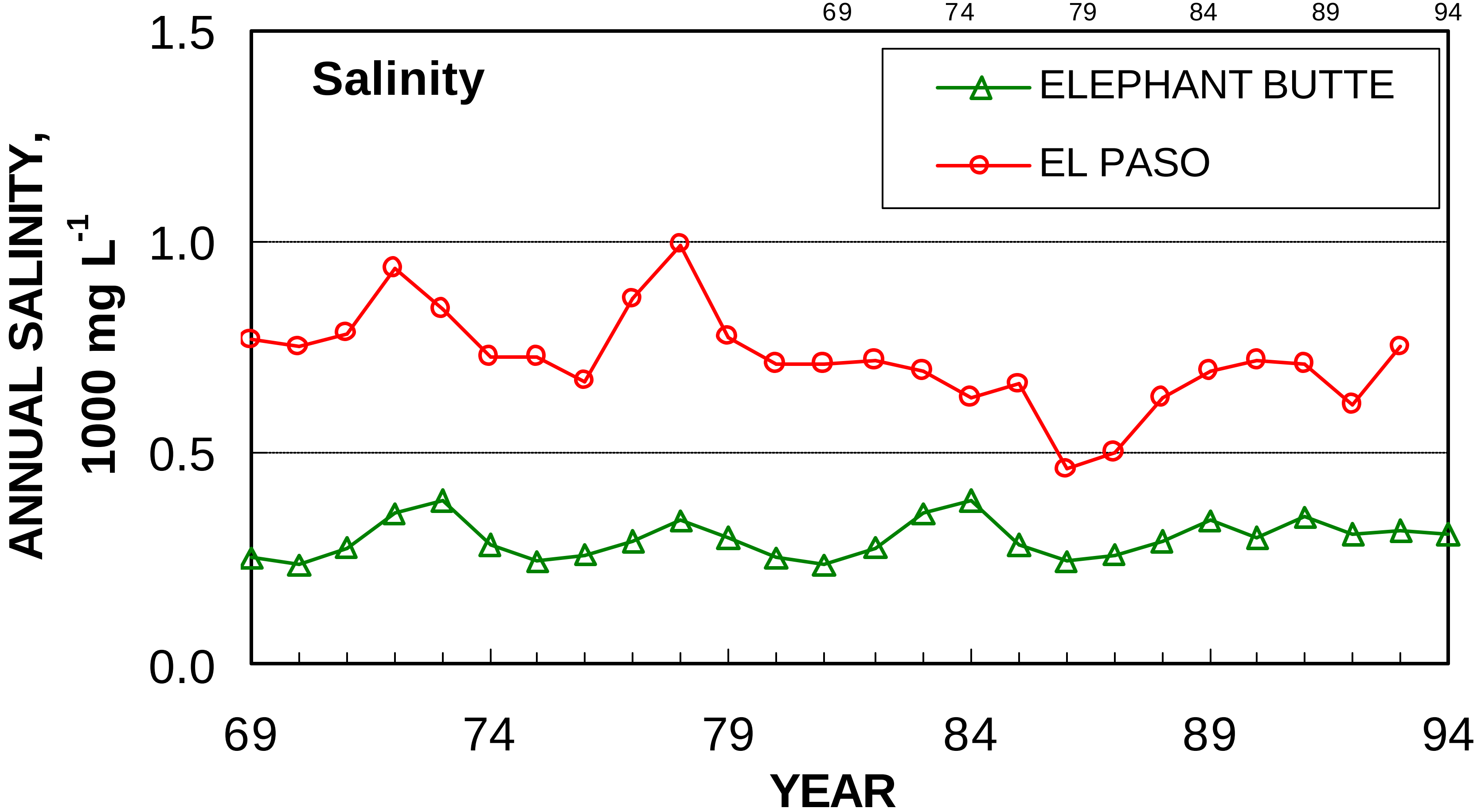
(1000 AF/Year)

	E. Butte	El Paso		E. Butte	El Paso
1971	**515**	**244**	**1977**	**335**	**214**
1972	**300**	**133**	**1978**	**375**	**156**
Normal	**871**	**377**			

