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3. WATER AND SEDIMENT QUALITY OF CORPUS CHRISTI BAY

The combined data bases for each of the study parameters formed the basis for characterization of water and sediment quality in Corpus Christi Bay. By “characterization” is meant the water- and sediment-quality “climate” of Corpus Christi Bay, as evidenced in objective statistical analysis of the historical data base. This characterization entails both the spatial dimension and the temporal, the latter including the analysis of trends in time. The word “climate” is well-chosen, because of its analog with individual experience, *viz.* the weather-climate dichotomy, serving to remind oneself that this characterization is the “average” or “representative” behavior of a suite of parameters that individually exhibit a high degree of variability. Moreover, it cautions one to avoid attaching too much significance to isolated measurements.

Since the water-quality “climate” is delineated by various statistical trends, the degree of scatter about these trends, i.e. the extent to which an individual measurement could be expected to depart from the overall trend, becomes an important aspect of characterization. Metaphorically, the statistical trend is a “signal” whose detection is confused-perhaps even masked-by the “noise” of variation from data point to data point. The degree of noise determines whether that signal is detected clearly, that is, it limits our confidence in the accuracy with which the signal is determined. Sources of variation that can potentially contribute to noise in the data include space and time variation of the parameter, which are introduced by the various physical and bio-chemical processes affecting that parameter, which in turn have their own space/time variations.

Noise in the data is also introduced by inaccuracies of measurement. Most of the parameters used to characterize water and sediment quality are not measured with a high degree of precision using standard methodologies. This is frequently not sufficiently appreciated by users of the data, whose accord a level of accuracy to individual measurements that is wholly unwarranted. Table 3-1 presents nominal estimates of the uncertainty of measurement as a coefficient of variation for the more important parameters (developed from data compiled by Ward and Armstrong, 1992a, from a study of current and historical laboratory procedural accuracy and precision data). (These were based upon typical values in Corpus Christi Bay for those parameters whose standard deviation does not vary proportionately with parameter value.) The associated confidence bounds for a high probability are two (95%) or three (98%) times the standard deviation, the latter corresponding to the intuitive notion of tolerance. Thus, a measurement of ammonia (WQAMMN) establishes a 98%-probable value nominally within ±60% of the measurement. This imprecision represents a source of variation in the data, in many cases considerable.

As detailed in the preceding chapter, the data record for each parameter was sorted into two different segmentations of the system: the Texas Natural Resource Conservation Commission Water Quality segments, and the CCBNEP hydrographic-area segments developed for this project. The philosophy of

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Table 3-1
Nominal uncertainty in measurement of water and sediment parameters,
standard deviation as fraction of measurement (per cent)
(See Table 2-1 for definition of abbreviations)

abbr	*st dev*	*abbr*	*st dev*	*abbr*	*st dev*
		- water analytes -			
conventional		WQMETBAT	15	WQMETZNT	15
WQTEMP	1	WQMETBAD	25	WQMETZND	100
WQSAL	1	WQMETB	25	*organics*	
WQDO	2	WQMETCDT	15	WQ-ABHC	10
WQDODEF	5	WQMETCDD	20	WQ-LIND	10
WQPH	5	WQMETCRT	100	WQ-XDDT	10
WQTURB	10	WQMETCRD	100	WQ-ALDR	5
WQTSS	10	WQMETCUT	25	WQ-CHLR	15
WQAMMN	20	WQMETCUD	100	WQ-DIEL	5
WQORGN	20	WQMETFET	20	WQ-ENDO	25
WQKJLN	20	WQMETFED	100	WQ-ENDR	5
WQNO3N	25	WQMETPBT	10	WQ-TOXA	30
WQTOTP	15	WQMETPBD	20	WQ-HEPT	5
WQVOLS	10	WQMETMNT	100	WQ-MTHX	5
WQVSS	20	WQMETMND	35	WQ-PCB	25
WQO&G	10	WQMETHGT	40	WQ-MALA	35
WQTOC	10	WQMETHGD	40	WQ-PARA	10
WQBOD5	20	WQMETNIT	20	WQ-DIAZ	20
WQCHLA	20	WQMETNID	30	WQ-MTHP	10
WQFCOLI	200	WQMETSET	50	WQ-24D	10
metals		WQMETSED	50	WQ-245T	10
WQMETAST	35	WQMETAGT	50	WQ-PAH	20
WQMETASD	35	WQMETAGD	50		
		- sediment analytes -			
conventional		SEDMETPB	60	SED-TOXA	25
SEDAMMN	20	SEDMETMN	5	SED-HEPT	25
SEDORGN	20	SEDMETHG	20	SED-HEPX	20
SEDKJLN	20	SEDMETNI	50	SED-MTHX	10
SEDTOTP	10	SEDMETSE	35	SED-PCB	25
SEDVOLS	25	SEDMETAG	50	SED-MALA	35
SEDO&G	25	SEDMETZN	10	SED-PARA	10
SEDTOC	10	*organics*		SED-DIAZ	20
metals		SED-ABHC	25	SED-MTHP	10
SEDMETAS	20	SED-LIND	25	SED-24D	15
SEDMETBA	5	SED-XDDT	25	SED-245T	15
SEDMETB	20	SED-ALDR	20	SED-PAH	25
SEDMETCD	35	SED-CHLR	25	SED-ACEN	15
SEDMETCR	20	SED-DIEL	25	SED-NAPT	25
SEDMETCU	25	SED-ENDO	10	SED-FLRA	5
SEDMETFE	10	SED-ENDR	20	SED-BNZA	10

segmentation is based upon the assumption that each segment is homogeneous, within an allowable scatter in the data (i.e., within a certain statistical confidence), so that data from that segment can be considered independent measurements of the same variate.

One must realize that Corpus Christi Bay is under-sampled, relative to the time and space scales of natural variability. Therefore, any partitioning of the data in space or time involves trade-offs in statistical confidence. The more segments that are defined (i.e., the smaller their spatial extent), the fewer data points that will be placed in each segment. While spatial variability is better delineated, the statistical confidence in the values at each segment is reduced because of the fewer number of data points. To improve the number of data points by aggregating into larger segments is to introduce more "noise" in the data due to spatial variability; the ultimate extreme of this strategy is the baywide analysis given in Tables 2-5 and 2-6, in which all available data are used to compute the statistics, but the high variance renders the computed statistics practically useless. The CCBNEP hydrographic segmentation developed in this study represents our best compromise between a sufficient data record in each segment for meaningful analyses and a sufficiently small and well-defined segment domain so as to reduce the spatially-induced noise. In this study, therefore, this segmentation formed the basis for analysis of spatial variation and temporal trends. Only selected results for the CCBNEP hydrographic segmentation are given in this summary report. Complete results for both systems of segmentation are presented in the Appendix to the Final Report (Ward and Armstrong, 1997a).

The historical statistics for each of the study parameters, for each of the TNRCC segments and each of the CCBNEP hydrographic-area segments, are presented in Appendices B-D of the Final Report (Ward and Armstrong, 1997a). For each parameter there is a pair of tables, the first, the period-of-record statistics, presenting basic data on magnitude and variance of the measurements, and the second, the time trend analysis, presenting data on the time history dimension of the parameter's variation. These tables, and their companions on sediment quality, are the central analytical product of this study and warrant examination far beyond the comments offered here. However, because of the considerable volume of the tables and the fact that most readers will not wish to delve into the details of the analyses, these results are relegated to the appendix of the Final Report.

Tables 3-2 and 3-3 present one example of these statistical analyses, for ammonia nitrogen. The first key entry is in the second column of the first table, *viz.* number of observations. This number obviously circumscribes the confidence of the remainder of the analyses for that segment: for many segments this number is zero, or is so small as to provide little useful information. It will be recalled (Section 2.5) that we have elected to treat measurements below detection limits (BDL) in three different ways. First, all such data are ignored. This is done in all computations of *variability*, including standard deviations and regressions, as well as in the first average (column three) of Table 3-2. Second, all BDL's are assigned a value of zero, the more optimistic extreme, assuming a BDL is equivalent to nonpresence of the analyte. Third, all BDL's are assigned the value

TABLE 3-2
Period of record statistics for CCBNEP Hydrographic Segments
WQAMMN

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
A1	7	0.001	0.004	7	100	0.000	741017	0.01	741017	0.01	741017	0.00143	0.00143
A2	31	0.101	0.078	31	100	0.000	730419	0.02	730220	0.47	720330	0.101	0.101
A3	61	0.077	0.073	61	100	0.000	710608	0.01	740418	0.44	720330	0.0766	0.0766
A4	34	0.024	0.015	34	100	0.010	850506	0.01	850506	0.1	860511	0.0238	0.0238
A5	11	0.008	0.008	11	100	0.000	750416	0.01	710608	0.03	710608	0.00818	0.00818
A6	0												
A8	0												
A9	0												
A10	2	0.030	0.010	2	100	0.020	710608	0.02	710608	0.04	710608	0.03	0.03
A11	0												
A12	81	0.064	0.066	81	100	0.000	711111	0.01	720724	0.41	801022	0.0637	0.0637
A13	1	0.100	0.000	1	100	0.100	740723	0.1	740723	0.1	740723	0.1	0.1
AL1	1	0.000	0.000	0	0	0.000	0	0	0	0	0	0	0.05
AL2	44	0.052	0.050	43	98	0.000	720928	0.02	750604	0.2	731017	0.0511	0.0523
AR1	81	0.106	0.093	43	53	0.020	750729	0.02	750729	0.43	700106	0.0561	0.0984
AYB	0												
BF1	284	0.066	0.210	256	90	0.000	690915	0.00014	890415	2.7	750409	0.0597	0.064
BF2	126	0.061	0.093	126	100	0.000	920415	0.002	911215	0.55	711215	0.0614	0.0614
BF3	201	0.046	0.071	175	87	0.000	690915	0.0021	890415	0.5	920407	0.04	0.0456
C01	0												
C02	95	0.070	0.077	68	72	0.008	880510	0.008	880510	0.47	880714	0.0499	0.0614
C03	54	0.134	0.130	54	100	0.000	720328	0.0048	880510	0.6	760109	0.134	0.134
C04	26	0.074	0.071	26	100	0.009	871020	0.0088	871020	0.26	880714	0.0743	0.0743
C05	67	0.080	0.100	67	100	0.000	720920	0.01	741024	0.82	801021	0.0804	0.0804
C06	36	0.073	0.040	36	100	0.000	701013	0.01	730517	0.11	740611	0.0731	0.0731
C07	97	0.077	0.100	97	100	0.000	720328	0.02	831128	1	721219	0.0767	0.0767
C08	24	0.091	0.083	24	100	0.010	880810	0.0095	880810	0.28	880714	0.0906	0.0906

(continued)

TABLE 3-2
WQAMMN period of record statistics (continued)

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
C09	22	0.078	0.170	22	100	0.000	750130	0.01	770210	0.84	801021	0.0777	0.0777
C10	113	0.066	0.069	113	100	0.000	690326	0.0055	880510	0.57	880714	0.0661	0.0661
C11	182	0.070	0.086	182	100	0.000	690917	0.01	710506	1	731115	0.0703	0.0703
C12	125	0.066	0.110	125	100	0.000	711111	0.01	720725	1	740114	0.0655	0.0655
C13	0												
C14	392	0.048	0.053	392	100	0.000	690326	0.00014	930415	0.4	720126	0.0476	0.0476
C15	295	0.107	0.170	253	86	0.000	680530	0.0036	880413	1.4	700922	0.0914	0.0979
C16	0												
C17	128	0.064	0.097	128	100	0.000	720920	0.0063	880510	0.95	801021	0.0643	0.0643
C18	0												
C19	0												
C20	22	0.071	0.053	22	100	0.009	880810	0.0094	880810	0.19	880714	0.0713	0.0713
C21	61	0.089	0.041	61	100	0.000	720328	0.01	720328	0.21	711105	0.0887	0.0887
C22	22	0.114	0.046	22	100	0.100	721219	0.1	721219	0.3	730312	0.114	0.114
C23	24	0.085	0.092	24	100	0.010	880510	0.01	880510	0.32	880714	0.0854	0.0854
C24	57	0.051	0.072	57	100	0.000	690916	0.0076	880510	0.32	871208	0.0513	0.0513
C25	0												
CB	67	0.081	0.092	67	100	0.000	721115	0.01	720330	0.51	731010	0.0813	0.0813
CBH	0												
CBY1	12	0.025	0.020	12	100	0.004	870126	0.0041	870126	0.062	870602	0.0245	0.0245
CBY2	0												
CCC1	143	0.046	0.042	143	100	0.000	690326	0.0095	880810	0.19	880714	0.0463	0.0463
CCC2	6	0.230	0.210	5	83	0.080	810507	0.08	810507	0.63	810507	0.192	0.2
CCC3	106	0.058	0.060	105	99	0.000	680326	0.0074	880510	0.24	880714	0.0573	0.0578
CCC4	6	0.100	0.000	5	83	0.100	740723	0.1	740723	0.1	740723	0.0833	0.0917
CCC5	56	0.059	0.075	56	100	0.000	711111	0.0081	880510	0.3	871208	0.0586	0.0586
CCC6	97	0.094	0.087	60	62	0.010	860528	0.01	860528	0.48	691208	0.0578	0.0738
CCC7	304	0.049	0.062	304	100	0.000	690325	0.0025	871019	0.48	710903	0.0488	0.0488
CCC8	108	0.212	0.670	93	86	0.010	760115	0.01	760115	6.3	760406	0.183	0.189
CP01	0												

(continued)

TABLE 3-2
WQAMMN period of record statistics (continued)

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min >0*	*date BDL=0*	*Min BDL=DL*	*date*	*Max*	*date*	*Avg w/*	*Avg w/*
CP02	25	0.027	0.036	25	100	0.000	711111	0.01	720724	0.16	720330	0.0268	0.0268
CP03	48	0.093	0.120	48	100	0.000	711111	0.01	720330	0.8	730311	0.0931	0.0931
CP04	1	0.040	0.000	1	100	0.040	710915	0.04	710915	0.04	710915	0.04	0.04
CP05	41	0.078	0.062	41	100	0.000	711111	0.01	720724	0.31	720330	0.0776	0.0776
CP06	0												
CP07	79	0.065	0.075	79	100	0.000	711111	0.01	740531	0.42	720330	0.0652	0.0652
CP08	0												
CP09	10	0.066	0.110	10	100	0.000	770210	0.01	770629	0.37	801022	0.066	0.066
CP10	159	0.103	0.150	127	80	0.000	711108	0.01	750318	1	690521	0.0825	0.0923
EF	0												
GR1	1	0.000	0.000	0	0	0.000	0	0	0	0	0	0	0.05
GR2	20	0.100	0.110	19	95	0.000	690915	0.01	741023	0.3	751029	0.0945	0.097
HI1	0												
HI2	1	0.020	0.000	1	100	0.020	770210	0.02	770210	0.02	770210	0.02	0.02
I1	0												
I2	12	0.196	0.300	12	100	0.100	700827	0.1	700827	1.2	700218	0.196	0.196
I3	58	0.095	0.110	55	95	0.000	720330	0.01	710608	0.64	720330	0.0903	0.0929
I4	5	0.170	0.000	1	20	0.170	840823	0.17	840823	0.17	840823	0.034	0.074
I5	40	0.046	0.041	39	98	0.000	711111	0.01	710608	0.12	720530	0.0448	0.046
I6	93	0.124	0.170	60	65	0.020	750721	0.02	750721	1.1	750423	0.0801	0.0948
I7	64	0.047	0.110	64	100	0.000	711111	0.01	710608	0.9	840530	0.0473	0.0473
I8	0												
I9	229	0.086	0.140	229	100	0.000	690916	0.0099	880510	1	690522	0.0863	0.0863
I10	57	0.015	0.015	57	100	0.000	930415	0.00014	930415	0.076	890315	0.0147	0.0147
I11	6	0.160	0.230	6	100	0.000	690916	0.02	701008	0.6	680828	0.16	0.16
I12	76	0.137	0.190	48	63	0.020	821122	0.02	821122	1.1	750707	0.0865	0.102
I13	156	0.024	0.034	156	100	0.001	911215	0.00098	911215	0.22	930715	0.024	0.024
I14	0												
I15	93	0.041	0.079	93	100	0.000	690916	0.0018	911215	0.67	680827	0.0411	0.0411
I16	0												

