Interior Columbia Basin
Ecosystem Management Project
Science Integration Team
Terrestrial Staff
Range Task Group

REVIEW DRAFT

Susceptibility to Rangeland Health Disturbance Stresses in the Interior Columbia Basin and Portions of the Klamath and Great Basin

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Susceptibility to Rangeland Health Disturbance Stresses

Report by S.G. Leonard and M.G. Karl

Rangeland health (National Research Council 1994) is defined as "the degree to which the integrity of the soil and ecological processes of rangeland ecosystems are maintained." Rangeland health incorporates indicators of 1) soil stability and watershed function, 2) distribution of nutrients and energy, and 3) recovery mechanisms. Soil stability and watershed function are given greatest importance; however, the determination is generally to be made based on a "preponderance of evidence" of both soil and vegetation indicators.

The present status of soil and vegetation indicators must be determined by on-site investigations. However, there are indicators of relative susceptibility to disturbance stresses. Soil properties that may make certain sites more susceptible to range health stress include erodibility by water or wind, salinity and sodicity, and shrink-swell potential. Climate is a driving variable affecting site susceptibility to stresses on both vegetation and soils and affecting resiliency to recover from stresses. Arid climates receiving less than 12 inches average annual precipitation in particular are subject to extremes and/or episodic events that in conjunction with other ecosystem stresses can lead to degradation and inhibit recovery. Vegetation indicators of susceptibility might also include composition of flammable exotics or noxious weed species, however, these plant community characteristics are more appropriately analyzed at the mid scale utilizing inventory data or on-site determinations.

Soil property indicators of susceptibility to rangeland health disturbance stress

Aerial extent (hectares) of soil properties evaluated (Table 1.) was

determined from the STATSGO data base (USDA 1991) where at least 75% of the soils in a map unit possessed the criteria described as follows:

Susceptibility to degradation is greatly dependent on natural erosivity of the soil. The soil erodibility factor (K) is a measure of the susceptibility of a soil to particle detachment and transport by rainfall. It is a quantitative value, experimentally determined. A K factor greater than .37 has been used in existing soil interpretations by the Natural Resource Conservation Service (NRCS) as a limiting factor or erosion hazard (USDA 1983). All soils with a K factor of .37 or greater were considered to have at least a moderate susceptibility to disturbance stresses.

A wind erodibility group (WEG) is a collection of soils that have similar properties affecting their resistance to soil blowing. Groups 1,2, and 3 are often included in interpretations as a limiting factor because of wind erodibility and is considered to be at least moderately susceptible to stress.

Salinity and sodicity affect plant growth and can exacerbate soil surface disturbances limiting reestablishment of plants. Salinity is the concentration of all salts more soluble than gypsum whereas sodicity relates specifically to exchangeable sodium. Salinity is measured by electrical conductivity in decisiemens per meter (dS/m) or millimhos per centimeter (mmhos/cm). The units are equivalent. The sodium adsorption ratio (SAR) is the standard measure of sodicity. High concentrations of salts can interfere with the absorption of water by plants and with the exchange capacity of nutrient ions, thereby resulting in nutritional deficiencies. Reduced infiltration and high evaporation rates associated with surface disturbance can lead to even higher surface concentrations of salts exacerbating negative affects on plant establishment and growth. The dispersal effects of sodium on soil particles in combination with disturbance can increase "slick spot" areas and physical crusting further limiting establishment of many plants. A

moderate susceptibility of soils with SAR 5-12 and/or salinity of 8-16 mmhos/cm and high susceptibility of soils with SAR of >12 and/or salinity >16 mmhos/cm is consistent with other interpretations of limitations to plant growth or seeding establishment.

Shrink-swell potential is the susceptibility of soil to volume change due to loss or gain in moisture content. Shrink-swell is expressed as percent change in linear extensibility (LE) or as a coefficient of linear extensibility (COLE) in decimal fraction from a moist to dry state. High (6-9 LE or .06-.09 COLE) and very high (>9 LE or >.09 COLE) shrinkage can damage plant roots and limit establishment of many perennial plants. These soils are particularly susceptible to exotic annuals such as cheatgrass that have fibrous root systems and need only to persist for one year in place. No map units were found to have 75% of the soils with a very high shrink-swell potential. Areas with high shrink-swell were considered moderately susceptible.

Table 1. Soil Susceptibility to Disturbance Stresses (hectares)

ERU	K Factor (mod.)	WEG (mod.)	Salinity (mod.)	SAR (severe)	SAR (mod.)	Shrink-Swell (mod.)
1.	136915	496252	3352			
2.	28226	1826				1826
3.		373926	99877			83055
4.	139255	2710595	496014			614131
5.	3141189	3660856	514628			480221
6.	245564	2306457	77262			596935
7.	370109	3071161	29448			
8.	90730	1543431				
9.	159398	1336702		1711	1711	3066

10.	1045316	5197317	1147419	5544	15863	1145886
11.	949074	963937	1190722		20942	73315
12.	277540	995584	32024			1632
13.	96051	2132411	372039			47225

ERU's (Ecological Reporting Units): 1. Northern Cascades, 2. Southern Cascades, 3. Upper Klamath, 4. Northern Great Basin, 5. Columbia Plateau, 6. Blue Mountains, 7. Northern Glaciated Mountains. 8. Lower Clark Fork, 9. Upper Clark Fork, 10. Owyhee Uplands, 11. Upper Snake, 12. Snake Headwaters, 13. Central Idaho Mountains

Location maps of soil map units containing the soil properties described are presented in appendix 1.

Climate indicators of susceptibility to rangeland health disturbance stress

The 10-12 inch precipitation zone in the ICRB appears to be particularly susceptible to invasion by exotic annuals. However, the 10-12 inch zone is proposed as moderately susceptible because it is recognized in most seeding guides as the lower range for successful reseeding of perennial species, providing that soil factors are not limiting. An annual precipitation zone less than 10 inches may be somewhat less susceptible to initial invasion by annuals, but once established, the likelihood of recovery by reseeding or other means is exceedingly diminished. Precipitation zones are presented in Illustration 1.

High incidence of drought and few favorable periods of precipitation for plant recruitment can exacerbate grazing disturbances if not managed properly (Vallentine 1990). Periodic drought might also facilitate woody plant establishment and canopy development (Archer 1994) or result in high weed biomass, including flammable exotics, in succeeding years of high rainfall

(Vallentine 1990). The frequency of drought years generally increases with increasing aridity. Seedling establishment of perennial species usually requires two or favorable years in succession. The occurrence of two or more favorable years in a row occurs infrequently in the ICRB, is unpredictable in occurrence, and in most cases is preceded or succeeded by at least moderate drought conditions.

Climate divisions with a high proportion of arid and semiarid rangelands in the ICRB can be generally characterized as follows:

- Although some skew is detectible, distribution of precipitation is nearly normal about the mean, resulting in near equal probability of being above or below normal. Mean precipitation approximates the median precipitation.

- The more arid the division, the greater the variance from the mean. Drought years as well as years above normal precipitation occur with greater frequency and greater magnitude (in most cases, but not always). The same relationship can be expressed for precipitation zones within a division (Redmond personal communication)[1].

- A high proportion of annual precipitation available for plant growth in the arid and semiarid portions of the ICRB is received during the winter months. The eastern most divisions in Idaho, Montana, Wyoming, and Utah have a higher proportion of spring/summer precipitation so relations change somewhat in these areas. Drought years 80% of normal or below for the October through March period occur 20 to 25% of the years in most divisions with 6-8 inches of precipitation during the

[1]Personal communication. 1995. Kelly Redmond. Climatologist, Western Regional Climate Center, Atmospheric Sciences Center, Desert Research Institute, PO Box 60220, Sage Bldg. 5625 Fox Ave., Reno NV 89506

period (about 10-12 inches annually). Extremes range from 14 to 38% of the years. About half of these will be 70% or less below normal, although there is still considerable variation.

- Drought years 80% of normal can be as high as 38% of the time with 26 of these being 70% of normal or less (Northwest Division, Nevada, Ave. 5.66 inches Oct.-March).

- Favorable conditions of 110% or greater precipitation, two or more years in a row, occur only 4 to 12 times in the 100 year record for the ICRB, with 8 to 10 periods more most common. Distribution is episodic and may have as little as one year between periods to as high as 61 years (the moderately mesic Canyons Division, Idaho) with 20 to 30 years between periods common in many divisions. Successive occurrences of favorable precipitation is less important in higher precipitation areas because moisture is generally not limiting for plant recruitment. However, it may be very important for other considerations such as domestic water supplies and stream flow dynamics.