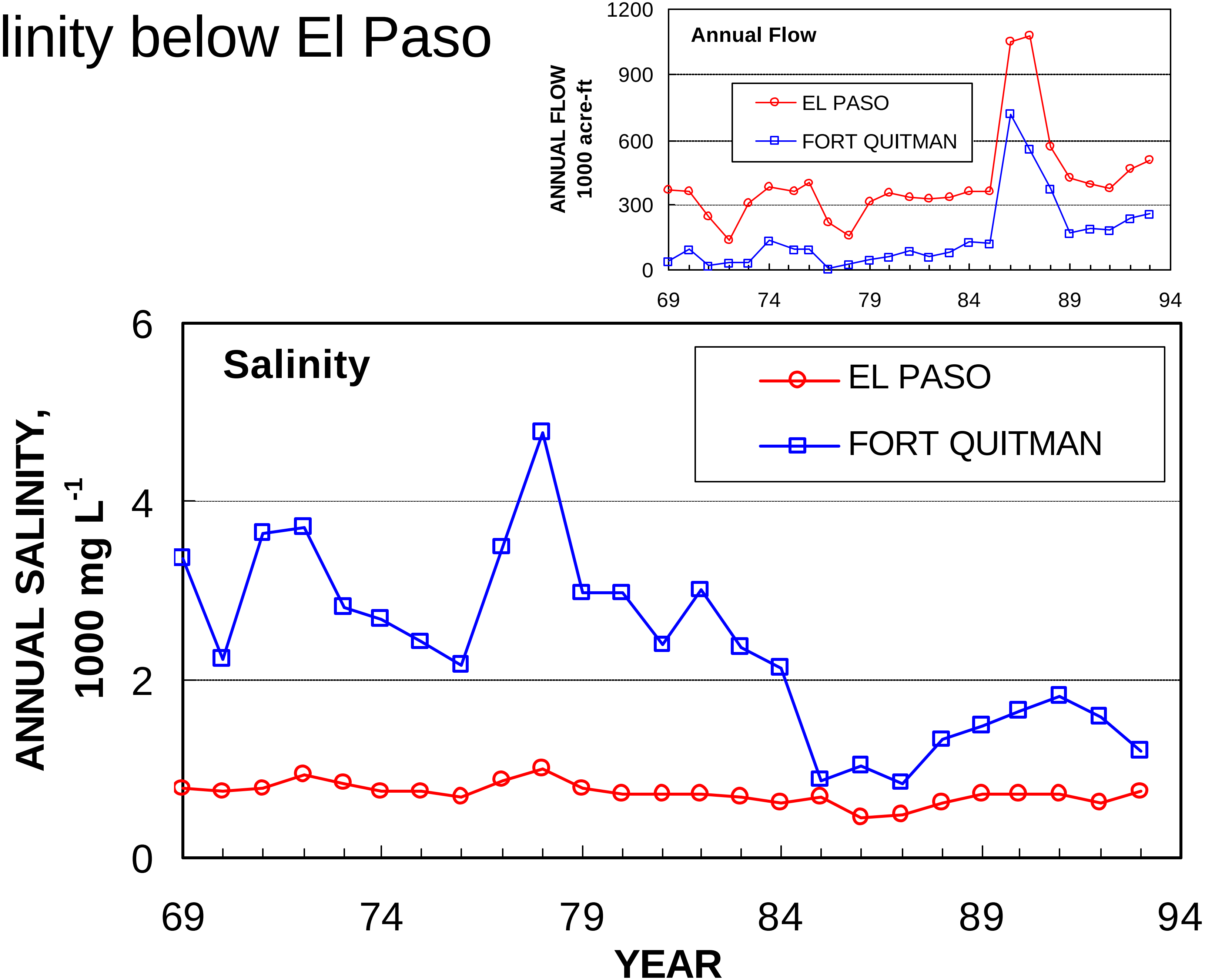


The Drought affected salinity at Elephant Butte, and El Paso



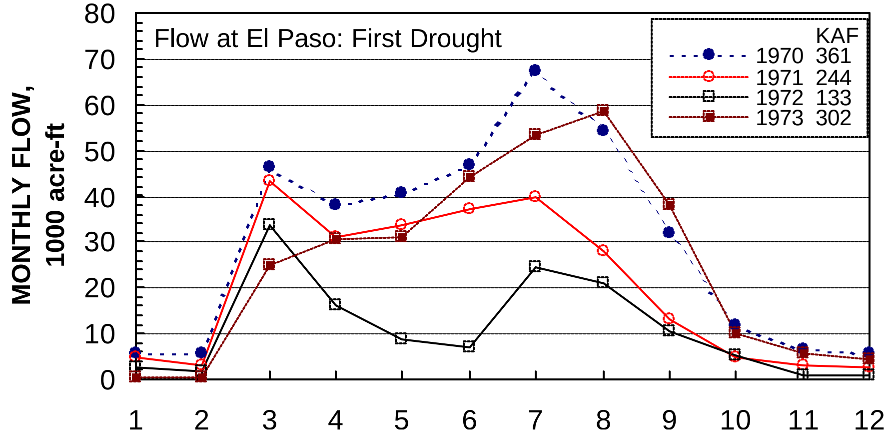


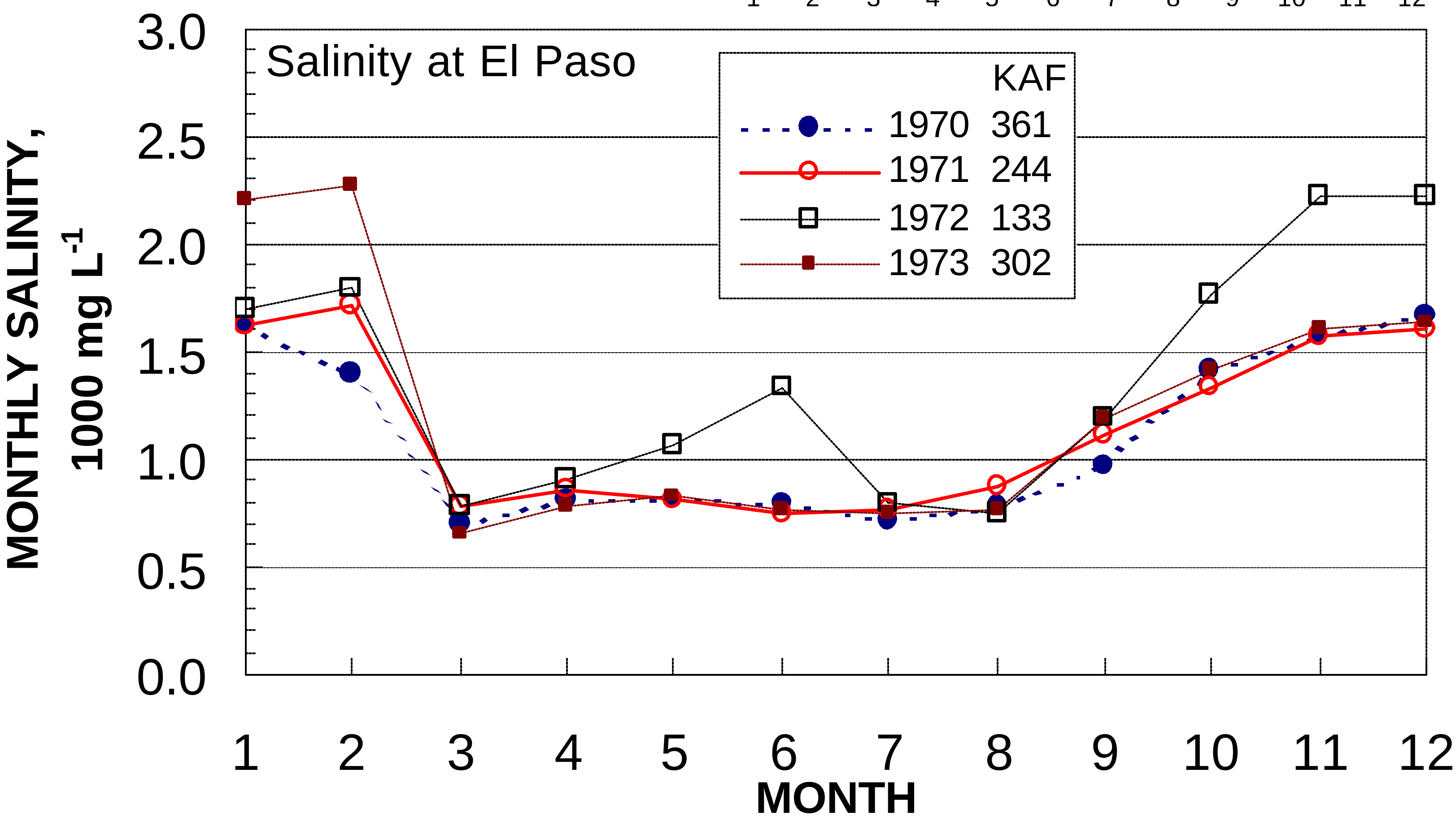
The Drought severely affected downstream salinity below El Paso