(continued)

TABLE 3-2
WQAMMN period of record statistics (continued)

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
I17	140	0.082	0.160	115	82	0.004	911115	0.0042	911115	1.3	900412	0.0677	0.075
I18	0												
IH1	128	0.490	0.740	115	90	0.000	690325	0.02	910710	4.4	760406	0.44	0.445
IH2	3	0.203	0.074	3	100	0.120	820810	0.12	820810	0.3	770621	0.203	0.203
IH3	8	0.209	0.069	8	100	0.120	820810	0.12	820810	0.3	770621	0.209	0.209
IH4	5	0.166	0.046	5	100	0.110	820810	0.11	820810	0.21	820810	0.166	0.166
IH5	129	0.460	0.670	124	96	0.000	680530	0.02	900808	5.4	760406	0.443	0.444
IH6	88	0.285	0.460	80	91	0.010	920728	0.01	920728	3.4	760406	0.259	0.263
IH7	96	0.226	0.190	95	99	0.000	680530	0.02	721116	1	800409	0.224	0.225
INL	4	0.333	0.330	3	75	0.100	740723	0.1	740723	0.8	820317	0.25	0.263
LAC	46	0.059	0.084	46	100	0.000	711108	0.01	721115	0.51	801022	0.0589	0.0589
LB	0												
LQ1	6	0.117	0.009	3	50	0.110	801203	0.11	801203	0.13	801203	0.0583	0.0833
LQ2	87	0.145	0.470	48	55	0.000	741024	0.01	750130	3	750423	0.0797	0.0996
LS1	56	0.036	0.061	55	98	0.003	890415	0.0031	890415	0.32	920215	0.0348	0.0357
LS2	69	0.026	0.038	68	99	0.000	690915	0.0014	890415	0.19	740424	0.0255	0.0262
M1	0												
M2	0												
MB1	89	0.092	0.150	54	61	0.000	750924	0.0035	870126	0.87	780206	0.0559	0.0727
MB2	23	0.030	0.030	23	100	0.004	870126	0.0039	870126	0.09	870602	0.0304	0.0304
NB1	111	0.098	0.085	111	100	0.017	871119	0.017	871119	0.59	880121	0.0982	0.0982
NB2	24	0.094	0.073	24	100	0.016	871119	0.016	871119	0.27	871209	0.094	0.094
NB3	58	0.060	0.058	58	100	0.016	880811	0.016	880811	0.23	871209	0.0599	0.0599
NB4	287	0.119	0.091	287	100	0.009	880811	0.0094	880811	0.83	920107	0.119	0.119
NB5	531	0.088	0.079	502	95	0.000	690326	0.0041	880412	0.74	920107	0.0835	0.086
NB6	66	0.113	0.120	66	100	0.000	690326	0.01	750417	0.8	720125	0.113	0.113
NB7	65	0.135	0.190	40	62	0.010	860826	0.01	860826	1.2	920107	0.083	0.0991
NB8	20	0.069	0.063	20	100	0.003	880413	0.0025	880413	0.22	871209	0.069	0.069
NB9	8	0.055	0.069	8	100	0.005	880413	0.005	880413	0.2	880712	0.0547	0.0547
ND1	0												

(continued)

TABLE 3-2
WQAMMN period of record statistics (continued)

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
ND2	16	0.096	0.054	16	100	0.045	781204	0.045	781204	0.2	790209	0.0956	0.0956
ND3	0												
ND4	0												
NR1	36	0.072	0.140	29	81	0.000	680530	0.01	730517	0.72	701012	0.0578	0.102
NR2	0												
NR3	6	0.208	0.310	6	100	0.000	731016	0.04	720725	0.86	701012	0.208	0.208
NR4	164	0.237	0.300	114	70	0.020	760908	0.02	760908	1.8	751209	0.164	0.179
NR5	33	0.132	0.120	33	100	0.000	680530	0.02	760608	0.46	750417	0.132	0.132
OS1	50	6.500	6.700	49	98	0.050	920928	0.05	920928	30	750422	6.37	6.38
OS2	0												
OS3	27	0.545	0.690	19	70	0.059	760419	0.059	760419	2.7	750701	0.384	0.407
OS4	0												
OS5	0												
OS6	47	0.187	0.460	33	70	0.010	930427	0.01	930427	2.7	890209	0.131	0.144
OS7	68	0.784	3.100	55	81	0.010	860826	0.01	860826	23	820505	0.634	0.643
PB1	70	0.112	0.220	50	71	0.010	870121	0.01	870121	1.6	750422	0.0797	0.0926
PB2	0												
RB1	18	0.043	0.037	18	100	0.000	711111	0.01	720724	0.12	711105	0.0433	0.0433
RB2	0												
RB3	83	0.113	0.220	56	67	0.000	690326	0.01	710506	1.6	870212	0.0759	0.0909
RB4	0												
RB5	22	0.100	0.000	22	100	0.100	721220	0.1	721220	0.1	721220	0.1	0.1
RB6	22	0.100	0.000	22	100	0.100	721215	0.1	721215	0.1	721215	0.1	0.1
RB7	8	0.044	0.030	8	100	0.010	790608	0.01	790608	0.1	790209	0.0444	0.0444
RB8	185	0.077	0.110	98	53	0.000	710506	0.01	740425	0.8	801021	0.0409	0.0613
RB9	6	0.047	0.038	6	100	0.020	890122	0.02	890122	0.1	740723	0.0467	0.0467
SC1	0												
SC2	26	0.084	0.250	26	100	0.000	720724	0.01	721115	1.3	711111	0.0838	0.0838
SC3	150	0.119	0.300	87	58	0.010	710608	0.01	710608	2.9	750422	0.0687	0.0879
UL01	0												

(continued)

TABLE 3-2
WQAMMN period of record statistics (continued)

Segmt	*No.of obs*	*Avg >DL*	*Std dev >DL*	*No. > DLs*	*% > DLs*	*Min*	*date*	*Min >0*	*date*	*Max*	*date*	*Avg w/ BDL=0*	*Avg w/ BDL=DL*
UL02	0												
UL03	53	0.026	0.043	53	100	0.000	690916	0.00084	920815	0.19	930715	0.0257	0.0257
UL04	69	0.094	0.076	43	62	0.010	821122	0.01	821122	0.3	750707	0.0584	0.0735
UL05	0												
UL06	0												
UL07	0												
UL08	0												
UL09	0												
UL10	0												
UL11	15	0.076	0.100	15	100	0.000	690916	0.01	780301	0.4	820330	0.076	0.076
UL12	0												
UL13	0												
UL14	0												
GMI1	0												
GMI2	0												
GMI3	0												
GMI4	39	0.179	0.34	25	64	0.04	770124	0.04	770124	1.8	750422	0.115	0.132
GMI5	0												
GMI6	112	0.115	0.21	90	80	0	690326	0.01	711111	1.5	700305	0.0924	0.102
GMI7	0												
GMI8	0												
GMI9	0												
GMO1	0												
GMO2	0												
GMO3	0												
GMO4	0												
GMO5	0												
GMO6	14	0.339	0.31	11	79	0	730516	0.03	730516	0.8	820317	0.266	0.277
GMO7	0												
GMO8	0												
GMO9	0												

Table 3-3
Time Trend Analysis for Hydrographic Area Segments: WQAMMN
(segments with no data omitted)

Seg-ment	*Period of record dates*		*Analysis period*		*Avg obs /yr*	*Regression on time*				*95% confidence limits on slope*		
			Start date	*End date*		*slope (per yr)*	*intercept (@ start)*	*SEE*	*residual variance*	*lower*	*upper*	
A1	741017	750827	741017	750827	8.1	-6.44E-03	0.004	0.00294	0.705	-1.80E-02	5.00E-03	
A2	720330	790501	720330	790501	4.4	-1.38E-02	0.13	0.0728	0.875	-2.80E-02	8.30E-05	poss
A3	710608	820408	710608	820408	5.6	-4.27E-03	0.09	0.0718	0.975	-1.10E-02	2.60E-03	
A4	831117	890729	831117	890729	6.0	-9.36E-04	0.027	0.0145	0.988	-4.00E-03	2.10E-03	
A5	710608	750827	710608	750827	2.6	-3.88E-03	0.02	0.00593	0.507	-6.80E-03	-9.20E-04	prob
A10	710608	710608										
A12	710608	820408	710608	820408	7.5	4.14E-03	0.05	0.0656	0.977	-1.90E-03	1.00E-02	poss
A13	740723	740723										
AL1	840808	840808										
AL2	720928	890728	720928	890728	2.6	-3.05E-03	0.084	0.0463	0.857	-5.40E-03	-7.40E-04	prob
AR1	690520	930408	691029	920929	1.9	-3.16E-03	0.14	0.0895	0.935	-6.80E-03	5.30E-04	poss
BF1	680827	931015	680827	931015	10.0	-1.38E-02	0.35	0.197	0.896	-1.90E-02	-8.80E-03	prob
BF2	691105	931015	691105	931015	5.3	-6.87E-03	0.18	0.0772	0.687	-8.70E-03	-5.10E-03	prob
BF3	680827	931015	680827	931015	7.0	-4.88E-03	0.15	0.0652	0.851	-6.60E-03	-3.10E-03	prob
C02	701013	930512	701013	930106	3.1	-8.01E-04	0.081	0.0764	0.995	-3.60E-03	2.00E-03	
C03	701013	880810	701013	880810	3.0	-4.27E-03	0.18	0.132	0.958	-9.90E-03	1.30E-03	poss
C04	710506	880810	710506	880810	1.5	3.11E-03	0.026	0.0696	0.961	-3.40E-03	9.60E-03	poss
C05	720920	830628	720920	830628	6.2	2.34E-03	0.07	0.102	0.993	-4.60E-03	9.30E-03	poss
C06	701013	741212	701013	741212	8.6	2.12E-02	0.013	0.0332	0.677	1.10E-02	3.20E-02	prob
C07	711105	890729	711105	890729	5.5	-6.62E-03	0.12	0.0964	0.854	-9.90E-03	-3.40E-03	prob
C08	870923	880810	870923	880810	27.0	4.66E-02	0.07	0.082	0.975	-8.30E-02	1.80E-01	poss
C09	741024	830628	741024	830628	2.5	1.22E-02	0.023	0.164	0.949	-1.20E-02	3.70E-02	poss
C10	690326	890729	690326	890729	5.6	-2.38E-03	0.094	0.0671	0.952	-4.40E-03	-3.90E-04	prob
C11	690917	890729	690917	890729	9.2	-3.74E-03	0.1	0.0835	0.945	-6.00E-03	-1.50E-03	prob
C12	711105	890729	711105	890729	7.0	-2.87E-03	0.089	0.11	0.969	-5.80E-03	1.50E-05	poss
C14	690326	930715	690326	930715	16.0	-1.68E-03	0.076	0.0516	0.964	-2.50E-03	-8.10E-04	prob
C15	680530	930413	680530	930413	10.0	-6.40E-03	0.17	0.161	0.929	-9.30E-03	-3.50E-03	prob

(continued)

Table 3-3
WQAMMN time trend analyses (continued)

Seg-ment	*Period of record dates*		*Analysis period Start date*	*End date*	*Avg obs /yr*	*Regression on time slope (per yr)*	*intercept (@ start)*	*SEE*	*residual variance*	*95% confidence limits on slope lower*	*upper*	
C17	701013	890122	701013	890122	7.0	-7.91E-04	0.072	0.0969	0.998	-3.60E-03	2.00E-03	
C20	871020	880810	871020	880810	27.0	6.34E-02	0.046	0.0502	0.905	-2.80E-02	1.50E-01	poss
C21	711105	890729	711105	890729	3.4	-3.55E-03	0.1	0.0389	0.906	-6.40E-03	-7.00E-04	prob
C22	721219	741212	721219	741212	11.0	-3.68E-02	0.15	0.0404	0.782	-6.90E-02	-4.20E-03	prob
C23	870923	880810	870923	880810	27.0	8.03E-02	0.05	0.0896	0.941	-6.10E-02	2.20E-01	poss
C24	690916	890729	690916	890729	2.9	4.91E-03	-0.034	0.0712	0.965	-2.00E-03	1.20E-02	poss
CB	711111	820408	711111	820408	6.4	-4.22E-03	0.095	0.091	0.987	-1.30E-02	4.80E-03	
CBY1	870126	880707	870126	880707	8.3	1.08E-02	0.02	0.0197	0.935	-1.80E-02	4.00E-02	poss
CCC1	690326	890729	690326	890729	7.0	-3.84E-04	0.051	0.0418	0.996	-1.40E-03	6.50E-04	
CCC2	740723	810507	740723	810507	0.7	3.19E-02	0.1	0.179	0.74	-6.70E-02	1.30E-01	poss
CCC3	680326	890729	680326	890729	4.9	-8.44E-04	0.069	0.0594	0.989	-2.40E-03	7.00E-04	
CCC4	740723	850423	740723	801203	0.8	0.00E+00	0.1	0	0	0.00E+00	0.00E+00	
CCC5	711111	881107	711111	881107	3.3	6.31E-03	-0.035	0.0724	0.929	1.50E-04	1.20E-02	prob
CCC6	690717	930512	690717	930512	2.5	-5.93E-03	0.16	0.0719	0.69	-8.20E-03	-3.60E-03	prob
CCC7	690325	890729	690325	890729	15.0	-2.85E-03	0.091	0.0588	0.909	-3.90E-03	-1.80E-03	prob
CCC8	731024	930512	731024	930512	4.8	-2.56E-02	0.48	0.648	0.949	-4.90E-02	-2.70E-03	prob
CP02	711105	760819	711105	760819	5.2	-2.19E-03	0.032	0.0357	0.992	-1.30E-02	8.40E-03	
CP03	710609	760819	710609	760819	9.2	-1.61E-02	0.13	0.12	0.97	-4.30E-02	1.10E-02	
CP04	710915	710915										
CP05	710609	750827	710609	750827	9.7	-8.14E-03	0.097	0.0614	0.976	-2.50E-02	8.30E-03	
CP07	710609	820408	710609	820408	7.3	-3.95E-03	0.079	0.0739	0.982	-1.00E-02	2.60E-03	
CP09	770210	820408	770210	820408	1.9	2.79E-02	-0.0049	0.0941	0.785	-1.60E-02	7.10E-02	poss
CP10	690521	930428	690521	930428	5.3	-3.99E-03	0.13	0.151	0.969	-7.90E-03	-5.50E-05	prob
GR1	840808	840808										
GR2	690915	840808	690915	760211	3.0	2.79E-02	-0.024	0.1	0.866	-8.50E-03	6.40E-02	poss
HI2	770210	770210										
I2	690716	730606	690716	730606	3.1	-1.19E-01	0.47	0.268	0.784	-2.80E-01	4.10E-02	poss
I3	710608	840823	710608	820408	5.1	-3.64E-03	0.11	0.11	0.991	-1.40E-02	6.80E-03	
I4	840508	840823										