Drought frequency of 70 and 80% or less of the median precipitation and favorable periods of two or more consecutive years 110% or more above median precipitation for the October through March period from 1895 to 1994 are presented in Table 2. for all climate Divisions in the ICRB assessment area:

Table 2. 100 YR. Climate Data Analysis

State, Climate division	Median PPT. Oct. - Mar.	# YRs. <70%	# YRs. <80%	# Periods >110% 2+ YRs.
Washington, E. Slope Cascades	23.25"	8	23	9

Okanogan-Big Bend	7.6"	9	22	9
Central Basin	6.47"	10	23	7
Northeast	12.43"	5	18	6
Palouse-Blue Mtns.	11.48"	7	20	5
Oregon, High Plateau	21.24"	15	23	8
North Central	11.51"	12	20	5
South Central	7.86"	13	25	7
Northeast	10.96"	10	20	5
Southeast	6.14"	14	25	8
Nevada, Northwest	5.52"	26	38	10
Northeast	5,84"	12	24	8
Idaho, Panhandle	17.56"	4	17	7
N-C Prairies	**12.16"**	4	14	5
Canyons	13.03"	7	18	4
Central Mountains	17.75"	11	25	7
Southwest Valleys	8.02"	11	24	8
Southwest Highlands	5.95"	11	16	10
Central Plains	5.96"	11	24	8
Northeast Valleys	3.32"	11	21	12
Upper Snake R. Plains	5.63"	13	19	8
East Highlands	8.07"	9	19	7
Utah, West	4.16"	11	25	9
Montana, West	10.01"	10	19	5
Southwest	5.52"	10	16	5
Wyoming, Yellowstone Drainage	6.74"	10	27	5
Snake Drainage	12.81"	10	20	7
Green & Bear Drainage	4.44"	12	20	8

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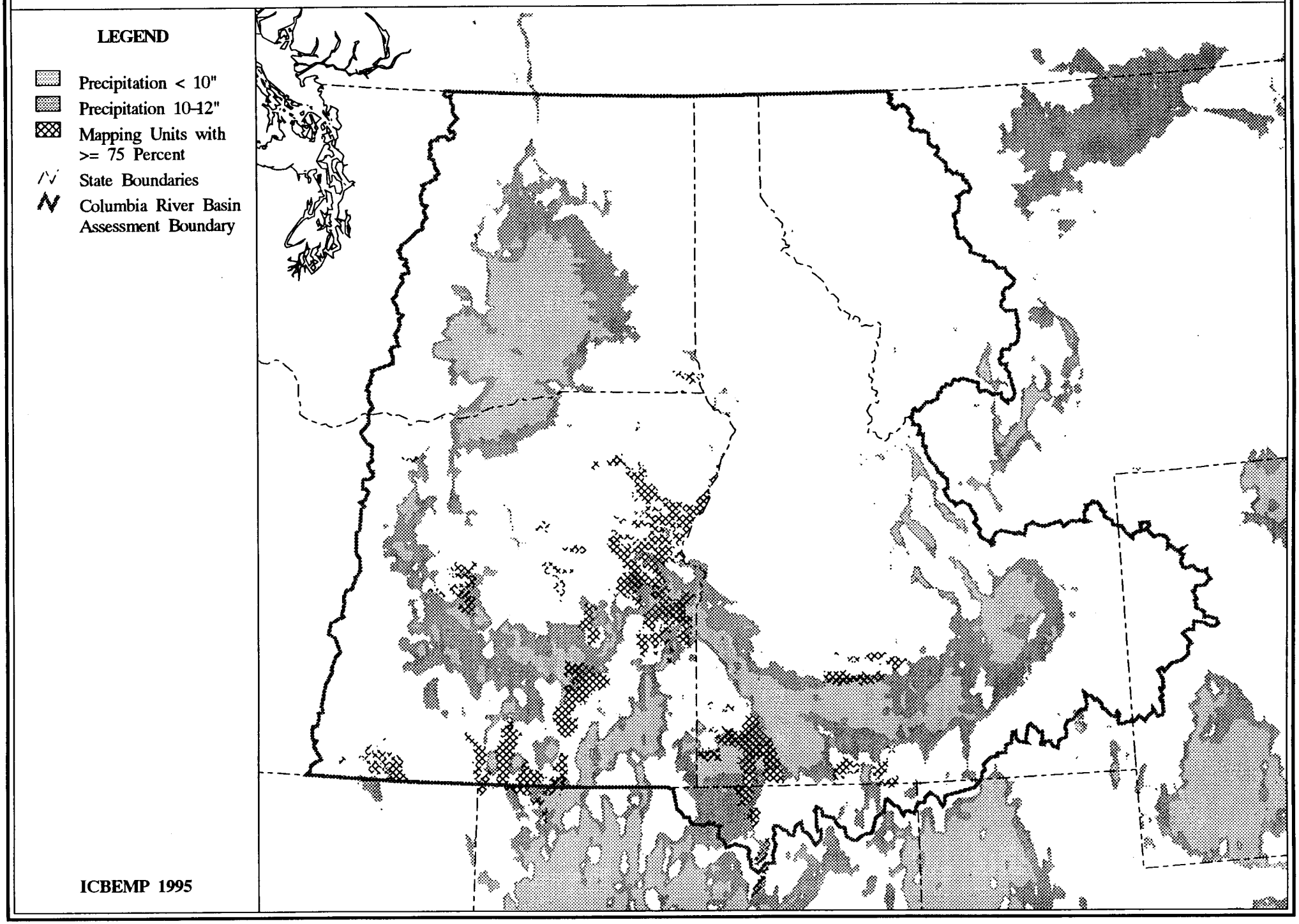
High SSP and Moderate WE



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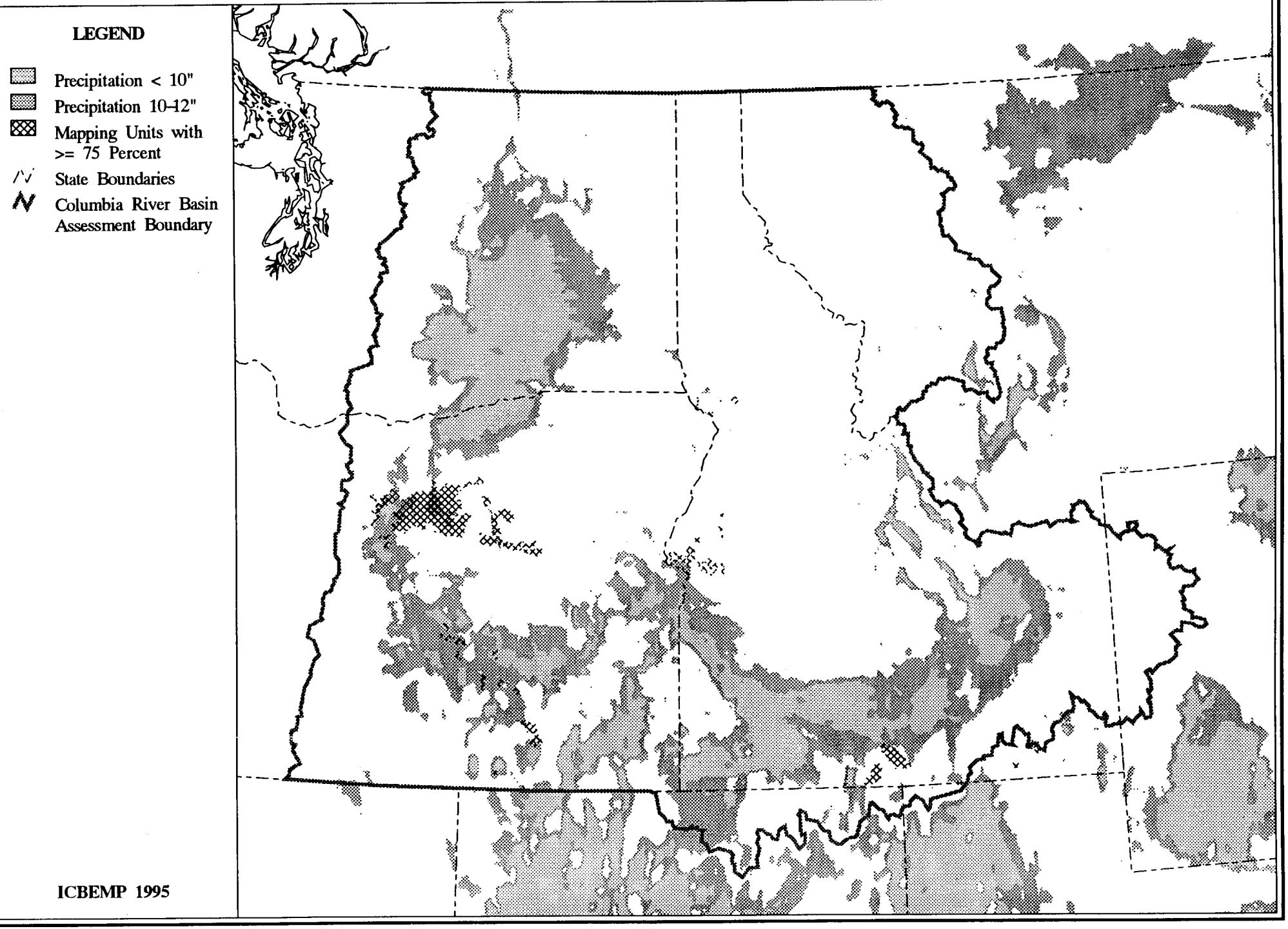