Monthly salinity depended on how the water was released

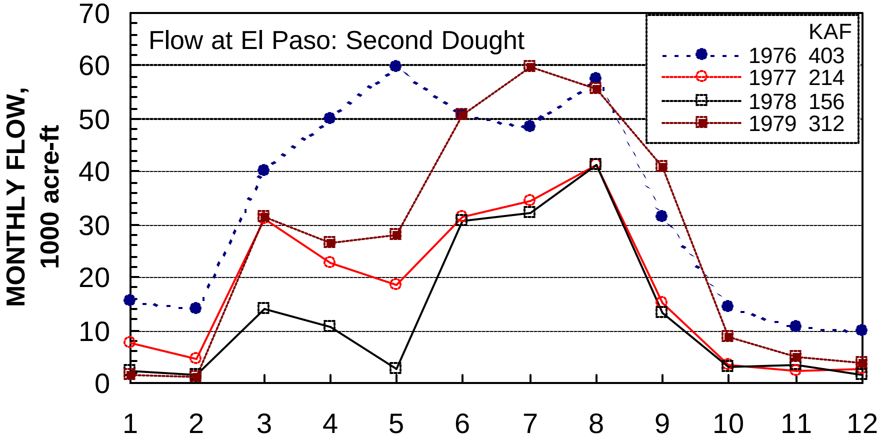
First Drought

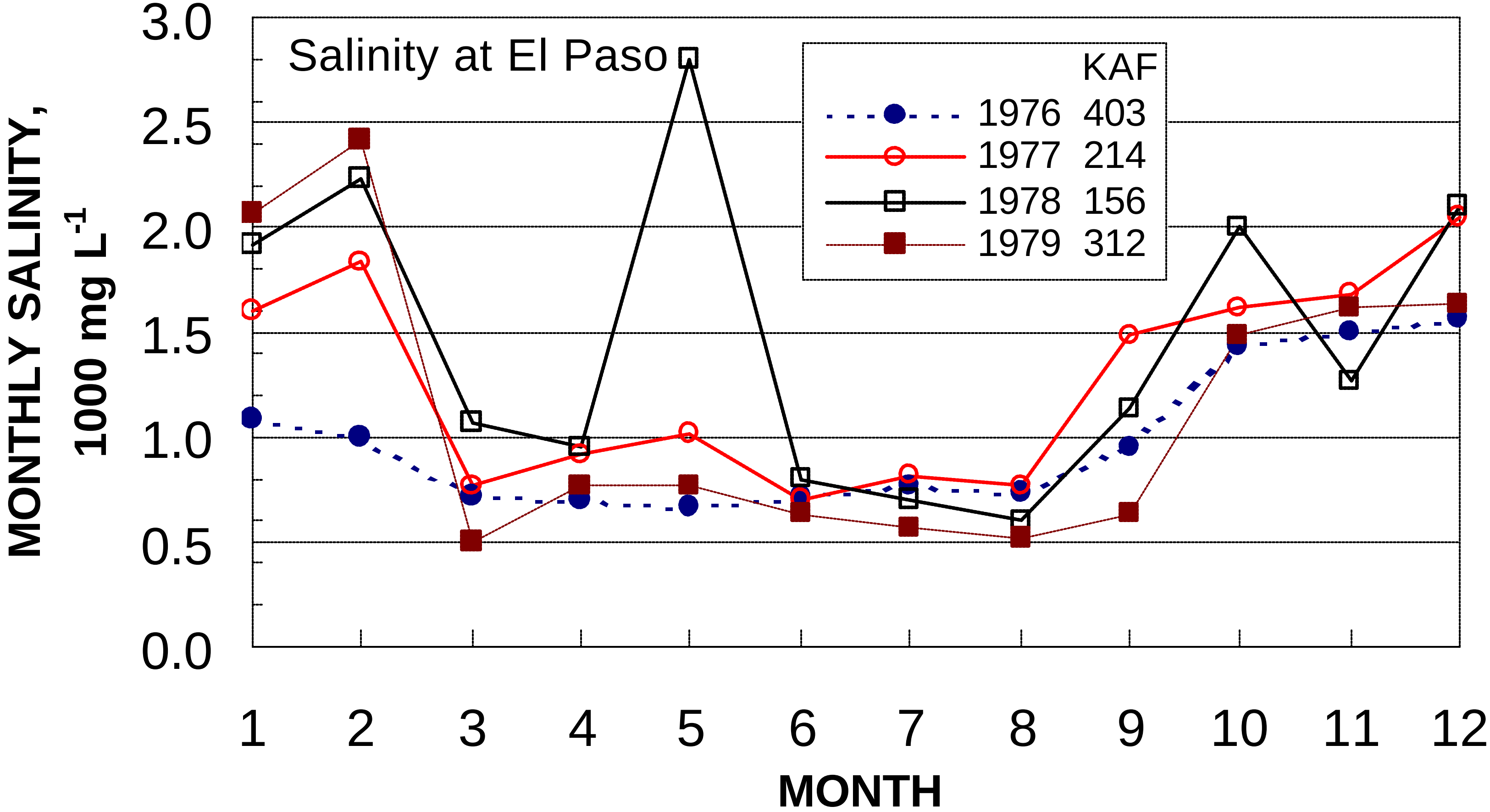




Monthly salinity depended on how the water was released

Second Drought





Flow and Salinity Relationships in May (ELP)

First Drought Period	**1970**	**1971**	**1972**	**1973**
Annual Flow (1000AF)	361	244	133	301
Flow: March-April cumul.	84	74	50	55
Flow: May	41	34	9	31
Salinity (ppm)	802	802	**1065**	823

Second Drought Period	**1976**	**1977**	**1978**	**1979**
Annual Flow (1000AF)	403	214	156	313
Flow:March-April cumul.	90	53	13	58
Flow: May	60	19	3	28
Salinity (ppm)	665	**1010**	**2795**	761

Flow and Salinity Relationships in September

First Drought Period	**1970**	**1971**	**1972**	**1973**
Annual Flow (1000AF)	361	244	133	302
Flow: March-August cumul.	293	212	112	241
Flow: September	32	13	10	38
Salinity (ppm)	976	**1107**	**1190**	**1190**