(continued)

Table 3-3
WQAMMN time trend analyses (continued)

Seg-ment	*Period of record dates*		*Analysis period Start date*	*End date*	*Avg obs /yr*	*Regression on time slope (per yr)*	*intercept (@ start)*	*SEE*	*residual variance*	*95% confidence limits on slope lower*	*upper*	
I5	710608	840823	710608	760419	8.0	-6.51E-03	0.06	0.0402	0.951	-1.60E-02	2.80E-03	poss
I6	690716	930429	690716	930429	2.5	-4.86E-03	0.18	0.168	0.948	-1.00E-02	5.30E-04	poss
I7	710608	890729	710608	890729	3.5	3.02E-04	0.045	0.114	1	-3.80E-03	4.40E-03	poss
I9	680828	890729	680828	890729	11.0	-4.51E-03	0.13	0.137	0.964	-7.60E-03	-1.50E-03	prob
I10	890315	930615	890315	930615	13.0	-5.51E-03	0.027	0.0133	0.78	-8.30E-03	-2.70E-03	prob
I11	680828	701008	680828	701008	2.8	-2.08E-01	0.38	0.139	0.377	-4.30E-01	1.70E-02	poss
I12	731023	930511	731023	930511	2.5	-8.53E-03	0.23	0.184	0.919	-1.70E-02	-1.40E-04	prob
I13	841202	931015	841202	931015	18.0	-1.50E-03	0.033	0.0336	0.991	-4.00E-03	1.00E-03	
I15	680827	930715	680827	930715	3.7	-6.02E-03	0.15	0.0678	0.729	-8.10E-03	-4.00E-03	prob
I17	720227	930715	720227	930715	5.4	-7.04E-03	0.19	0.151	0.914	-1.10E-02	-2.80E-03	prob
IH1	680530	930512	680530	930512	4.6	-2.33E-02	0.76	0.717	0.948	-4.20E-02	-4.70E-03	prob
IH2	770621	820810	770621	820810	0.6	-2.82E-02	0.3	0.0286	0.149	-1.80E-01	1.20E-01	
IH3	770621	820810	770621	820810	1.6	-2.37E-02	0.3	0.0451	0.423	-4.40E-02	-3.40E-03	prob
IH4	770621	820810	770621	820810	1.0	-8.27E-03	0.2	0.0426	0.863	-4.60E-02	3.00E-02	
IH5	680530	930512	680530	930512	5.0	-2.54E-02	0.74	0.646	0.922	-4.10E-02	-9.80E-03	prob
IH6	731024	930512	731024	930512	4.1	-2.13E-02	0.49	0.444	0.93	-3.90E-02	-3.90E-03	prob
IH7	680530	830628	680530	830628	6.3	1.57E-02	0.11	0.176	0.879	7.00E-03	2.40E-02	prob
INL	740723	840628	740723	820317	0.4	9.15E-02	0.1	1.83E-08	0	9.20E-02	9.20E-02	prob
LAC	710608	820408	710608	820408	4.2	5.53E-03	0.044	0.082	0.953	-1.90E-03	1.30E-02	poss
LQ1	801203	850423										
LQ2	731024	930512	731024	930512	2.5	-8.55E-03	0.23	0.462	0.981	-2.70E-02	9.60E-03	
LS1	840808	931015	890315	931015	12.0	8.84E-03	0.012	0.0599	0.964	-3.60E-03	2.10E-02	poss
LS2	690915	931015	690915	931015	2.8	-1.41E-03	0.051	0.0368	0.917	-2.60E-03	-2.70E-04	prob
MB1	730912	930506	730912	930506	2.7	-5.39E-03	0.15	0.147	0.952	-1.20E-02	1.20E-03	poss
MB2	870126	880707	870126	880707	16.0	7.67E-03	0.027	0.03	0.985	-2.00E-02	3.50E-02	poss
NB1	870923	880811	870923	880811	130.0	8.17E-02	0.06	0.0825	0.933	2.40E-02	1.40E-01	prob
NB2	870923	880811	870923	880811	27.0	3.99E-02	0.077	0.0724	0.977	-7.40E-02	1.50E-01	poss
NB3	831128	890729	831128	890729	10.0	1.21E-02	0.018	0.0558	0.909	2.00E-03	2.20E-02	prob
NB4	780613	930413	780613	930413	19.0	1.97E-02	-0.071	0.0876	0.933	1.10E-02	2.80E-02	prob

(continued)

Table 3-3
WQAMMN time trend analyses (continued)

Seg-ment	*Period of record dates*		*Analysis period Start date*	*Analysis period End date*	*Avg obs /yr*	*Regression on time slope (per yr)*	*Regression on time intercept (@ start)*	*Regression on time SEE*	*Regression on time residual variance*	*95% confidence limits on slope lower*	*95% confidence limits on slope upper*	
NB5	690326	930413	690326	930413	21.0	-4.50E-04	0.096	0.0793	0.999	-1.80E-03	9.00E-04	
NB6	690326	880811	690326	880811	3.4	-3.86E-03	0.15	0.12	0.951	-8.10E-03	3.50E-04	poss
NB7	731015	930413	731015	921123	2.1	2.87E-03	0.11	0.193	0.992	-7.50E-03	1.30E-02	poss
NB8	871021	880811	871021	880811	25.0	2.61E-02	0.058	0.0629	0.988	-9.00E-02	1.40E-01	poss
NB9	880324	880811	880324	880811	21.0	1.86E-01	0.02	0.0624	0.813	-2.00E-01	5.70E-01	poss
ND2	781017	790608	781017	790608	25.0	5.57E-02	0.078	0.0531	0.95	-8.30E-02	1.90E-01	poss
NR1	680530	730618	680530	730517	5.8	-6.22E-03	0.093	0.138	0.996	-4.50E-02	3.20E-02	
NR3	701012	731016	701012	731016	2.0	-1.99E-01	0.54	0.208	0.462	-4.50E-01	5.70E-02	poss
NR4	730917	920929	740531	920929	6.2	-1.63E-02	0.4	0.288	0.938	-2.80E-02	-4.40E-03	prob
NR5	680530	760830	680530	760830	4.0	2.13E-02	0.0091	0.114	0.915	-3.50E-03	4.60E-02	poss
OS1	720131	930427	720131	930427	2.3	-1.51E-01	8.1	6.61	0.973	-4.10E-01	1.10E-01	
OS3	720115	791101	720425	790828	2.6	-4.31E-02	0.68	0.682	0.981	-2.00E-01	1.20E-01	
OS6	810514	930427	810514	930427	2.8	6.07E-03	0.14	0.461	0.998	-4.30E-02	5.50E-02	poss
OS7	731003	910702	731003	910702	3.1	-4.47E-02	1.2	3.09	0.993	-1.90E-01	1.00E-01	
PB1	731029	930428	731029	930428	2.6	-8.70E-03	0.19	0.214	0.942	-1.90E-02	1.30E-03	poss
RB1	710608	730419	710608	730419	9.7	-2.44E-02	0.067	0.0343	0.846	-5.50E-02	6.00E-03	poss
RB3	690326	921013	690326	921013	2.4	3.86E-03	0.073	0.222	0.987	-5.20E-03	1.30E-02	poss
RB5	721220	741212	721220	741212	11.0	0.00E+00	0.1	0	0	0.00E+00	0.00E+00	
RB6	721215	741214	721215	741214	11.0	0.00E+00	0.1	0	0	0.00E+00	0.00E+00	
RB7	781017	790608	781017	790608	12.0	-5.02E-02	0.06	0.0276	0.864	-1.80E-01	7.60E-02	
RB8	710506	930427	710506	930427	4.5	-9.39E-04	0.087	0.114	0.997	-4.30E-03	2.50E-03	
RB9	740723	890729	740723	890729	0.4	-5.42E-03	0.1	0.000855	0.001	-5.60E-03	-5.20E-03	prob
SC2	711105	760819	711105	760819	5.4	-4.70E-02	0.19	0.234	0.908	-1.10E-01	1.50E-02	poss
SC3	710608	930428	710608	930428	4.0	-6.75E-03	0.18	0.301	0.981	-1.70E-02	3.60E-03	
UL03	690916	930715	690916	930715	2.2	-1.60E-03	0.058	0.0424	0.969	-4.10E-03	8.70E-04	
UL04	750106	930511	750106	930511	2.3	-1.97E-03	0.11	0.0749	0.981	-6.30E-03	2.40E-03	
UL11	690916	820330	690916	820330	1.2	1.56E-02	-0.058	0.0901	0.765	-1.30E-03	3.20E-02	
GMI4	731003	830926	731003	830810	2.5	-2.03E-02	0.26	0.332	0.965	-6.60E-02	2.60E-02	
GMI6	690326	930429	690326	930429	3.7	-3.51E-03	0.14	0.211	0.989	-1.10E-02	3.50E-03	
GMO6	720919	840628	720919	820317	1.2	6.50E-02	0.051	0.0877	0.079	5.10E-02	7.90E-02	prob

of the corresponding detection limit, the more pessimistic extreme, assuming a BDL variate is present to the maximum concentration that remains undetectable. The separate averages using these latter two strategies are given in the final two columns of the period-of-record statistics tables (e.g., Table 3-2). These represent upper and lower bounds on the actual mean concentration. Because many of the data records contain a high frequency of BDL values, and (worse) reported values of 0 instead of a detection limit, a census of BDL's, minimum values, and *non-zero* minima is also given in the period-of-record statistics tables. Discussion of the time trend analysis, Table 3-3, is given in Section 3.3 below.

3.1 Spatial variation in water and sediment quality

The general spatial variation of selected water and sediment quality parameters, for selected subregions of the study area, is depicted in Figs. 3-1 through 3-43. These are based upon the average values for each segment computed with BDL values (where applicable) taken as 0. Temperature, salinity, and dissolved oxygen warrant special treatment because of the nature of the external controls and the manner in which data is taken. To emphasize the horizontal variation in these parameters, as well as to eliminate any spurious weighting of stations where profile data were taken over those where only one measurement in the vertical was made, these parameters are plotted for near-surface values only, defined to be measurements within the upper metre (3.3 ft).

Clearly, the large extent of the study area requires a substantial space to present the data-analysis results, whether by graphical (e.g., Figs. 3-1 *et seq*.) or tabular (e.g., Table 3-2) means. To facilitate a summary of the general spatial variation across the study area, principal components ("bays") of the Corpus Christi Bay system were defined by grouping various hydrographic-area segments, presented in Table 3-4. The objective is to identify and group segments characteristic of the open waters of the indicated component of the study area, but to exclude regions that are probably biased by external factors so as to be atypical. For example, areas that are semi-enclosed and under the immediate influence of inflows are omitted, such as Mission Bay, Port Bay and the upper segments of Nueces Bay. The segments in the open areas of Corpus Christi Bay are included, but the regions adjacent to Ingleside and East Flats, and Shamrock Cove are omitted. Similarly, the segments along the southern shore of Nueces Bay, which could be affected by the CP&L Nueces steam-electric station discharge, are excluded. After much deliberation, the narrow segments adjacent to the shoreline of the City of Corpus Christi were included in the open-bay region, though for some parameters, such as coliforms, these will not be representative of open-bay conditions. The Upper Laguna is subdivided into two reaches, the northern reach (but excluding the region in immediate proximity to the JFK Causeway, which is considered separately as Causeway S) being designated as the King Ranch reach, and the southern reach as the Baffin reach. GOM Inlet designates the Gulf of Mexico in proximity to Aransas Pass.

In this summary report only selected parameters are shown, which are most meaningful as an index to the water and sediment quality of the system, based on

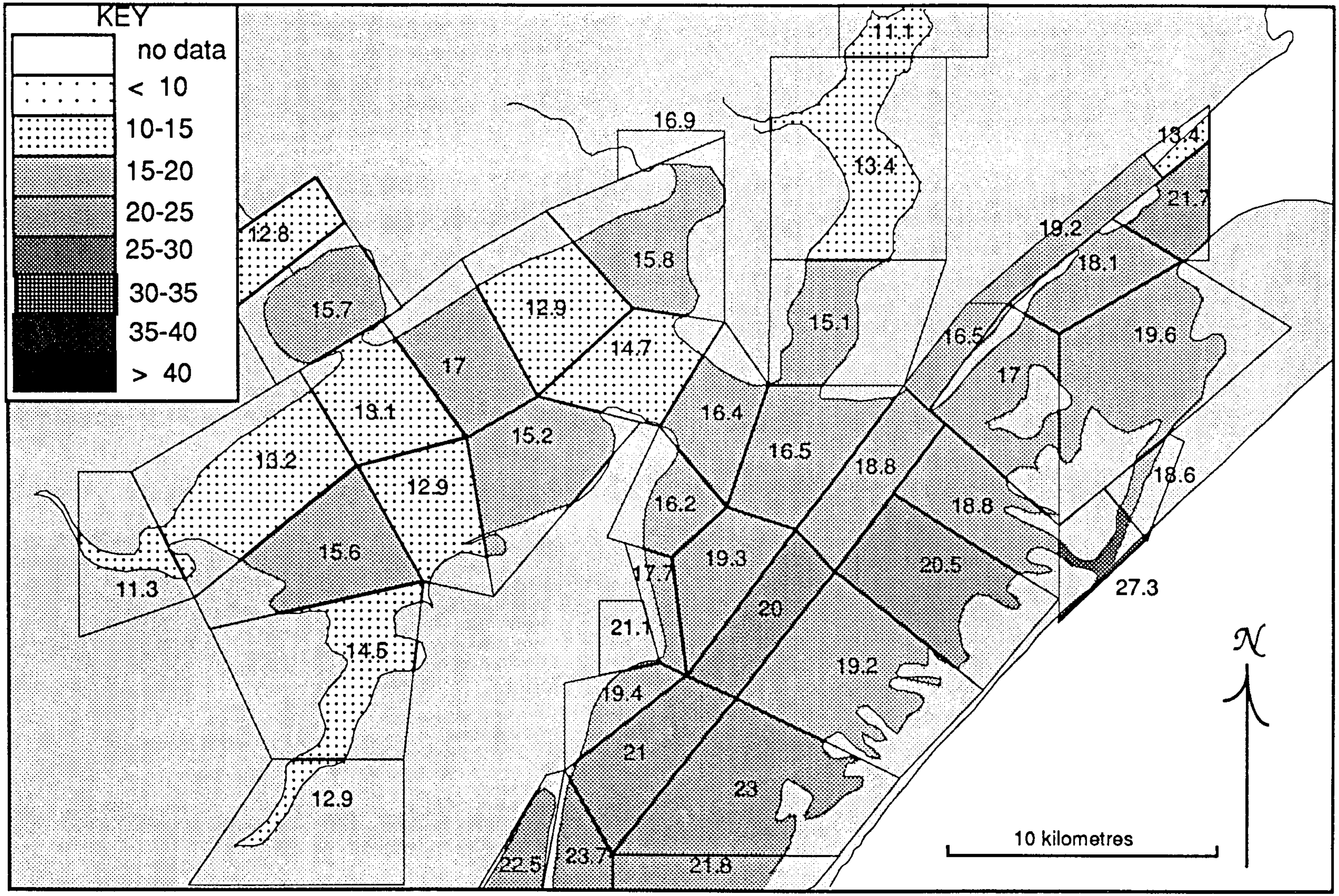

Figure 3-1. Period-of-record means of WQSAL, upper 1 m, for Aransas-Copano system