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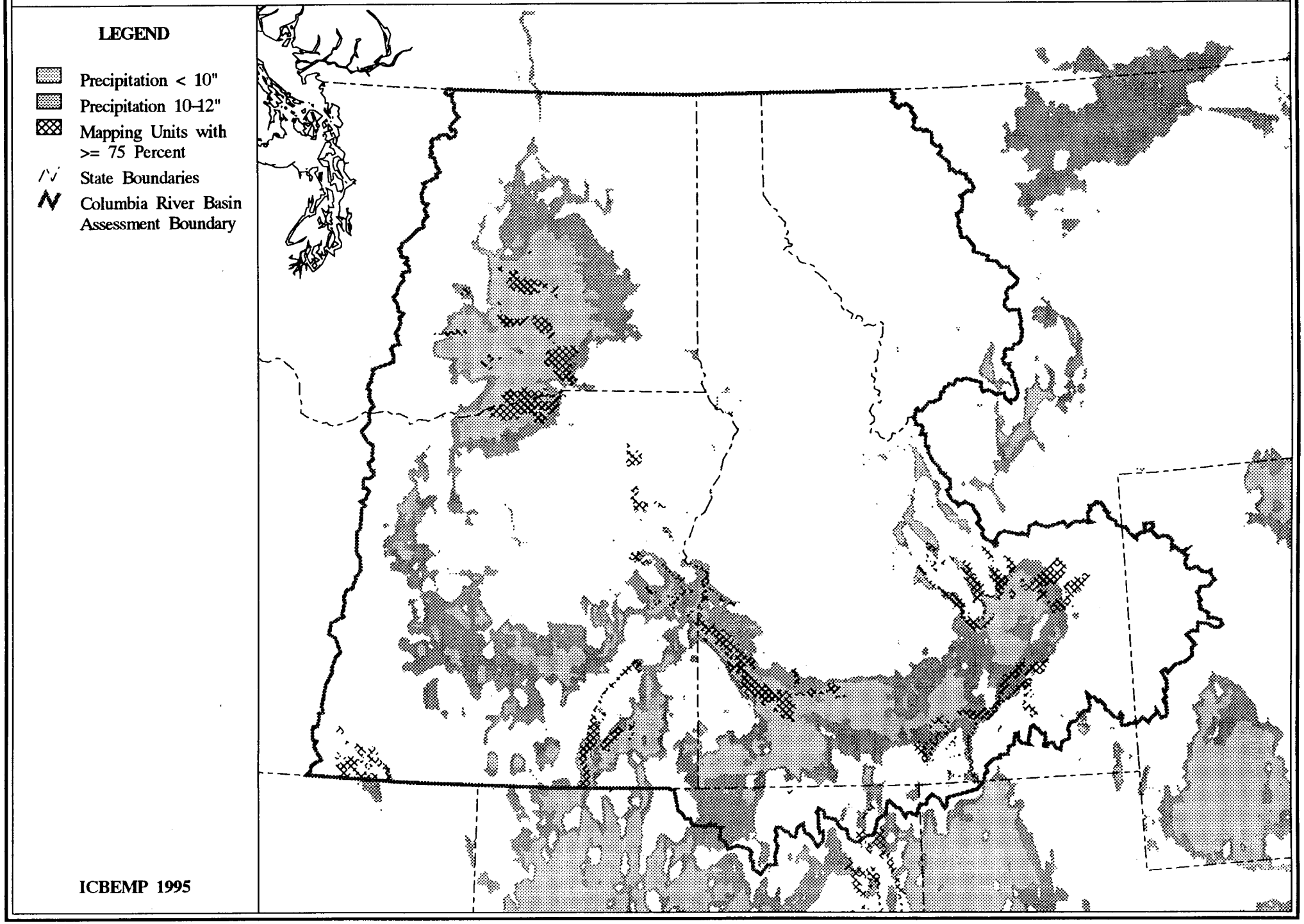

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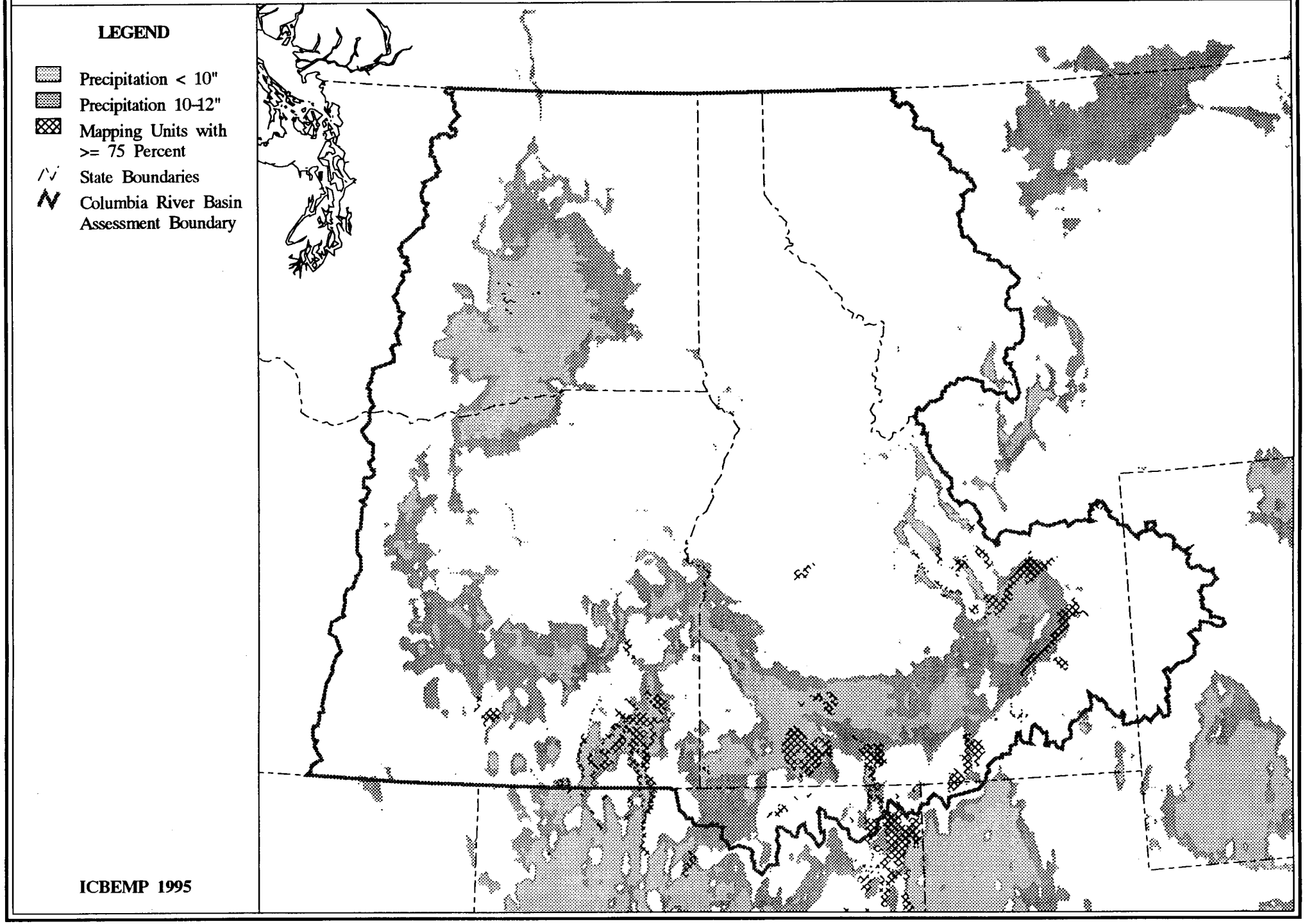