Second Drought Period	**1976**	**1977**	**1978**	**1979**
Annual Flow (1000AF)	403	214	156	313
Flow: March-August cumul.	293	137	132	252
Flow: September	37	15	13	40
Salinity (ppm)	948	**1480**	**1128**	641

The minimum flow required for salinity control below 1000 ppm

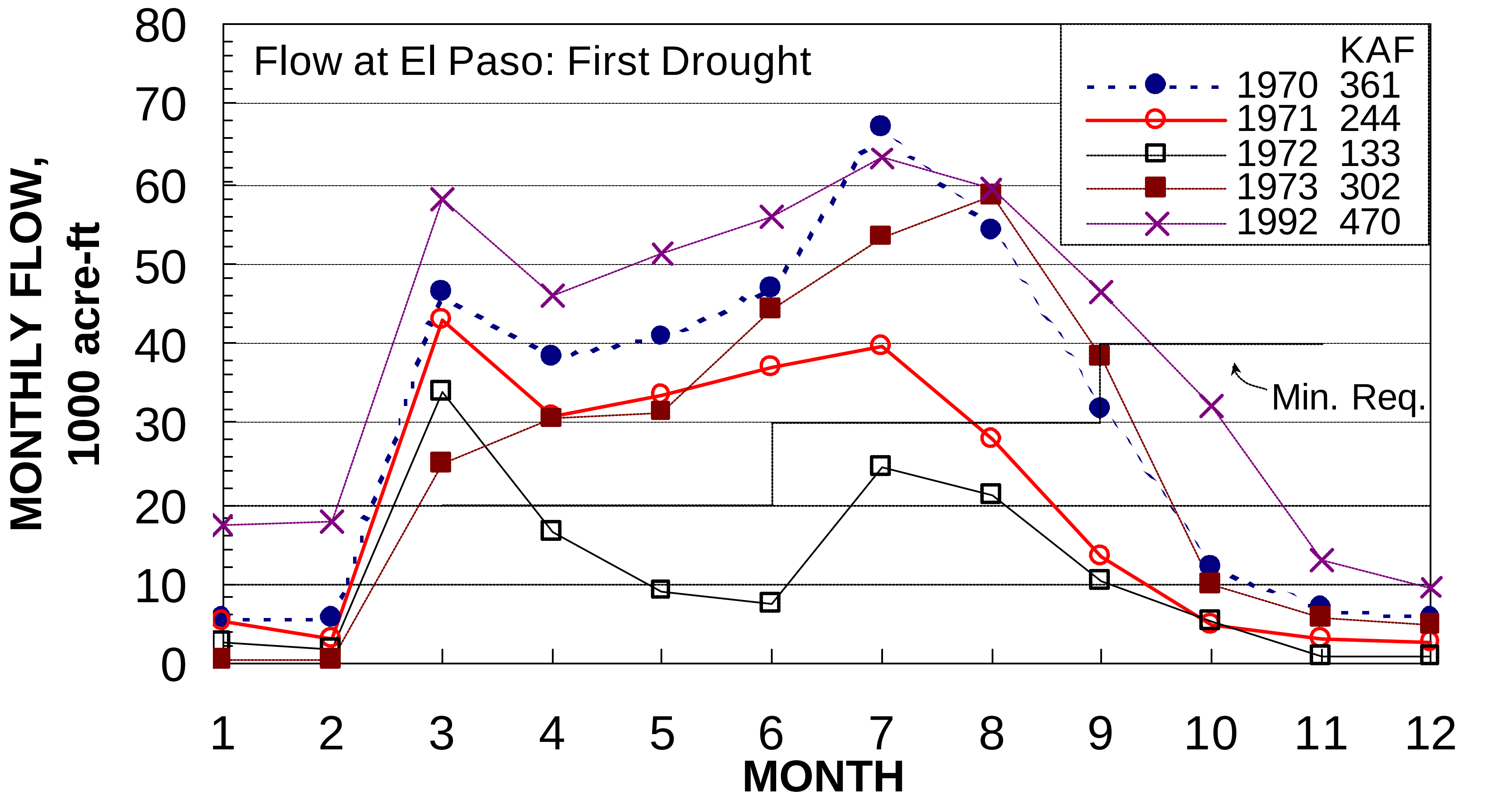
(Based on historical records and tentative)
(Flow-history dependent)

	Monthly[1] -	cumul.	salinity
	1000 AF		ppm
Jan.- Feb.	14	28	1003
March, April, May	20+	88+	1060
June, July, August	30	178	880
September	30-40	208-218	950-1000
October	14	222-232	1100+

[1] - The min. flow required does not necessarily coincide with seasonal agricultural water demands