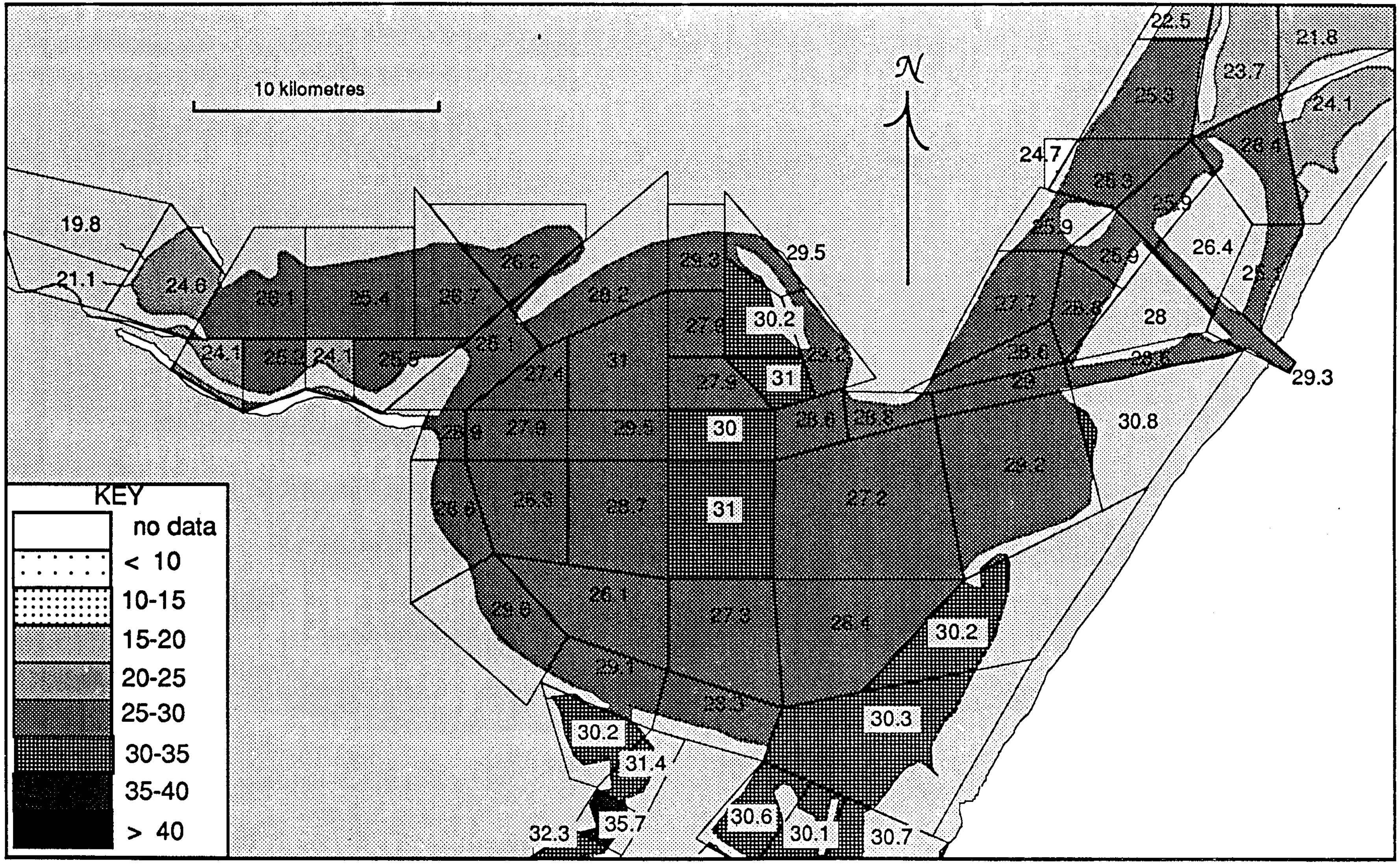

Figure 3-2. Period-of-record means of WQSAL, upper 1 m, for Corpus Christi system

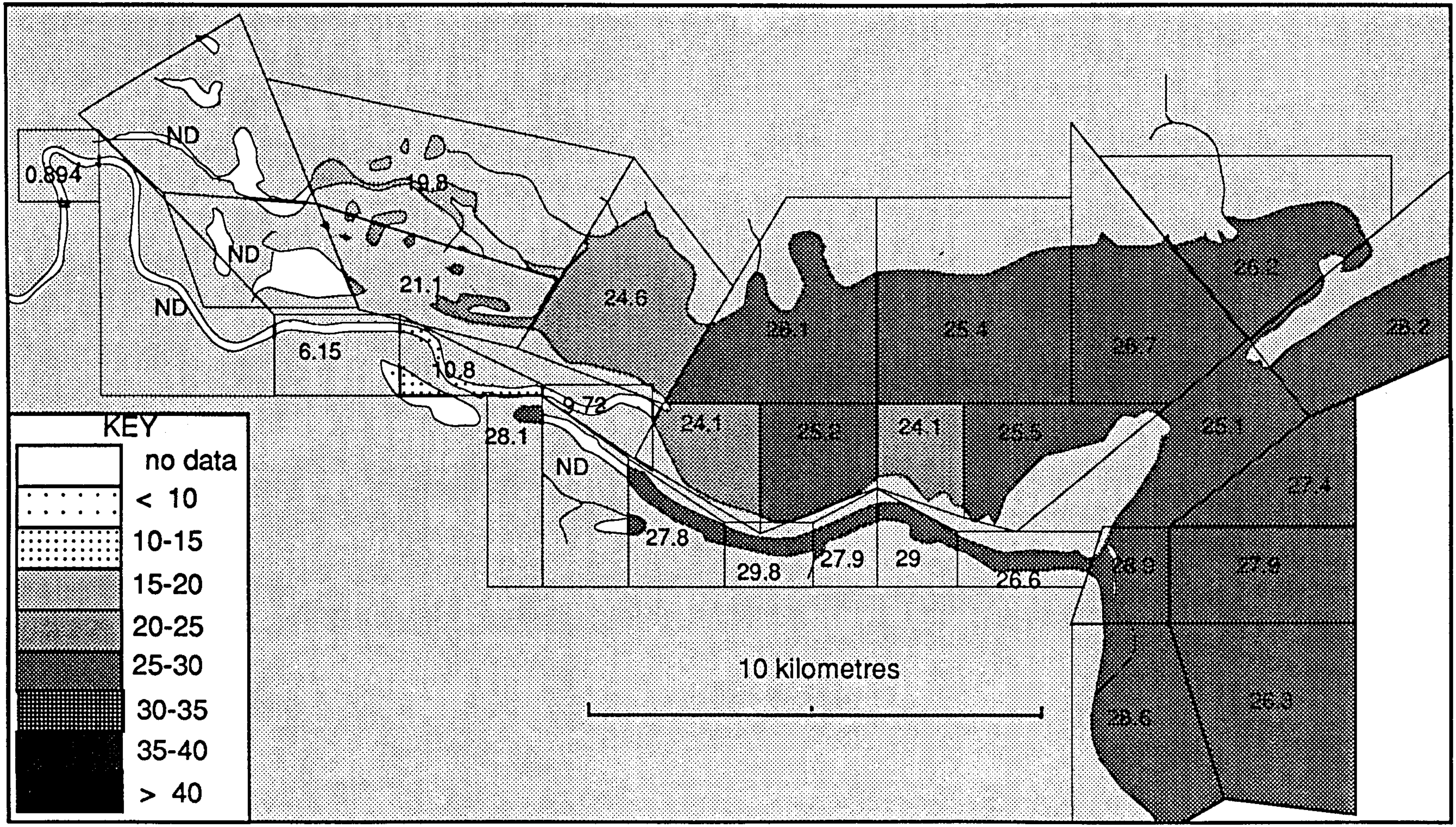

Figure 3-3. Period-of-record means of WQSAL, upper 1m, for Nueces Bay region, including Inner Harbor