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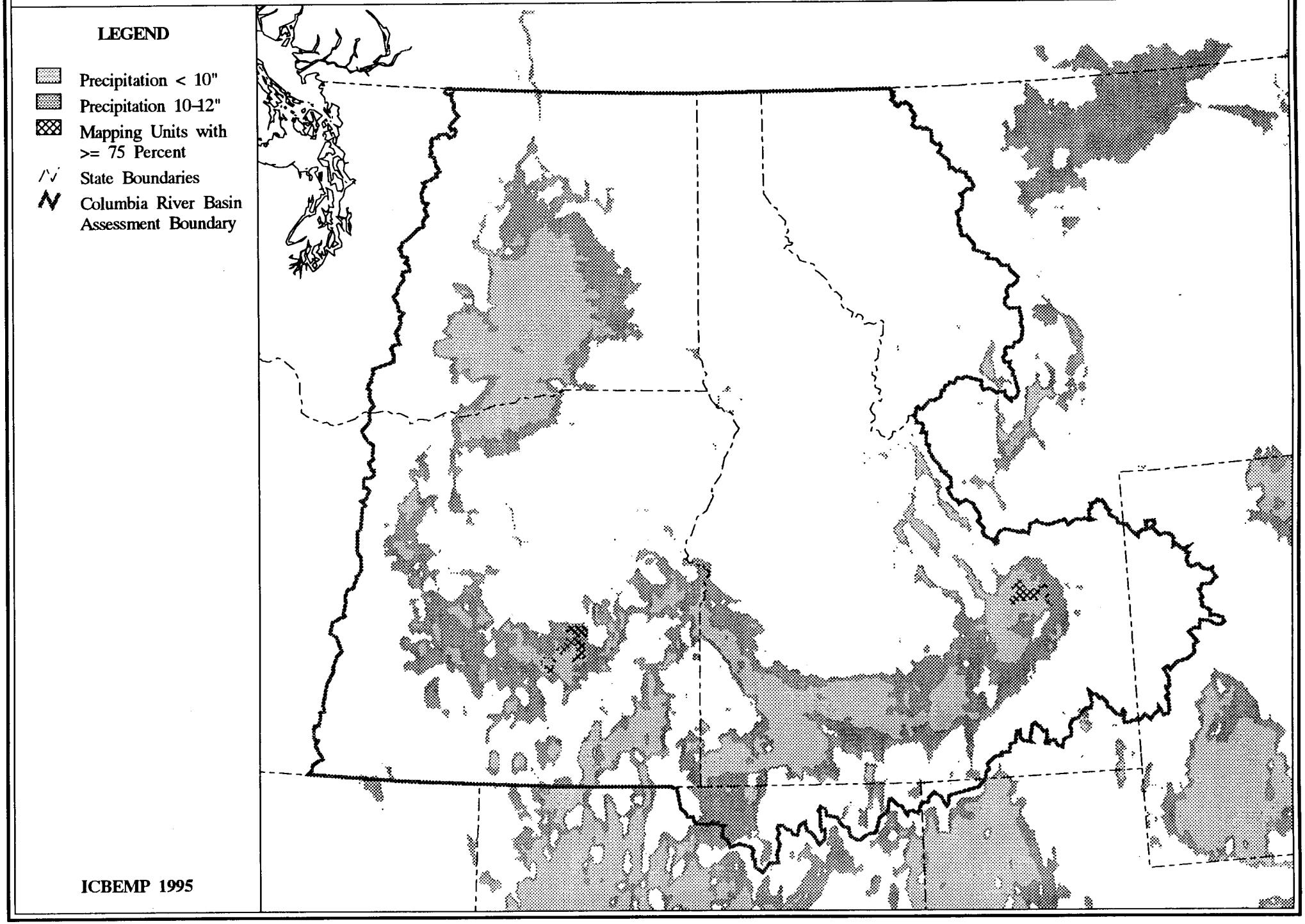

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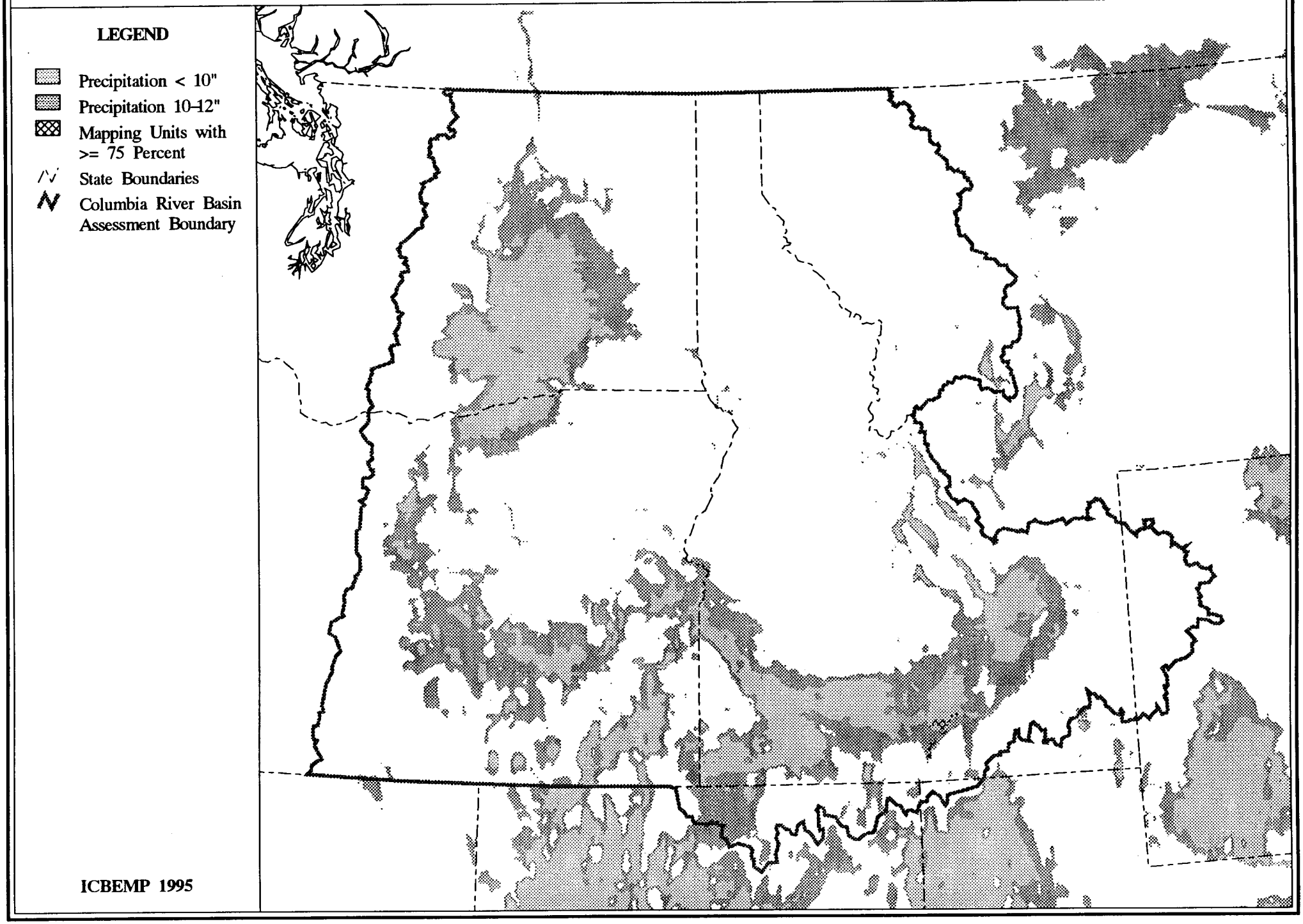