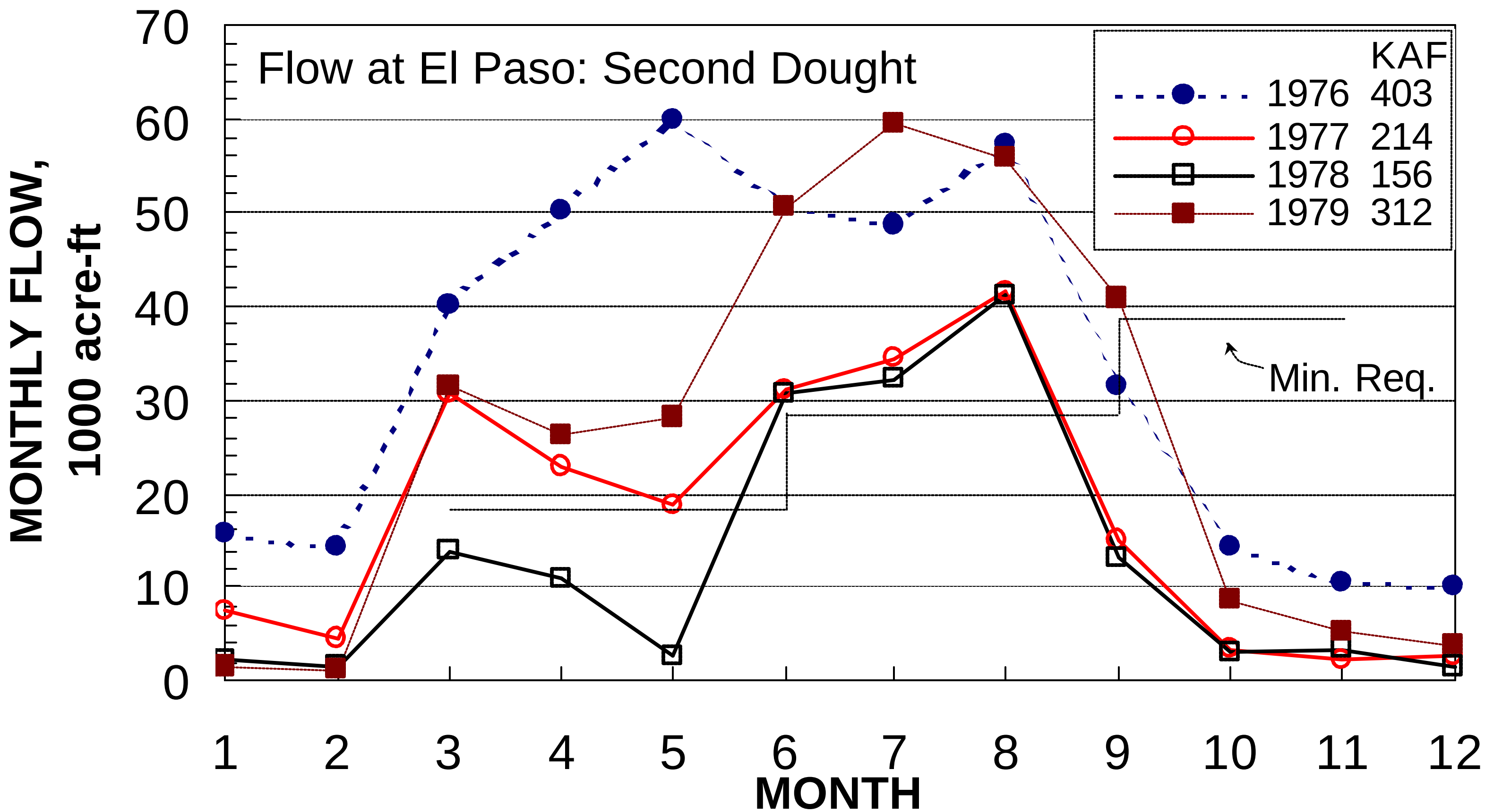
Agricultural Water Demands

Irrigation demands normally exceed the minimum flow required in March. One scenario is excessive use of the limited water in the early season, thus causing salinity increases during the late season.