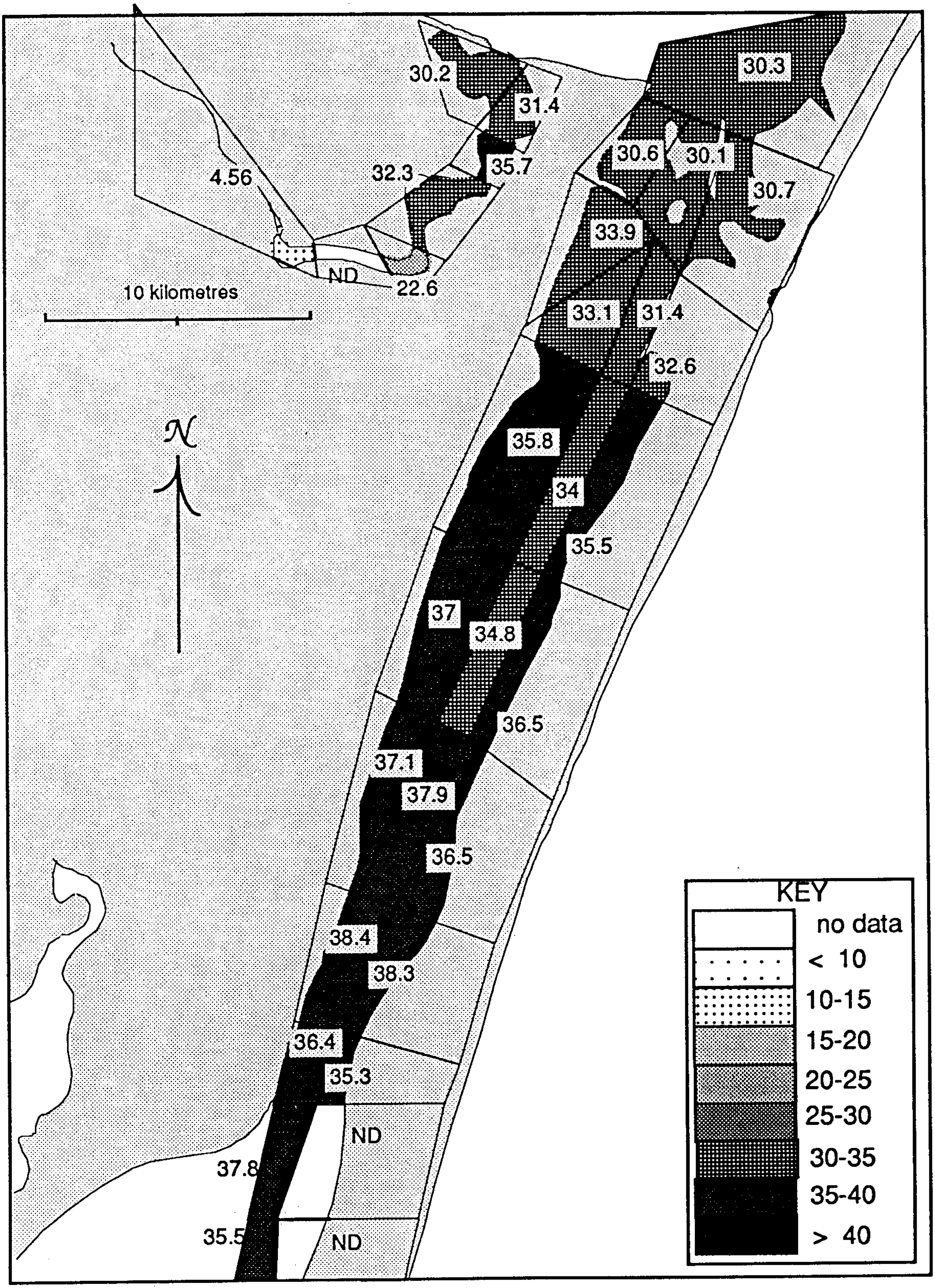

Figure 3-4. Period-of-record means of WQSAL, upper 1 m, for Upper Laguna Madre

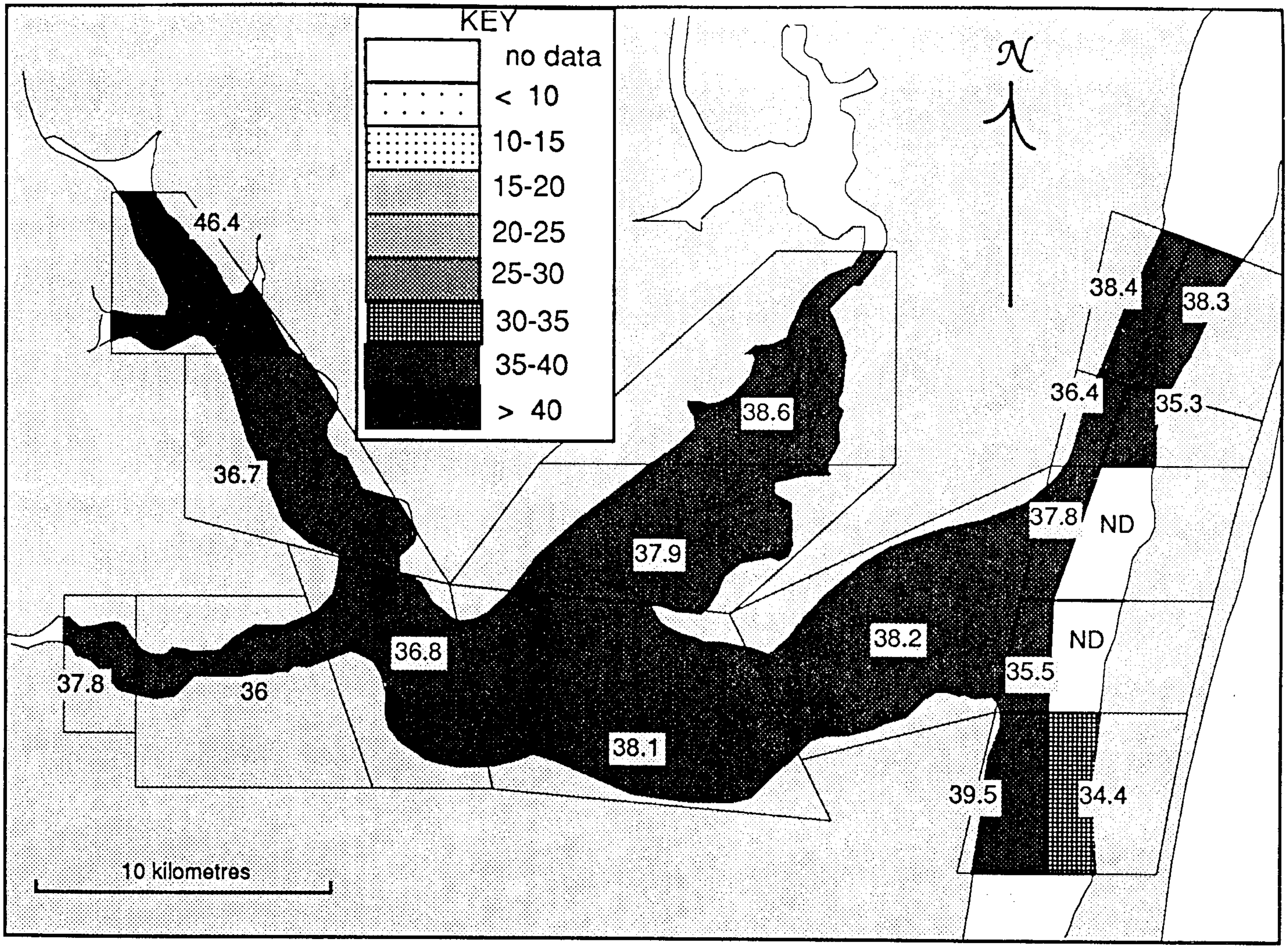

Figure 3-5. Period-of-record means of WQSAL, upper 1m, for Baffin Bay region

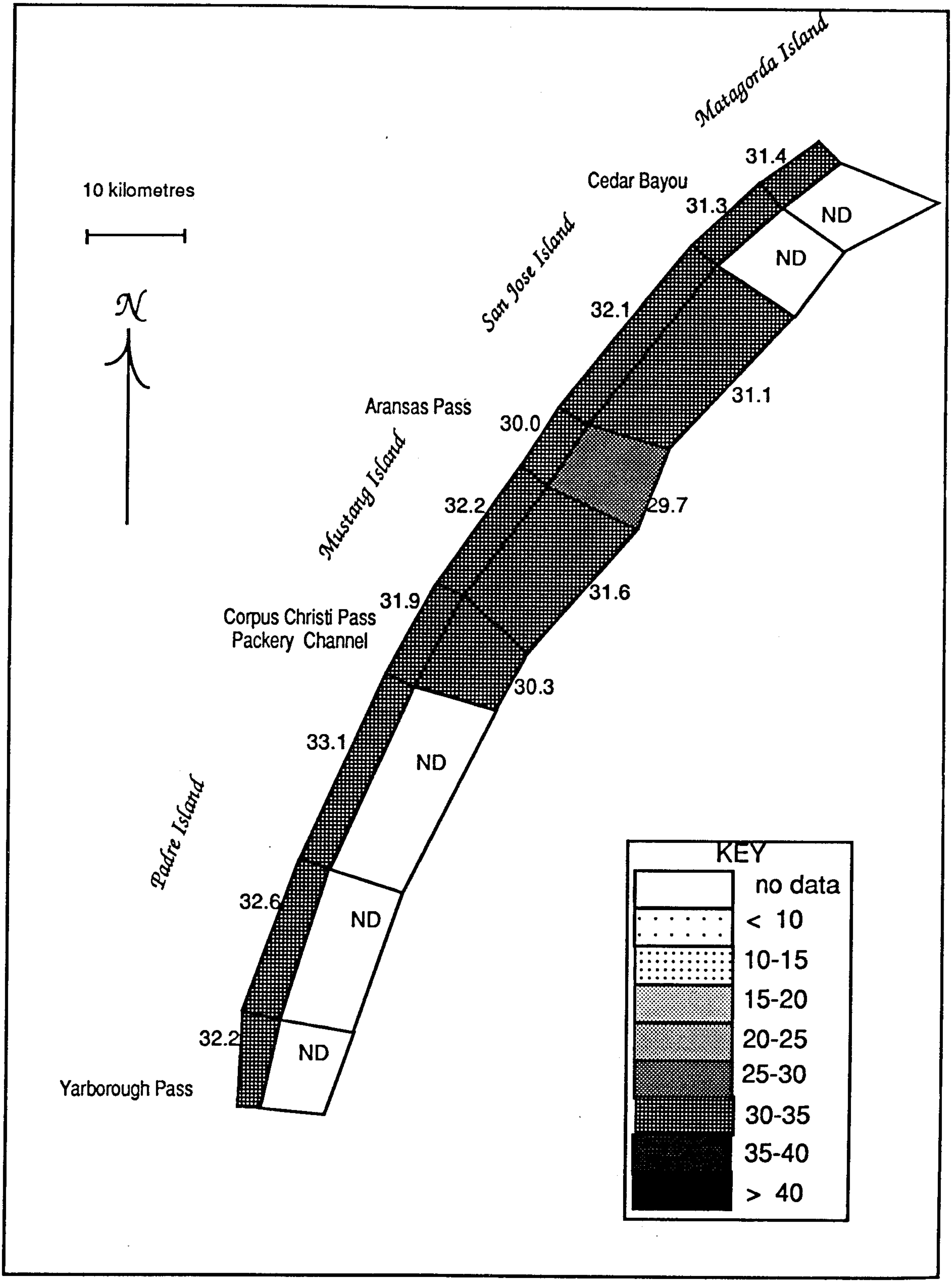

Figure 3-6. Period-of-record means of WQSAL, upper 1 m, for Gulf of Mexico

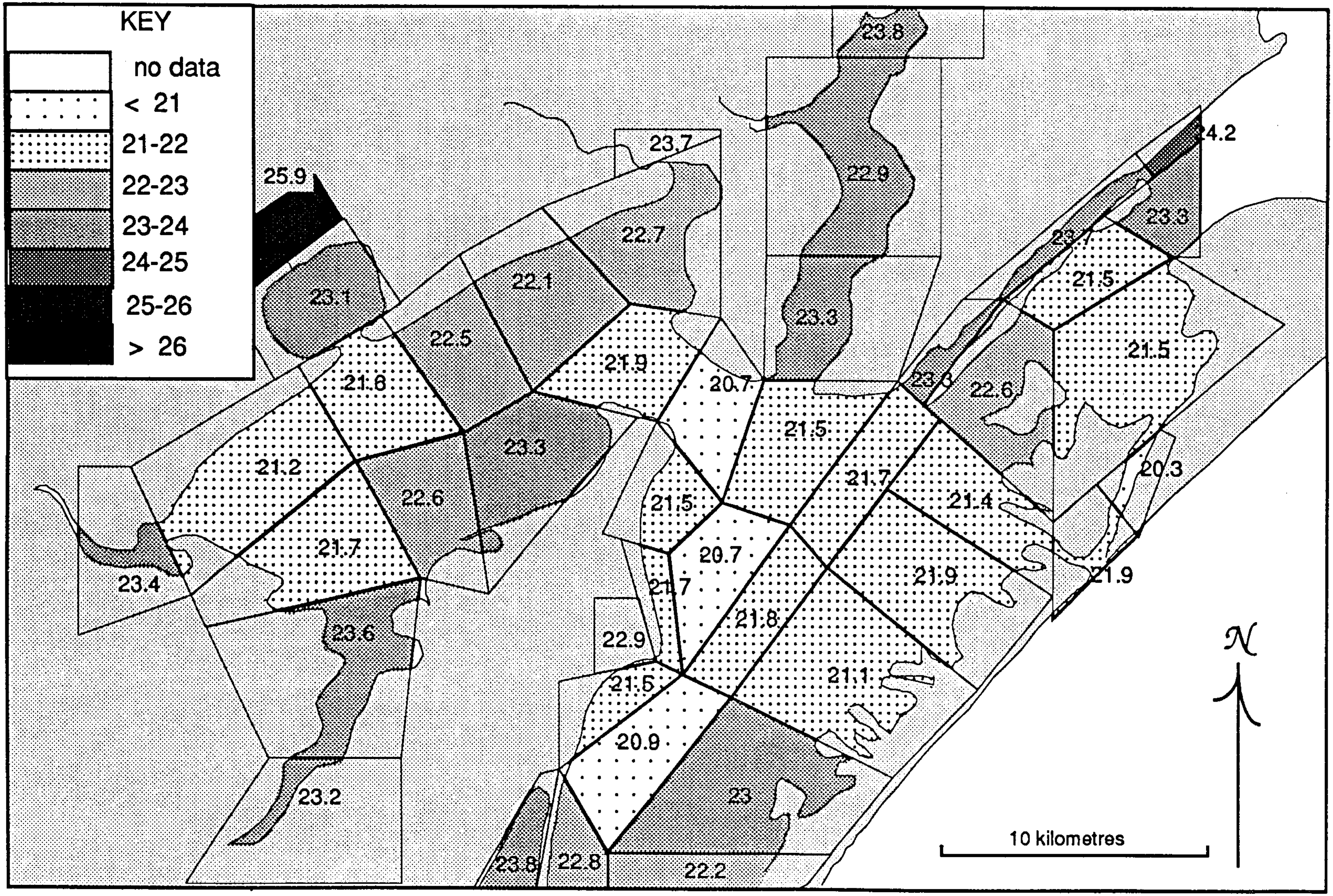

Figure 3-7. Period-of-record means WQTEMP, upper 1 m, for Aransas-Copano system

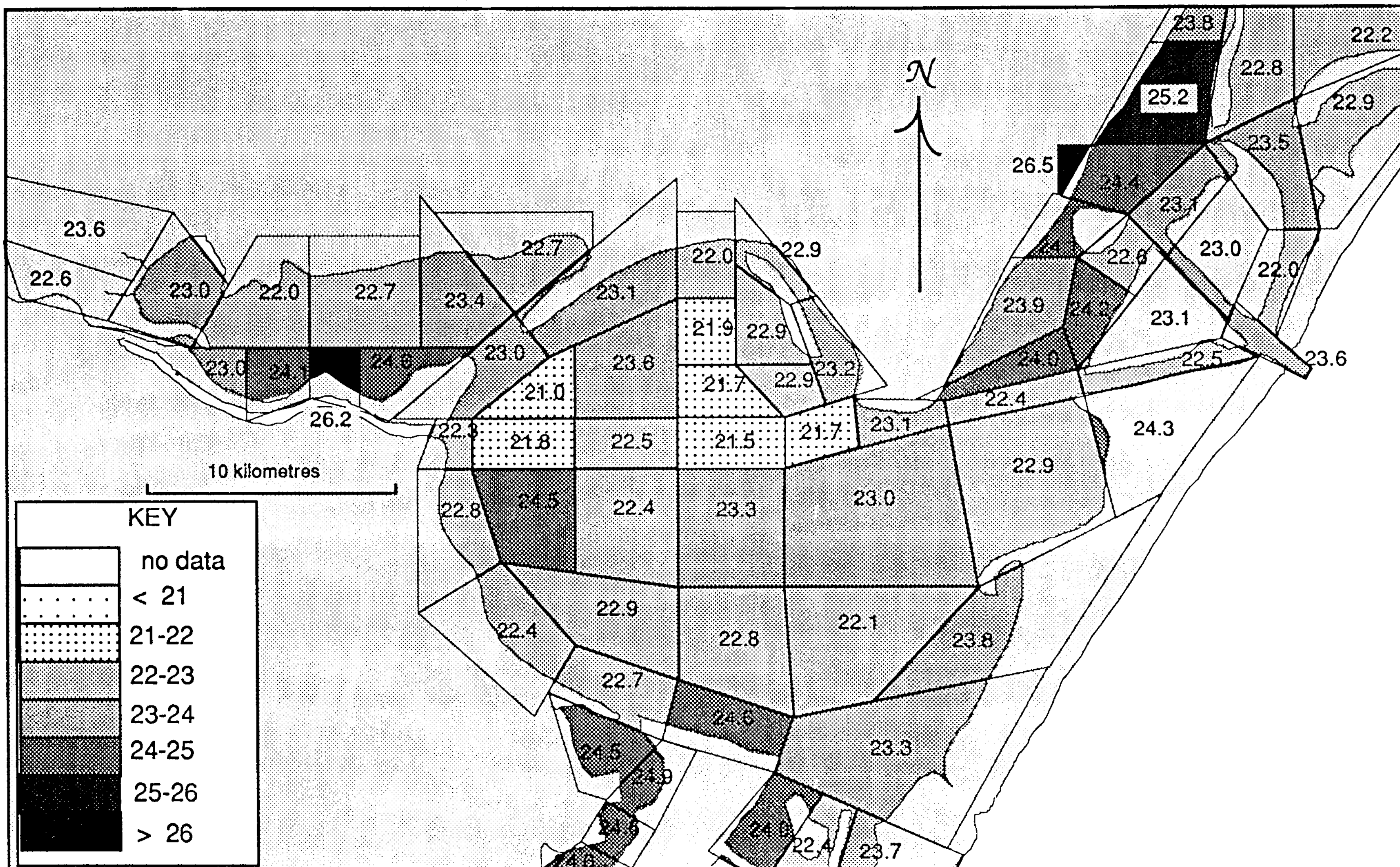

Figure 3-8. Period-of-record means of WQTEMP, upper 1 m, for Corpus Christi system