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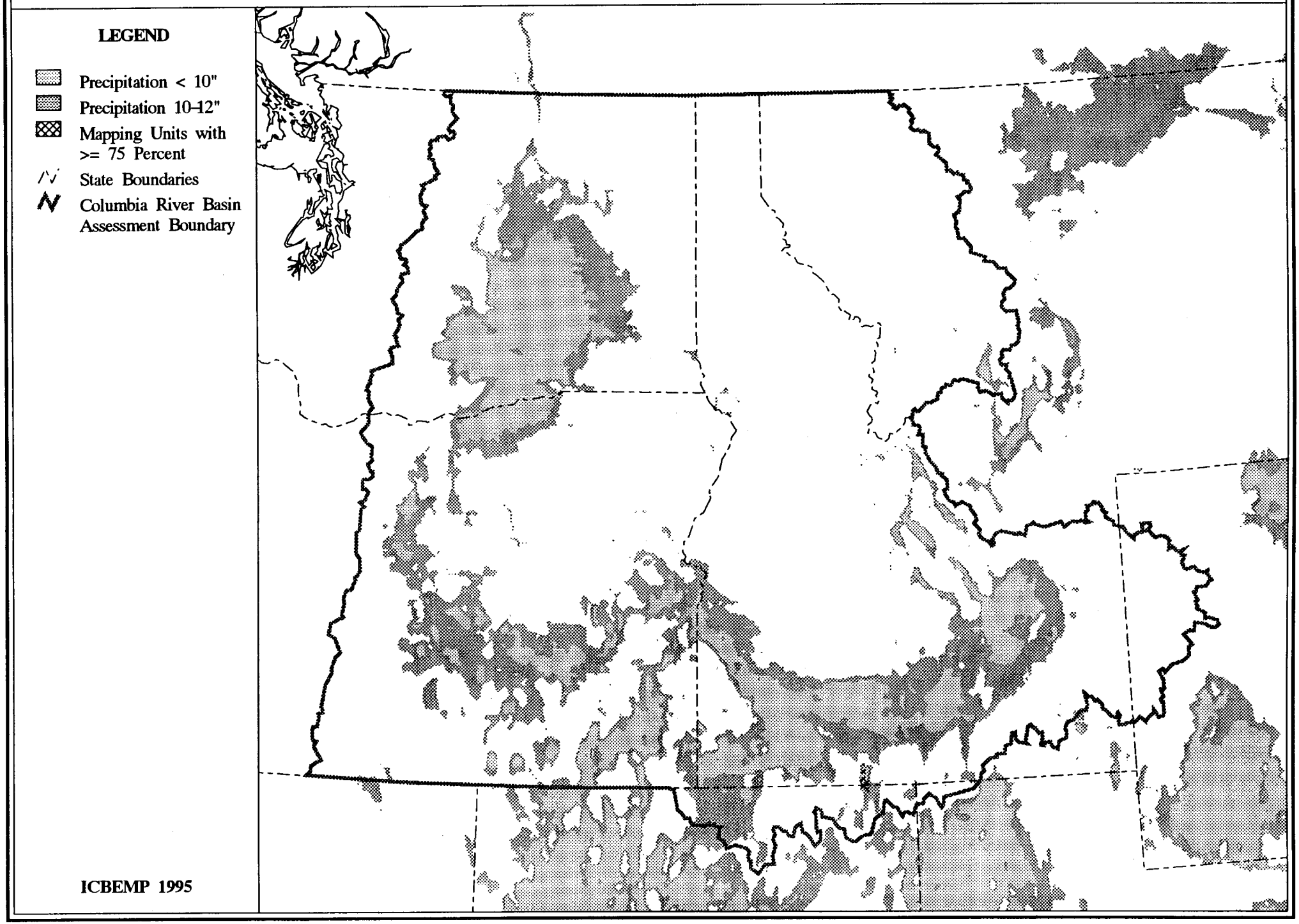

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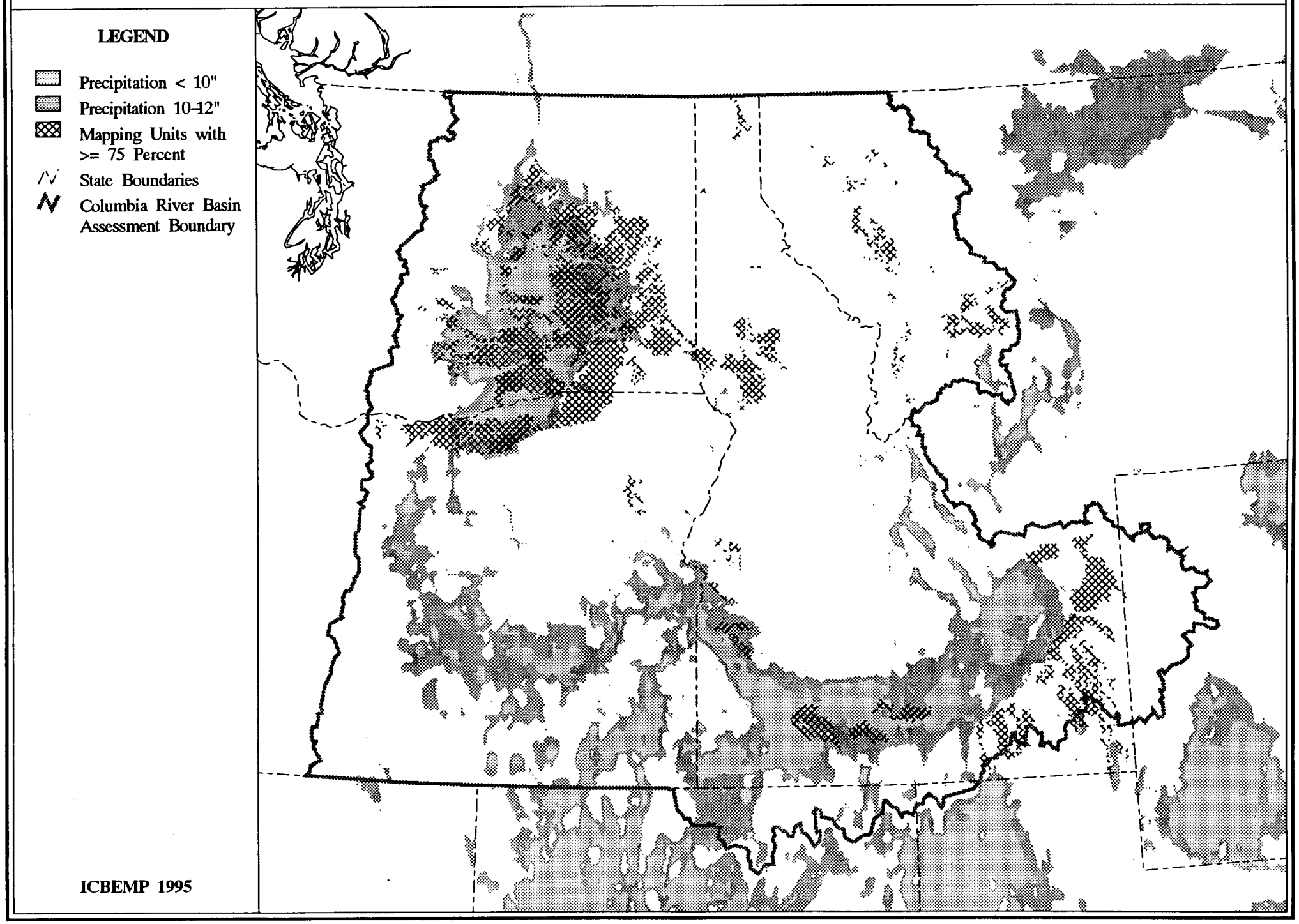