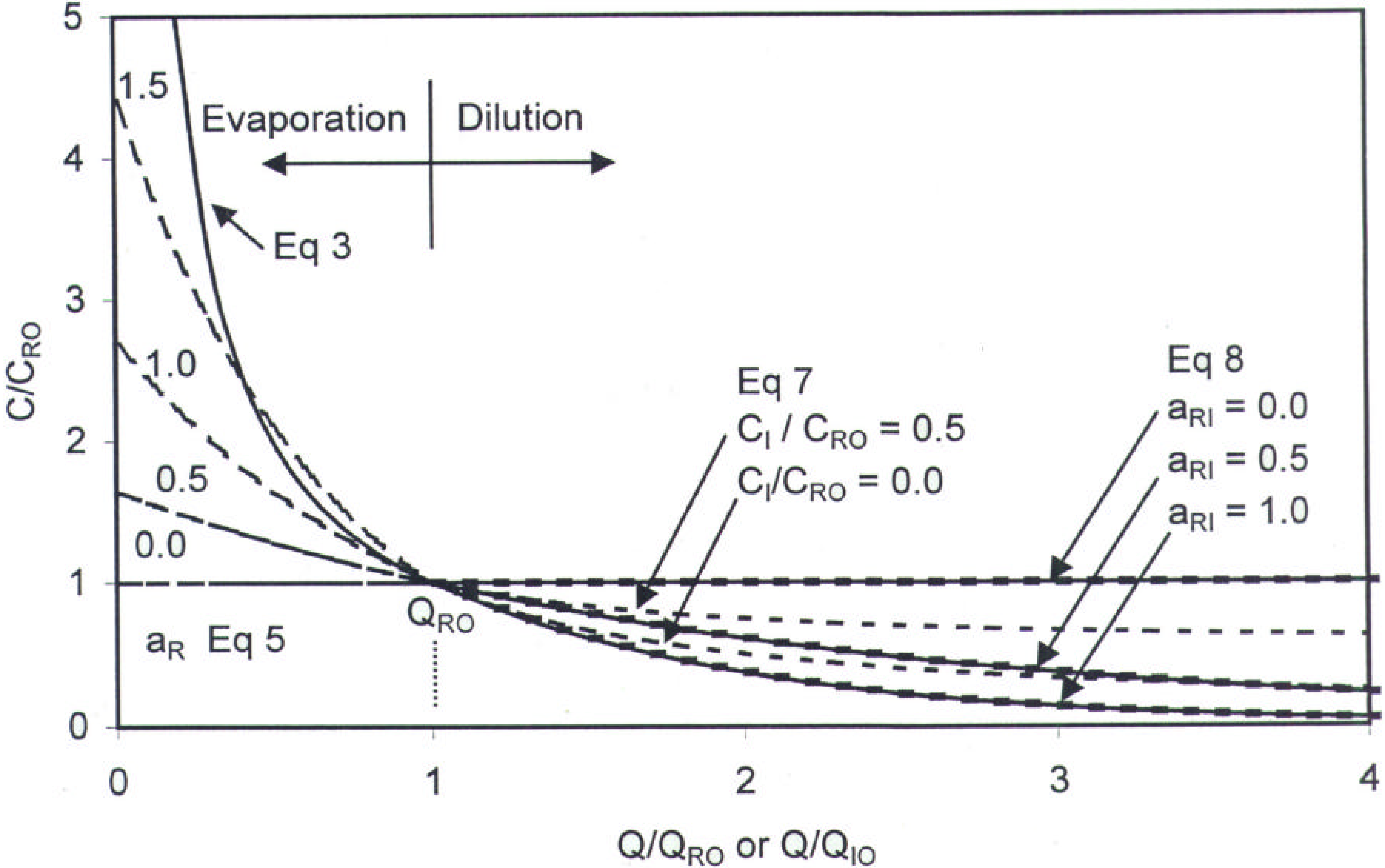


Agricultural Water Demands

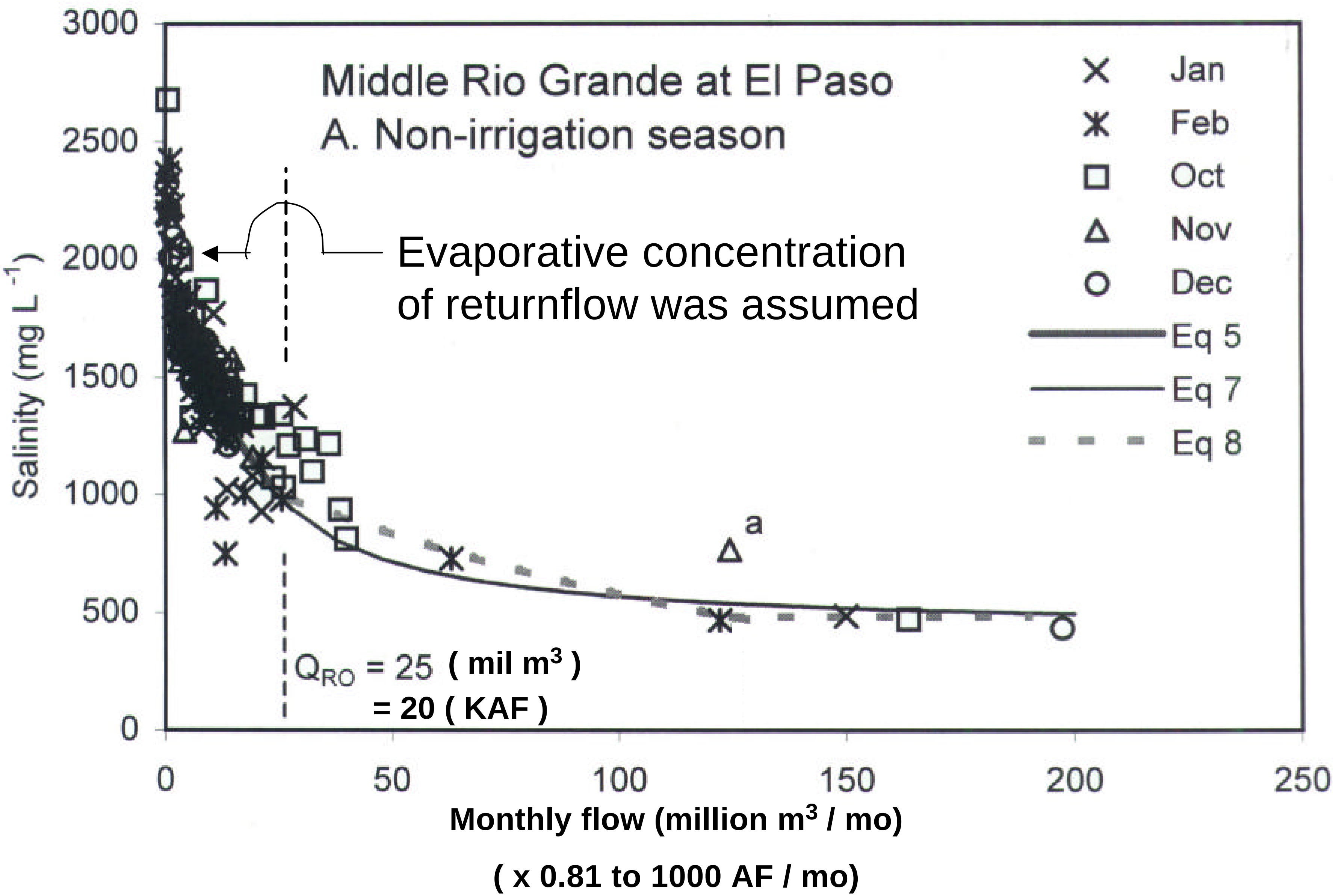
The grim forecast of the project water supply can lead to agricultural water demands below the minimum flow required during the early season, thus causing salinity increases during the period.



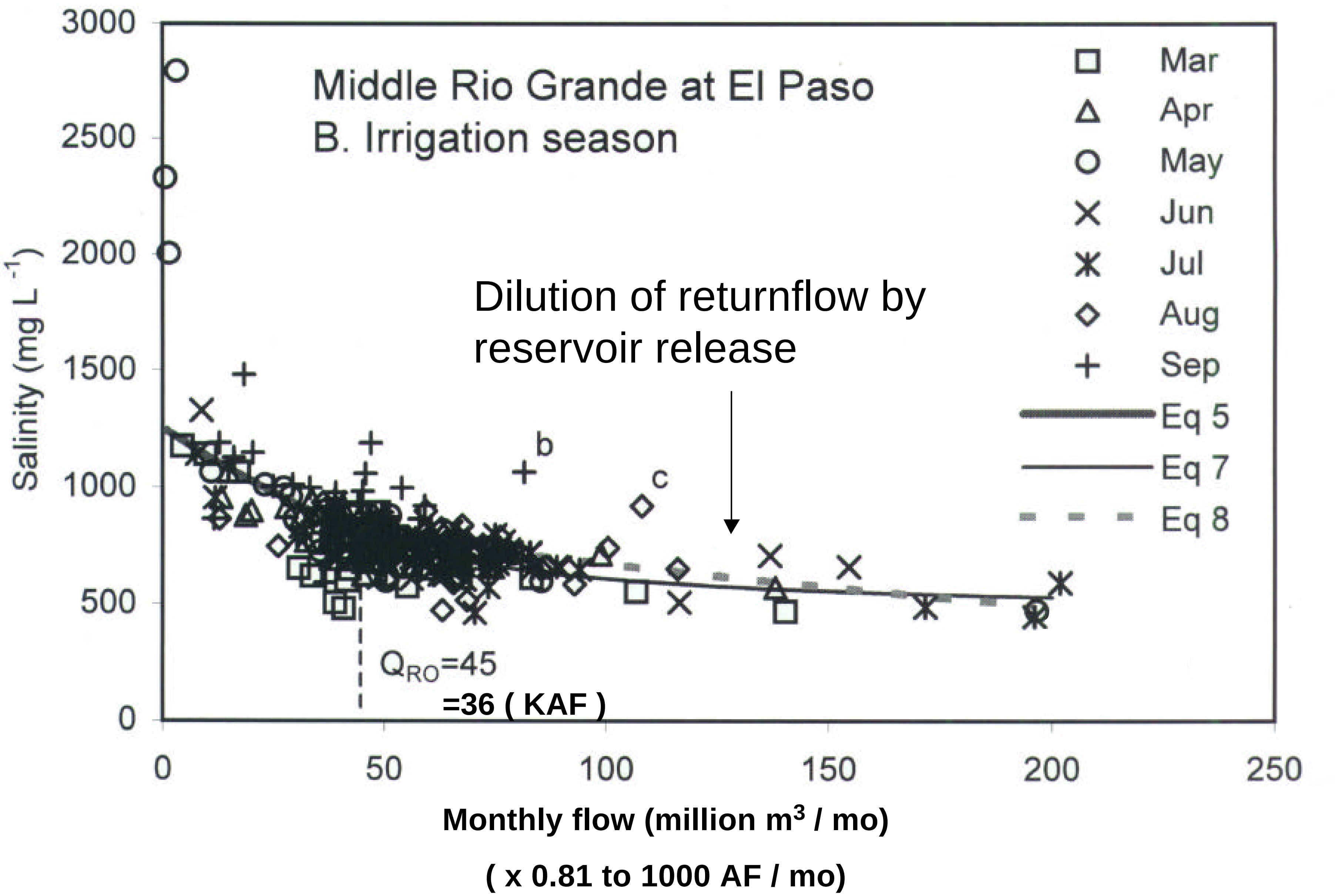
The Flow Required to Prevent the Sharp Increase in Salinity