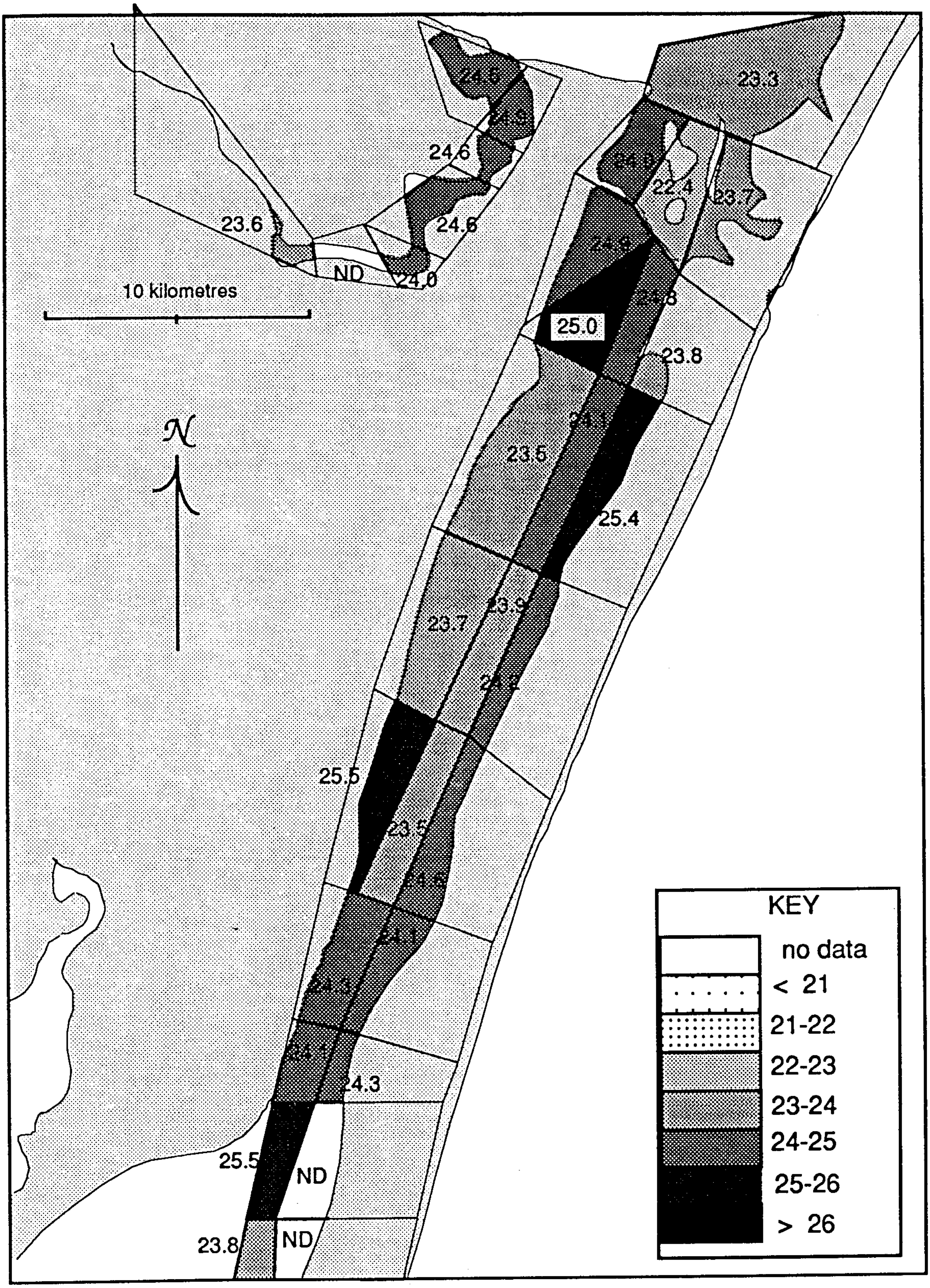

Figure 3-9. Period-of-record means of WQTEMP, upper 1 m, for Upper Laguna Madre

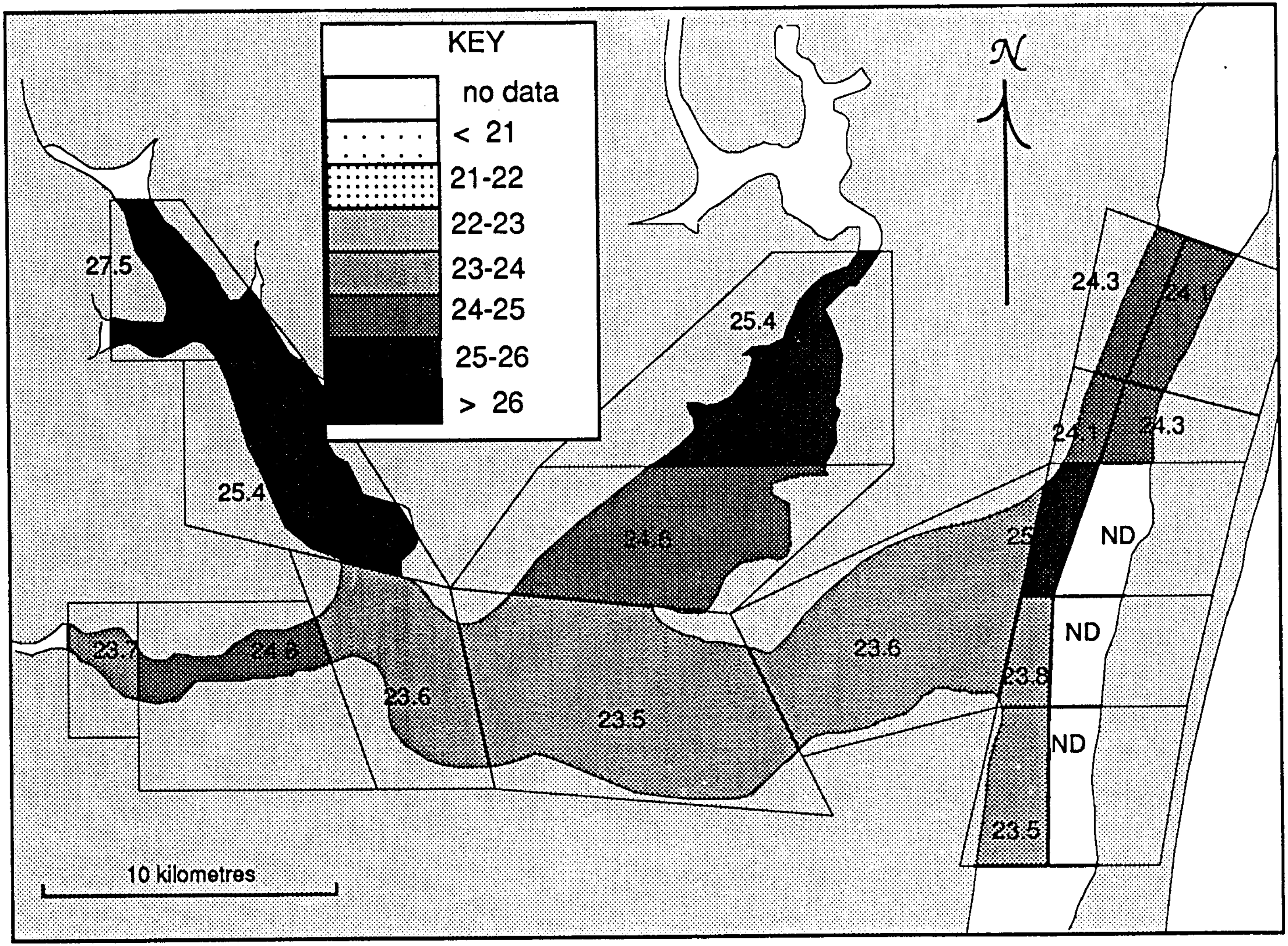

Figure 3-10. Period-of-record means of WQTEMP, upper 1 m, for Baffin Bay region

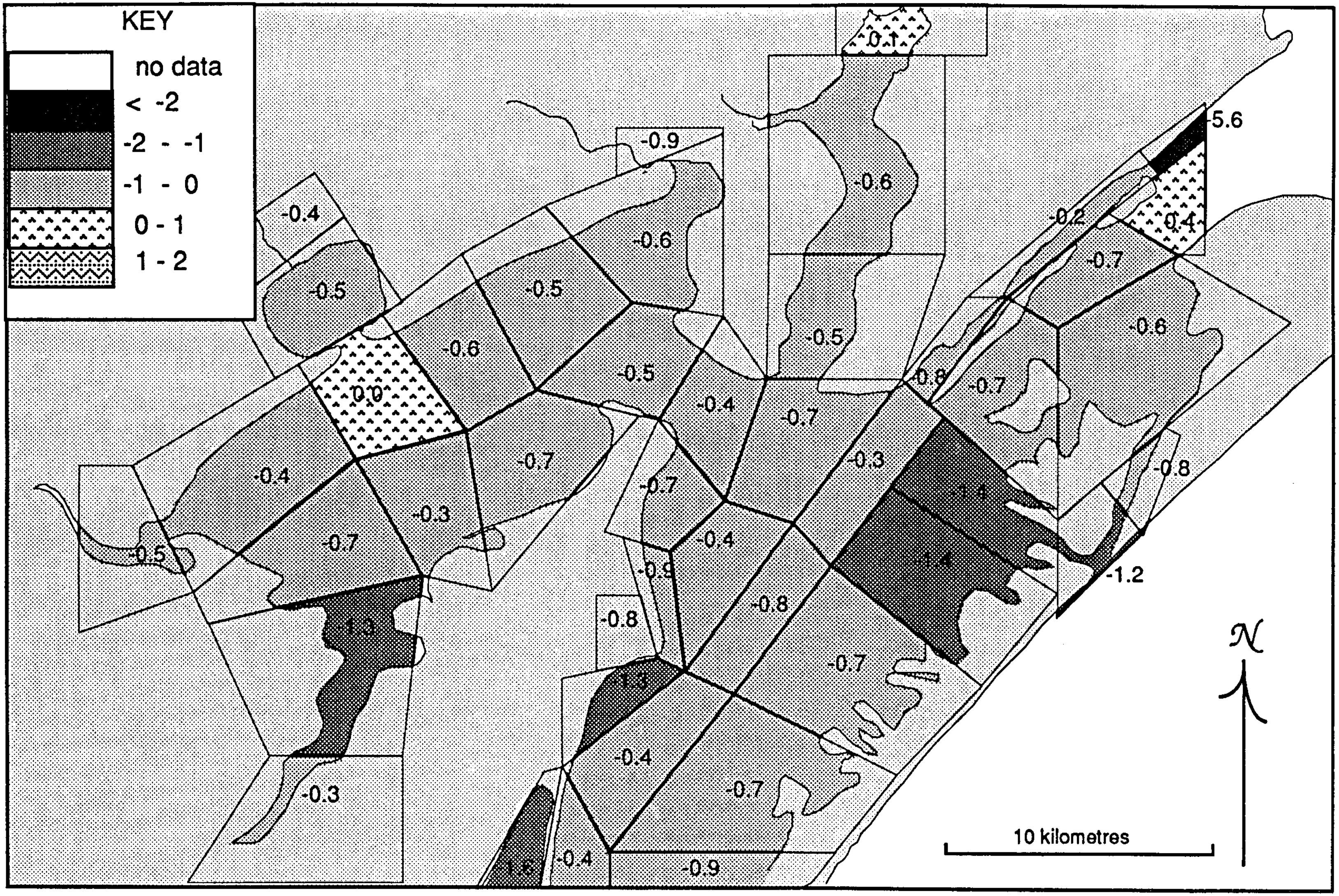

Figure 3-11. Period-of-record means of WQDODEF, upper 1 m, for Aransas-Copano system

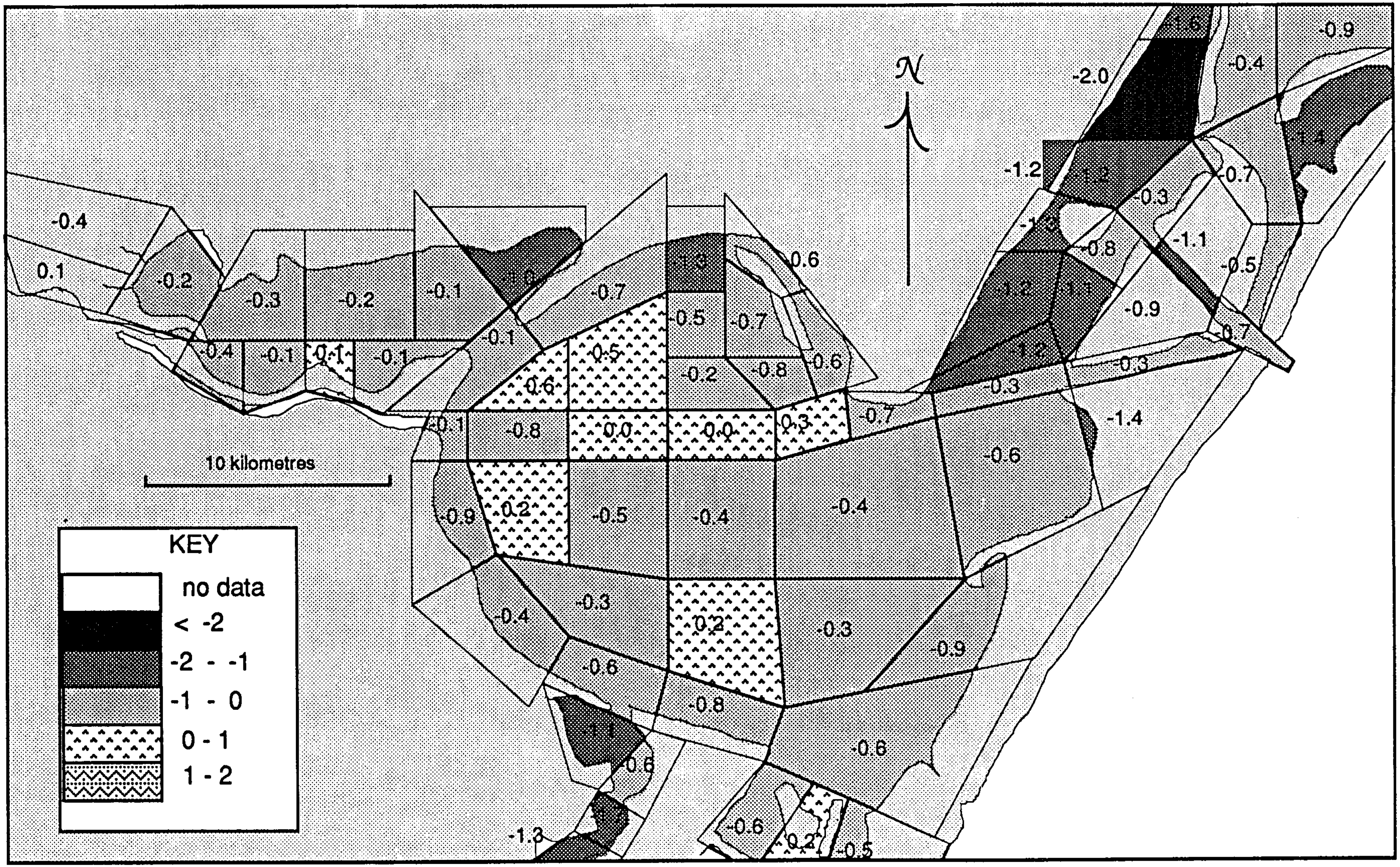

Figure 3-12. Period-of-record means of WQDODEF, upper 1 m, for Corpus Christi system