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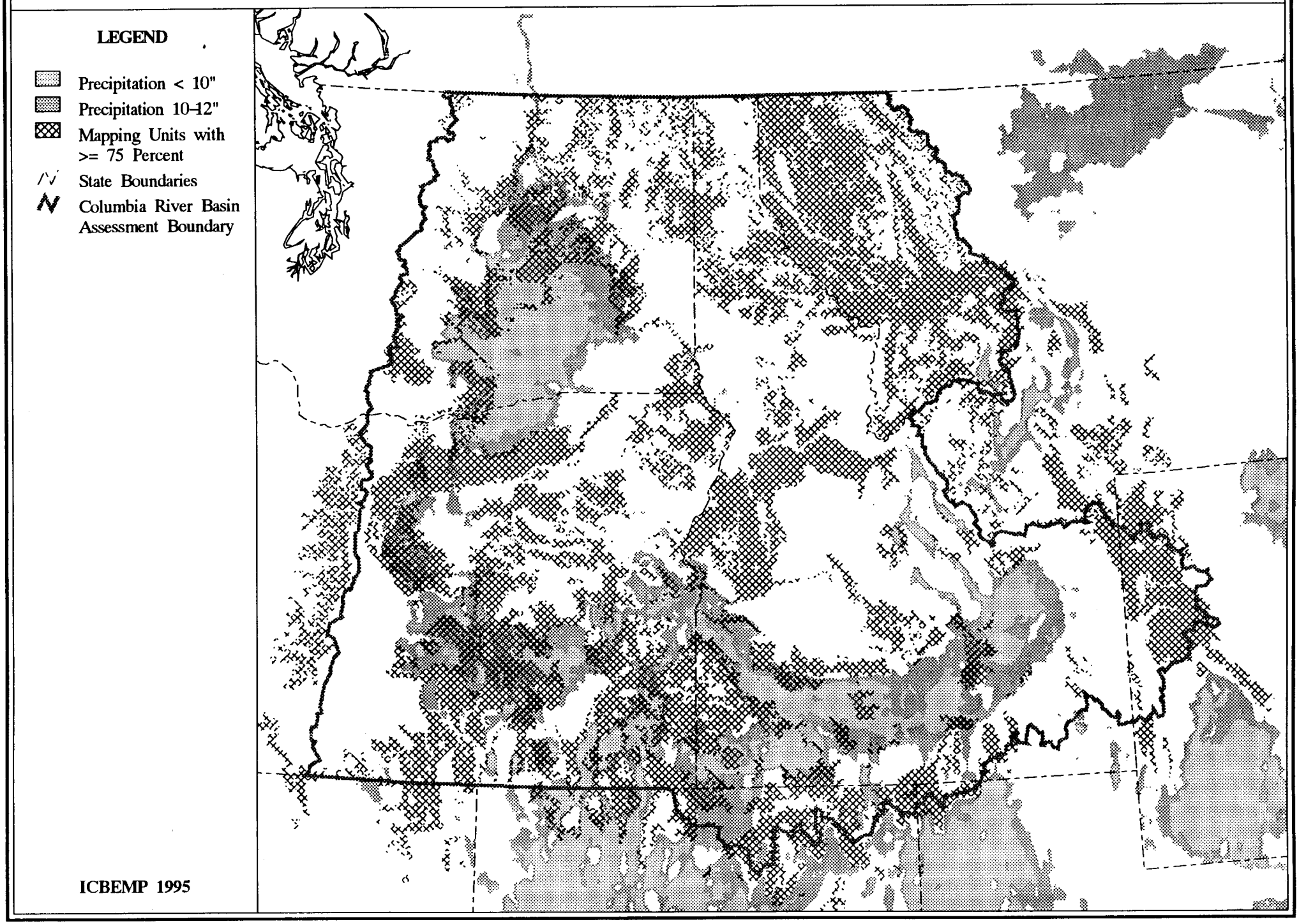

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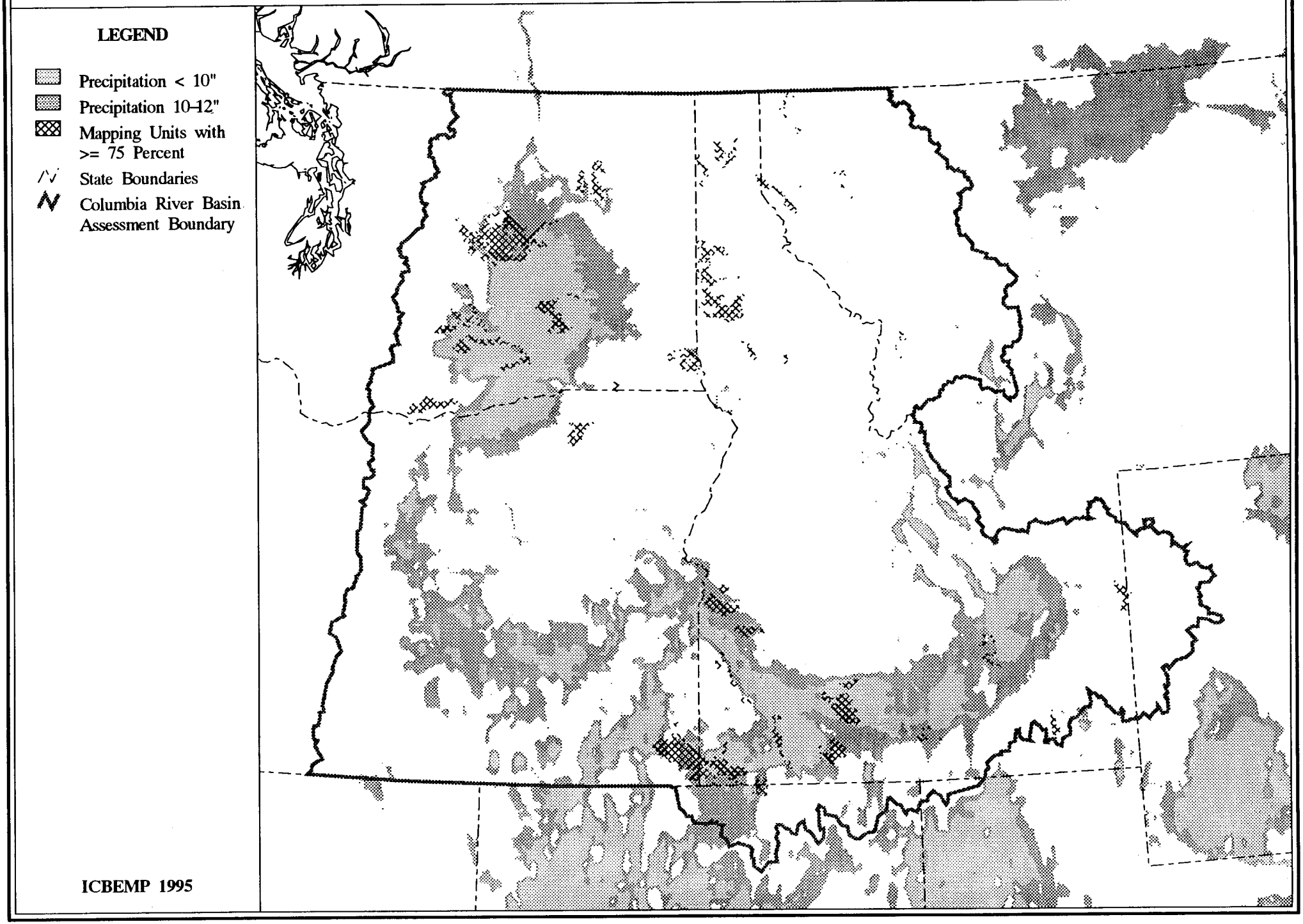

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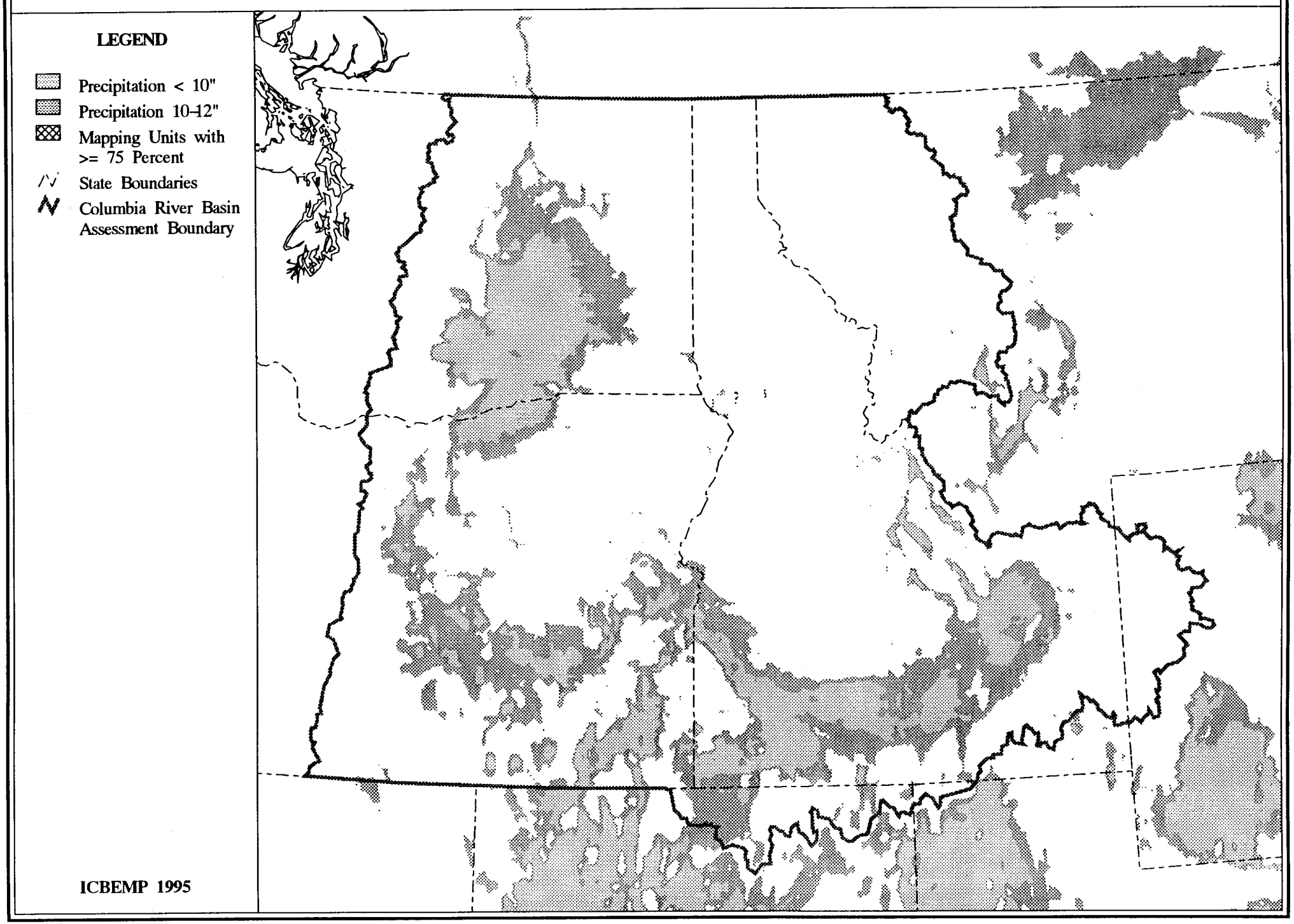