Salinity during non-irrigation season at El Paso



Salinity during irrigation seasons at El Paso



Dilution by Reservoir Release

$$C = (C_{RO}Q_{RO} + C_I Q_I) / (Q_{RO} + Q_I)$$

$$= C_{RO} + C_I (Q_I / Q_{RO}) / (Q / Q_{RO})$$

$$Q = Q_{RO} + Q_I$$

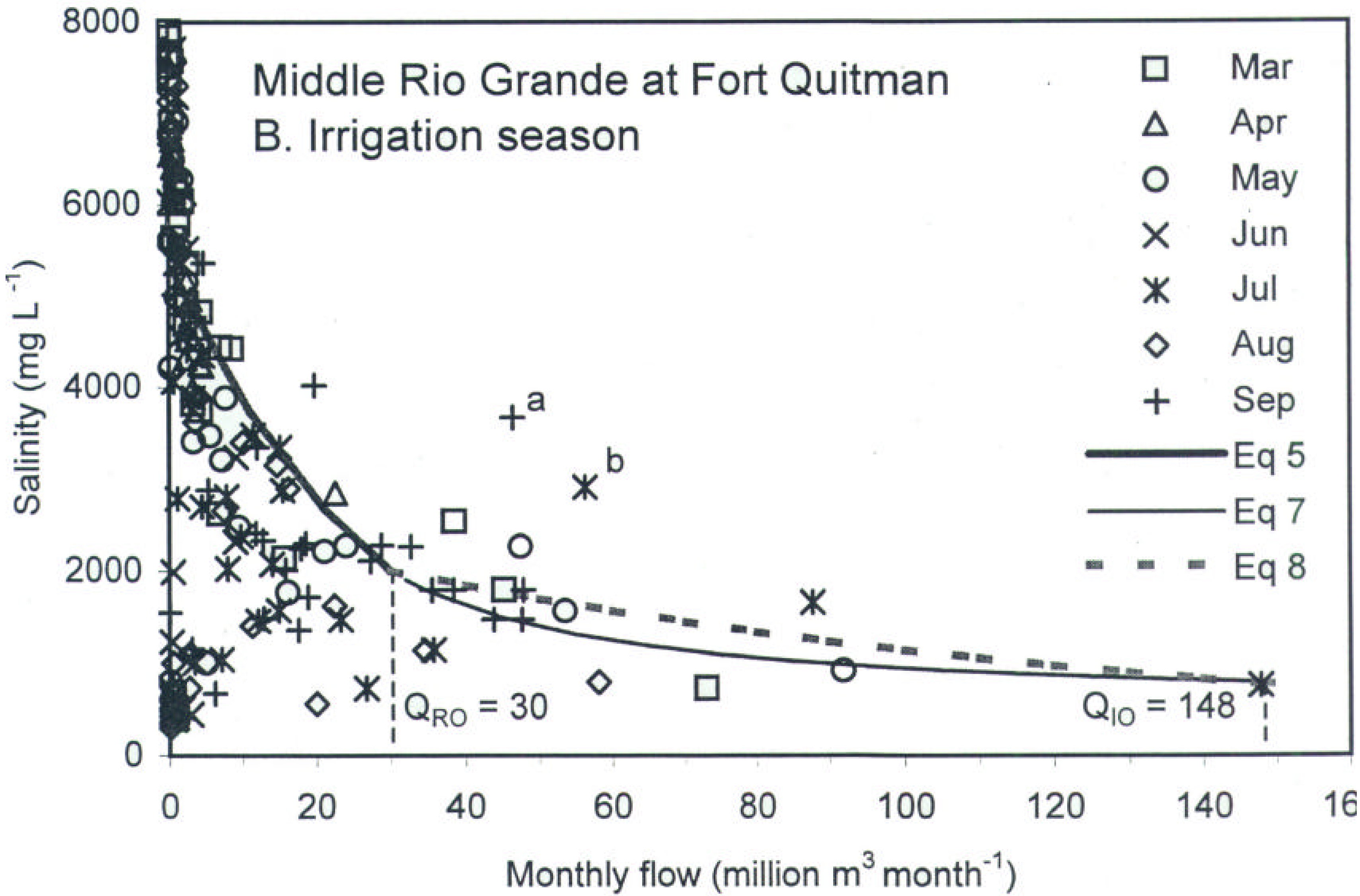
If $Q_{RO} = 0.$, $C_I = C$

Q_{RO} : Returnflow before evaporative concentration Q_I : Reservoir release

C_{RO} : Salinity of returnflow before evaporative concentration

C_I : Salinity of reservoir release

When river bank is salinized, or there are other sources of saline flow, salinity is not a straight function of reservoir release



The Base-Flow Required

	Minimum[1] -			Desirable[2] -		
	Q	Cum.	Salinity	Q_{RO}	Cum.	C_{RO}
Non-irrigation		1000 AF	ppm		1000 AF	ppm
January - Feb.	14	28	1003	20	40	1000
Irrigation Season						
March - April - May	20	88	1060	32	136	600 - 800
June - July - Aug.	30	178	880	36[2] -	244	800
Sept	30 - 40	213	950	48	292	900
Post-Irrigation Season						
Oct	14	227	1420	24	316	1100

[1] - Bare minimum to keep salinity below 1000 ppm or less

[2] - Base-flow required for preventing a sharp increase in salinity, including agricultural water demands in excess of the minimum flow