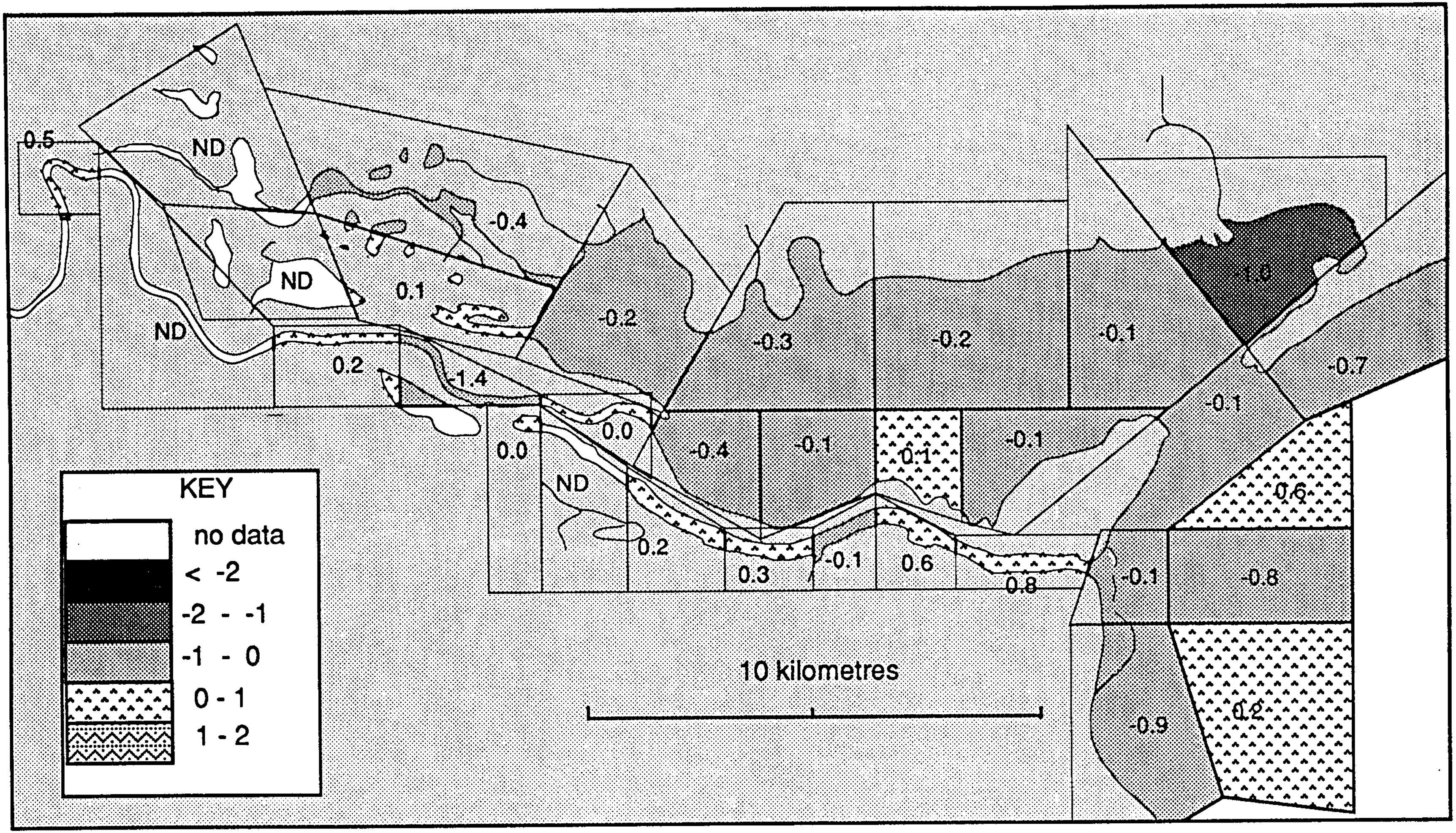

Figure 3-13. Period-of-record means of WQDODEF, upper 1m, for Nueces Bay region, including Inner Harbor

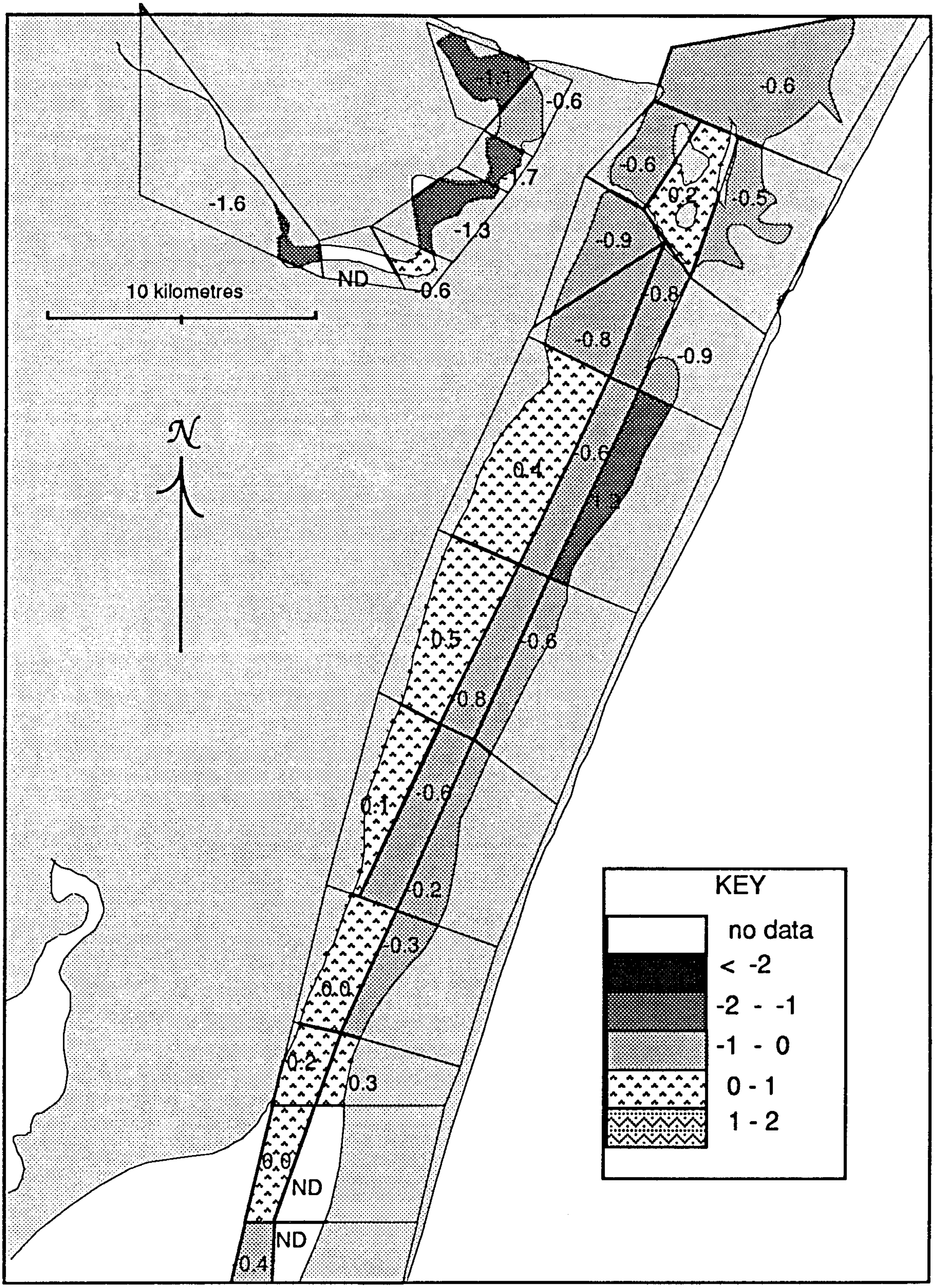

Figure 3-14. Period-of-record means of WQDODEF, upper 1 m, for Upper Laguna Madre