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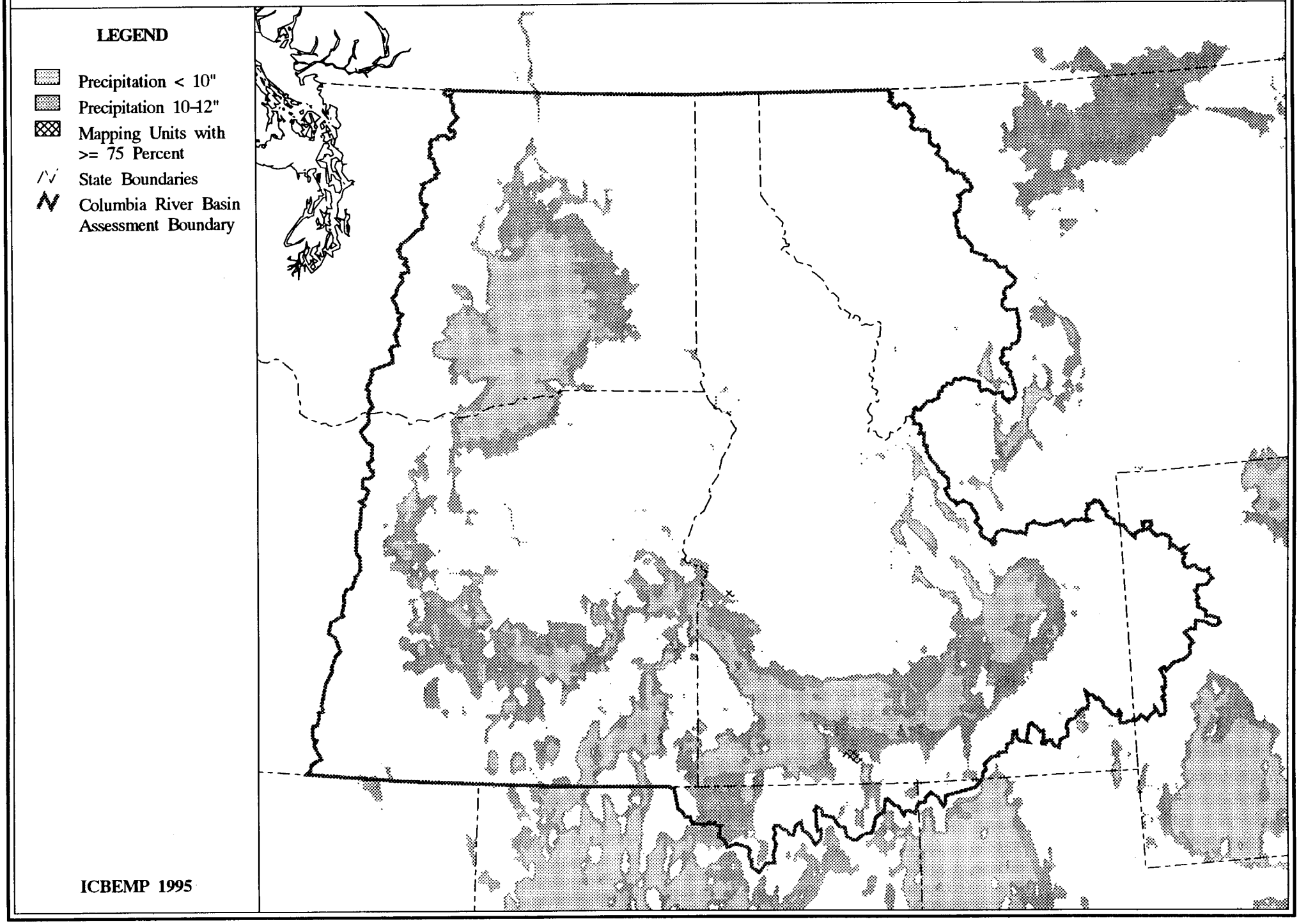

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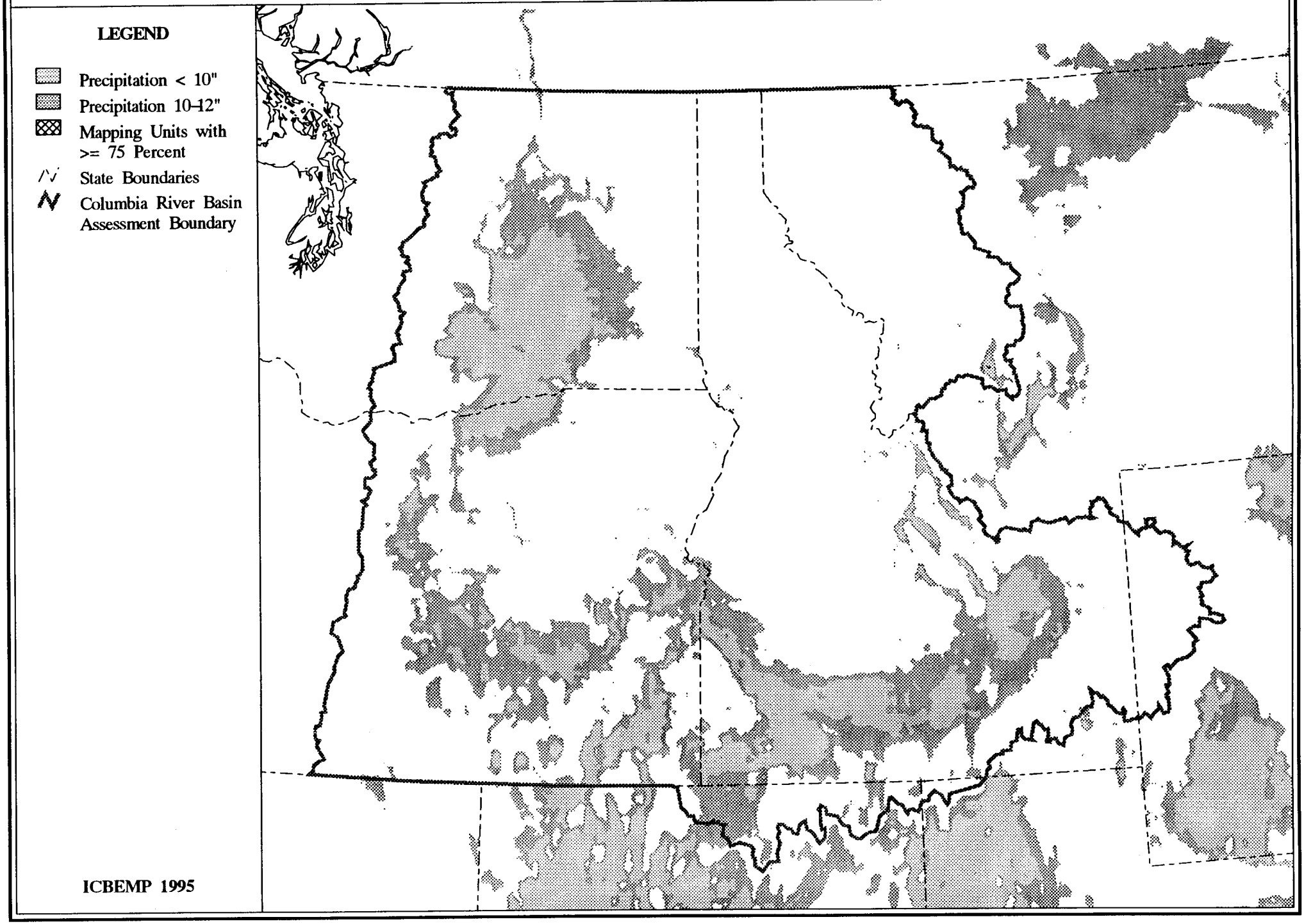