Effects of Prolonged Low Flow on Downstream Salinity

- Increase salt accumulation or storage in river bank and riparian zones

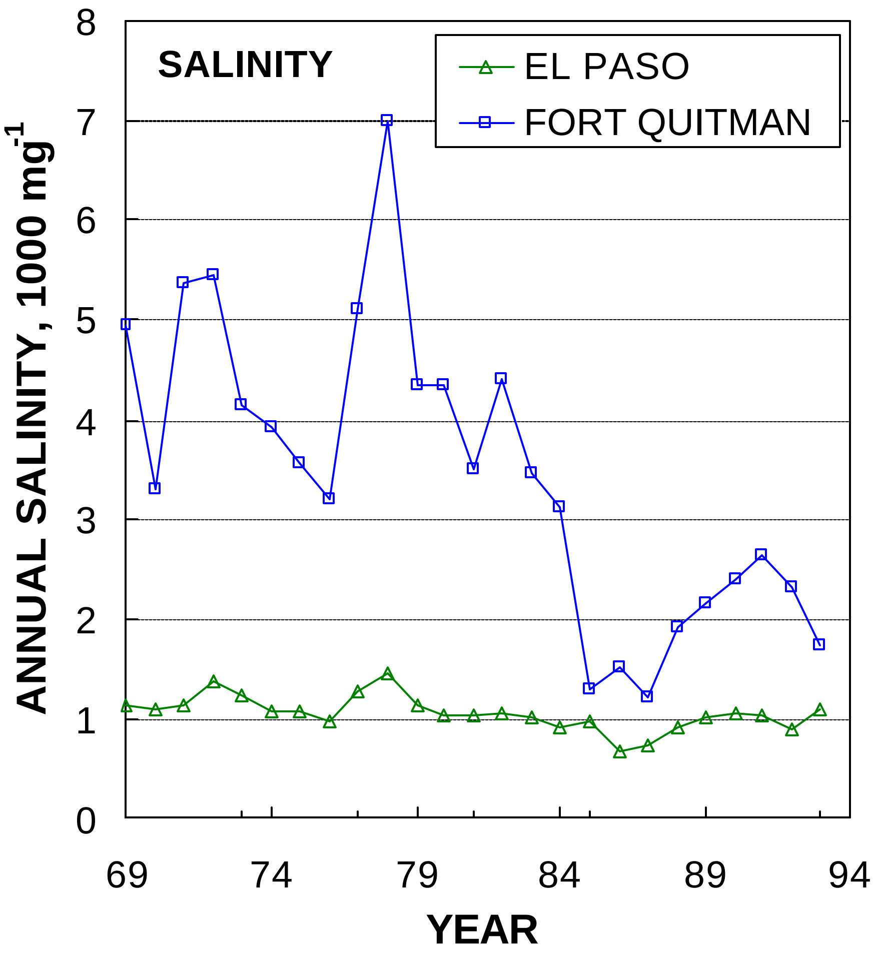
Excluded photos for smaller file size

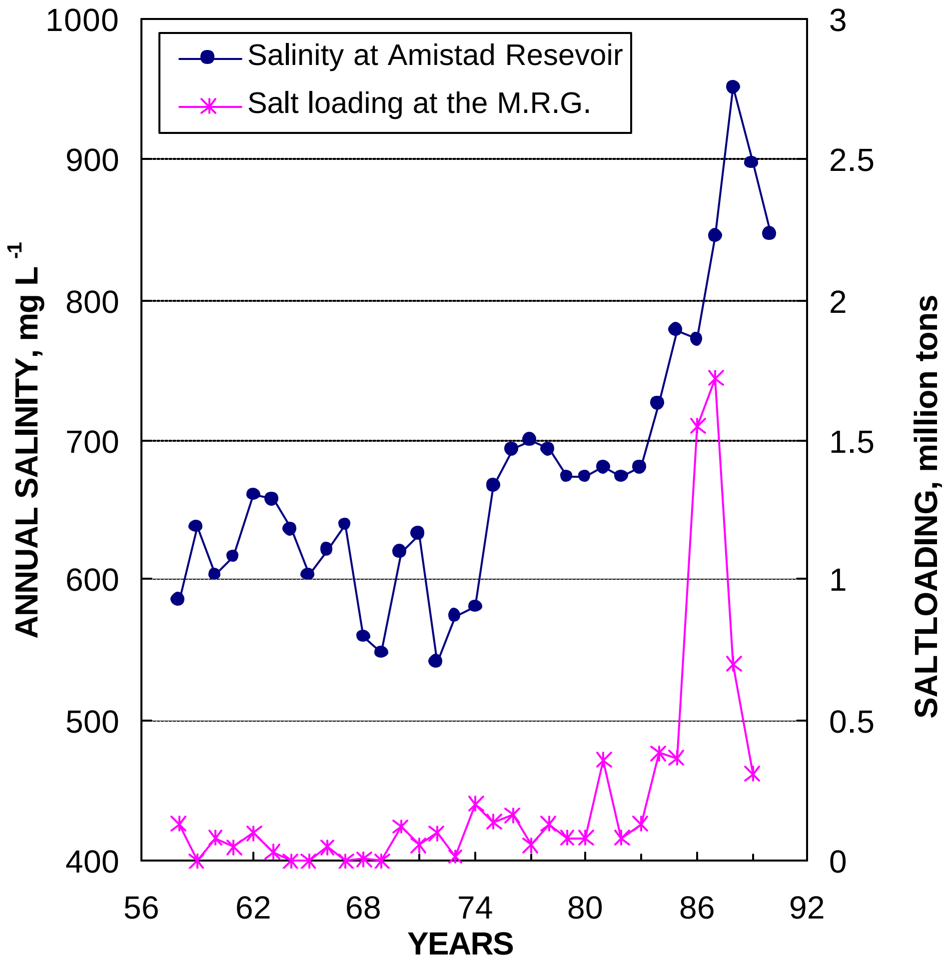
Effects of Prolonged Low Flow on Downstream Salinity

- Salinity increases will be followed by changes in vegetation

Excluded photos for smaller file size

- Salt flushing during high flow contributes to salinity fluctuation





Summary

Drought Impacts on River Salinity

1. Salinity can increase to over 1000 ppm during May and especially Sept., depending on the actual irrigation demands and reservoir release.
2. The minimum flow required to keep salinity below 1000 ppm as well as the base flow required to avoid a sharp increase in salinity were suggested.
3. Prolonged low flow increases salt storage in river banks and riparian zones, which is subject to flushing during high flow.
4. Detailed study of salinization processes is needed for addressing salinity control strategies.