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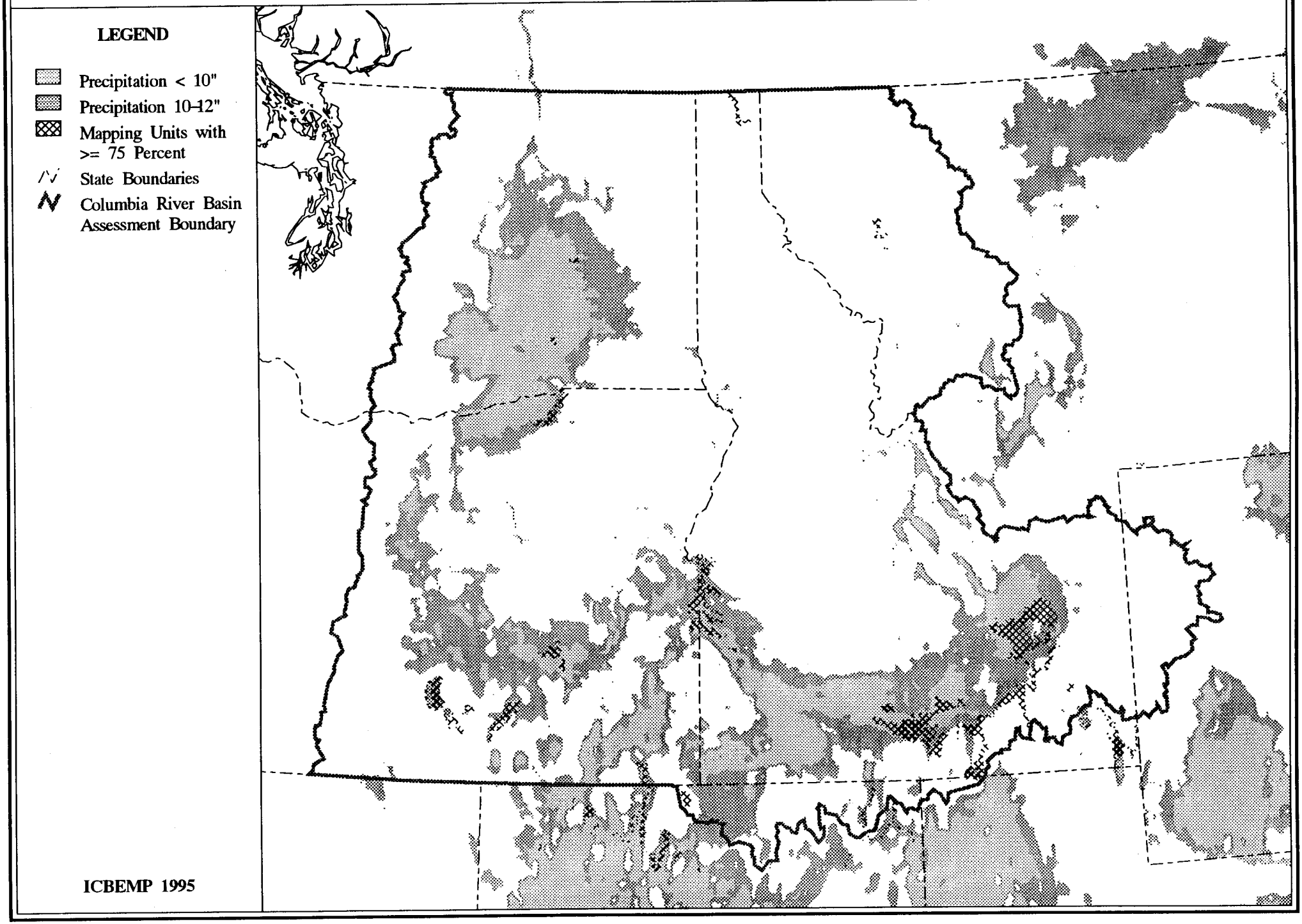

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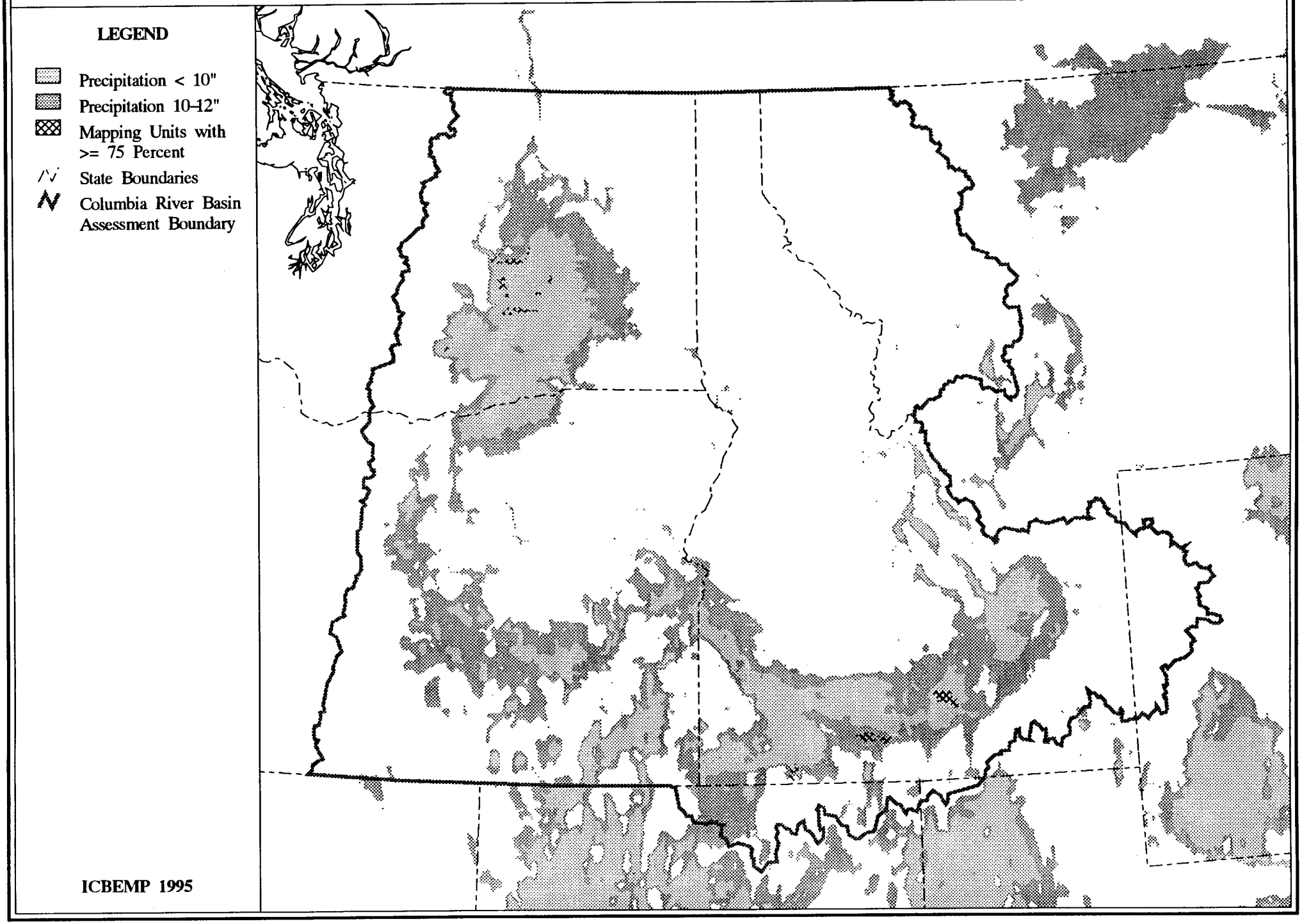

Moderate SE and Moderate Sal. and Severe SAR