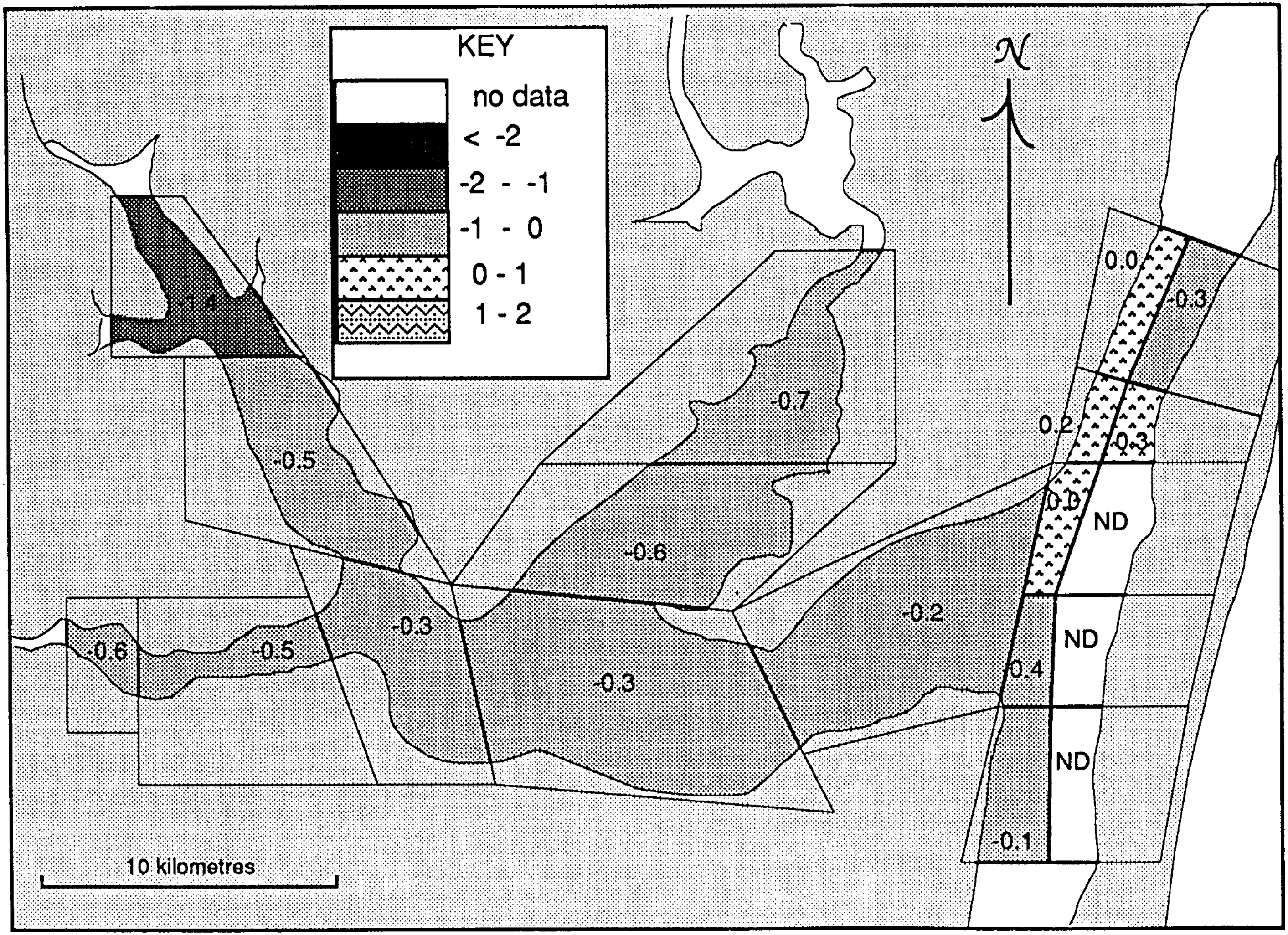

Figure 3-15. Period-of-record means of WQDODEF, upper 1 m, for Baffin Bay region

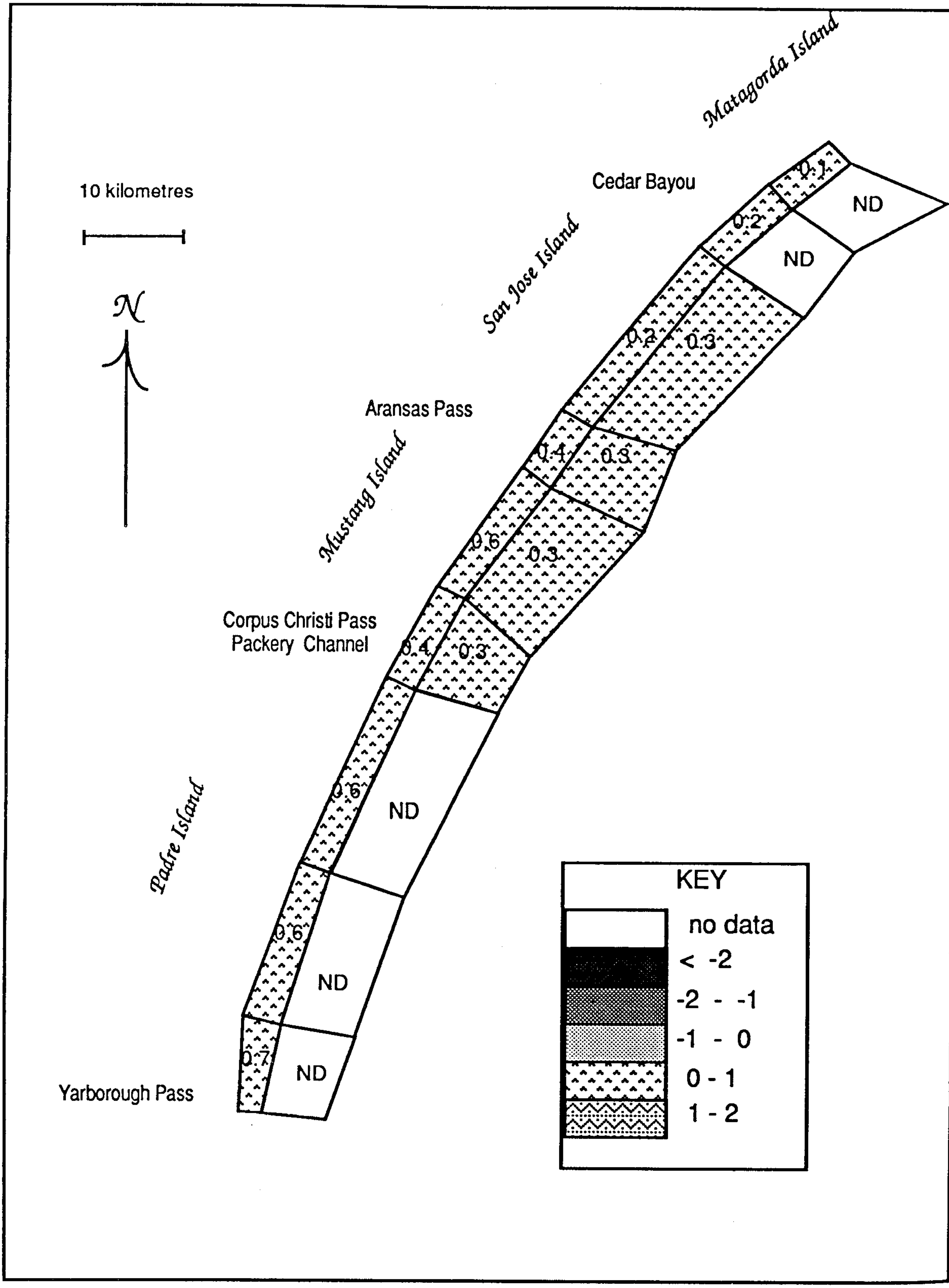

Figure 3-16. Period-of-record means of WQDODEF, upper 1 m, for Gulf of Mexico

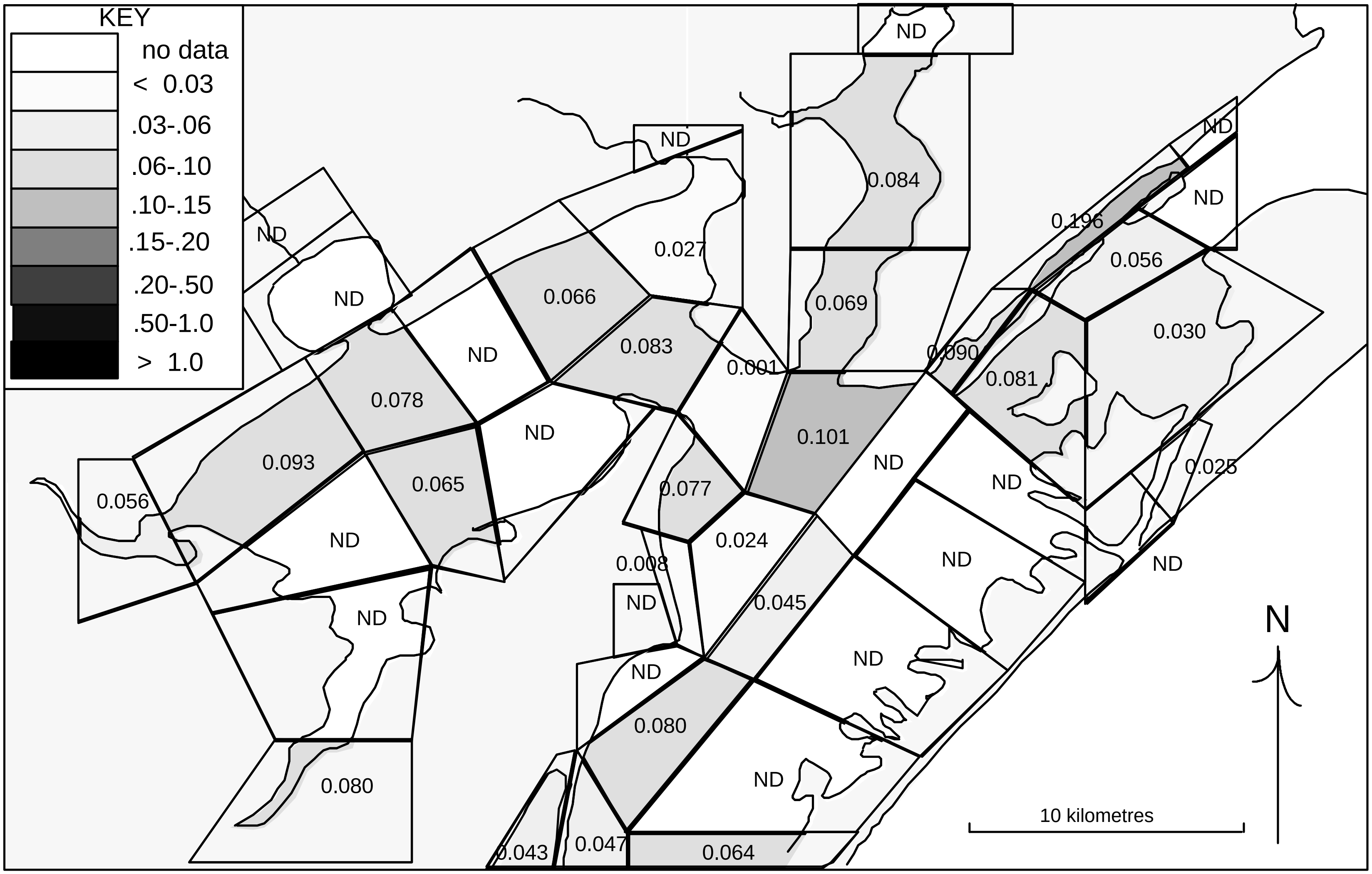

Figure 3-17. Period-of-record means of WQAMMN for Aransas-Copano system

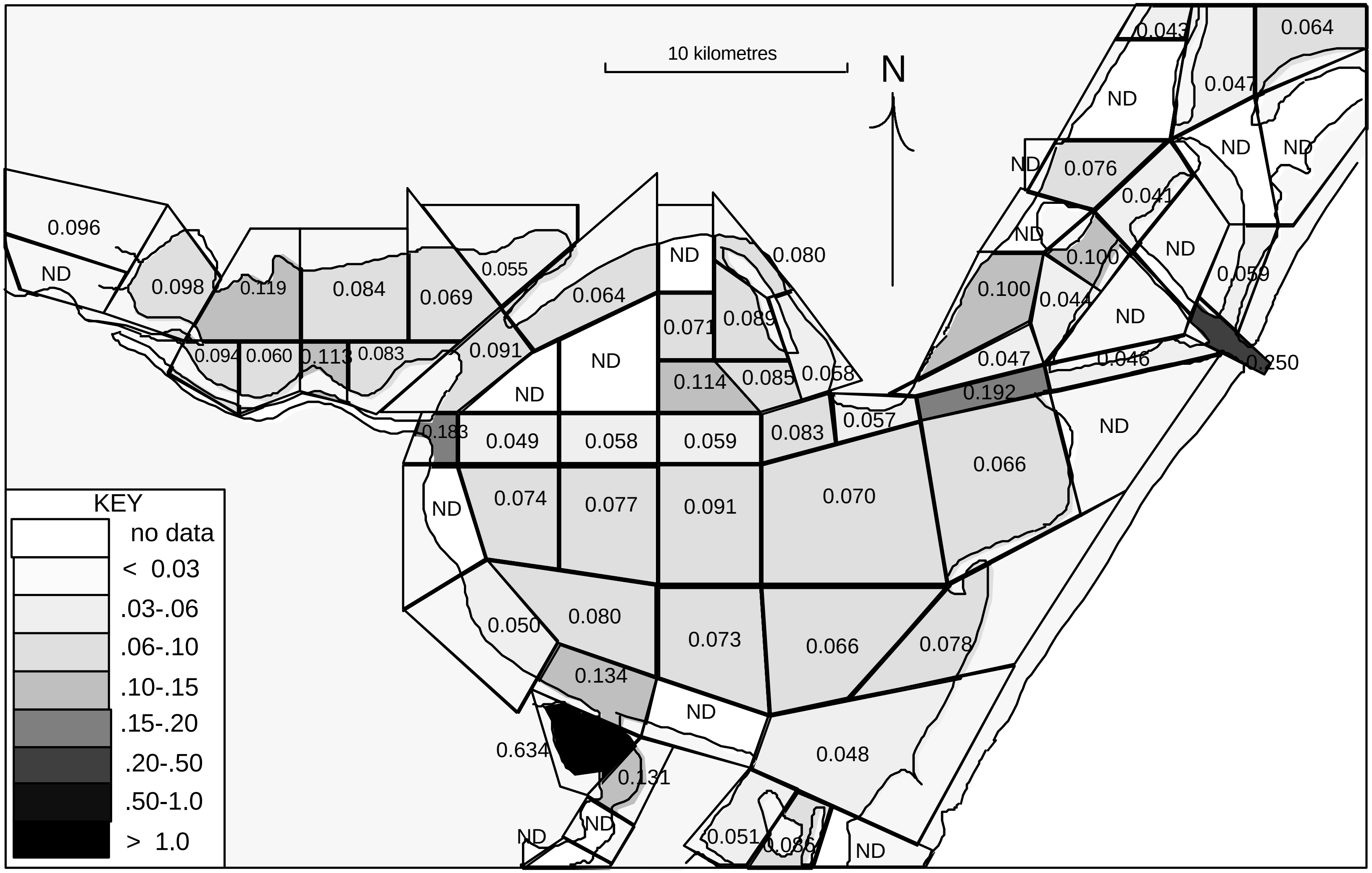

Figure 3-18. Period-of-record means of WQAMMN for Corpus Christi system

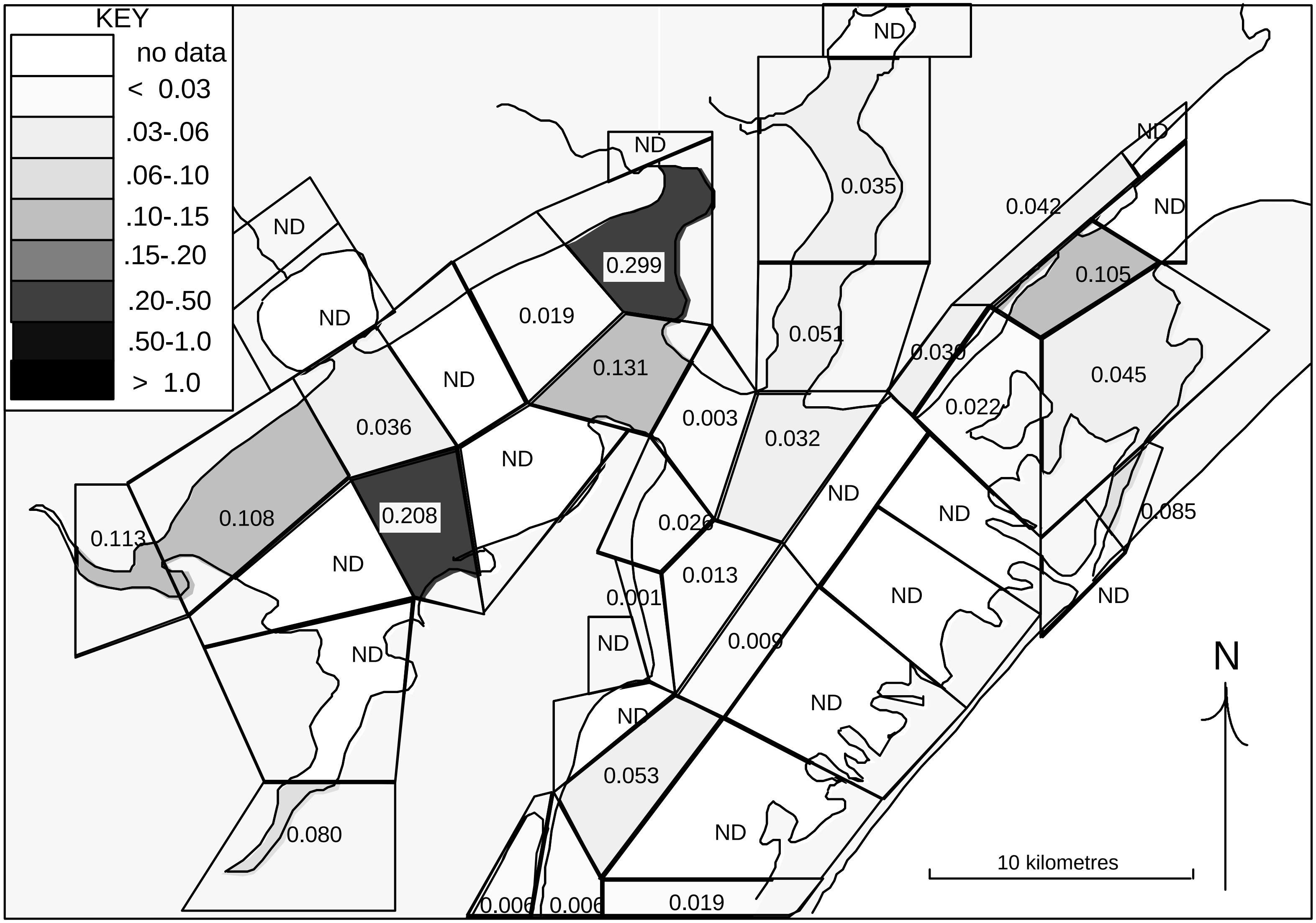

Figure 3-19. Period-of-record means of WQNO3N for Aransas-Copano system

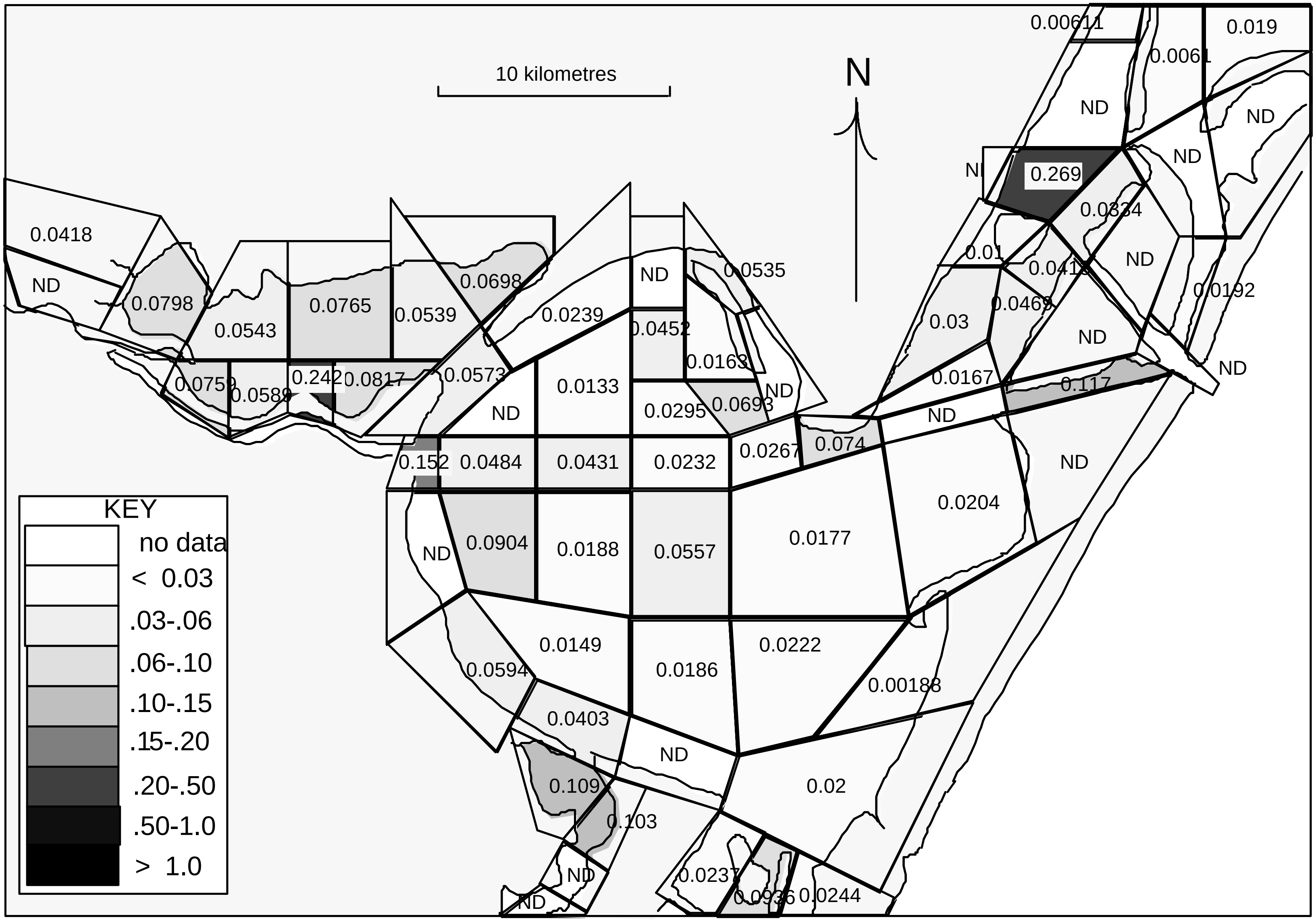

Figure 3-20. WQNO3N period-of-record means for Corpus Christi system

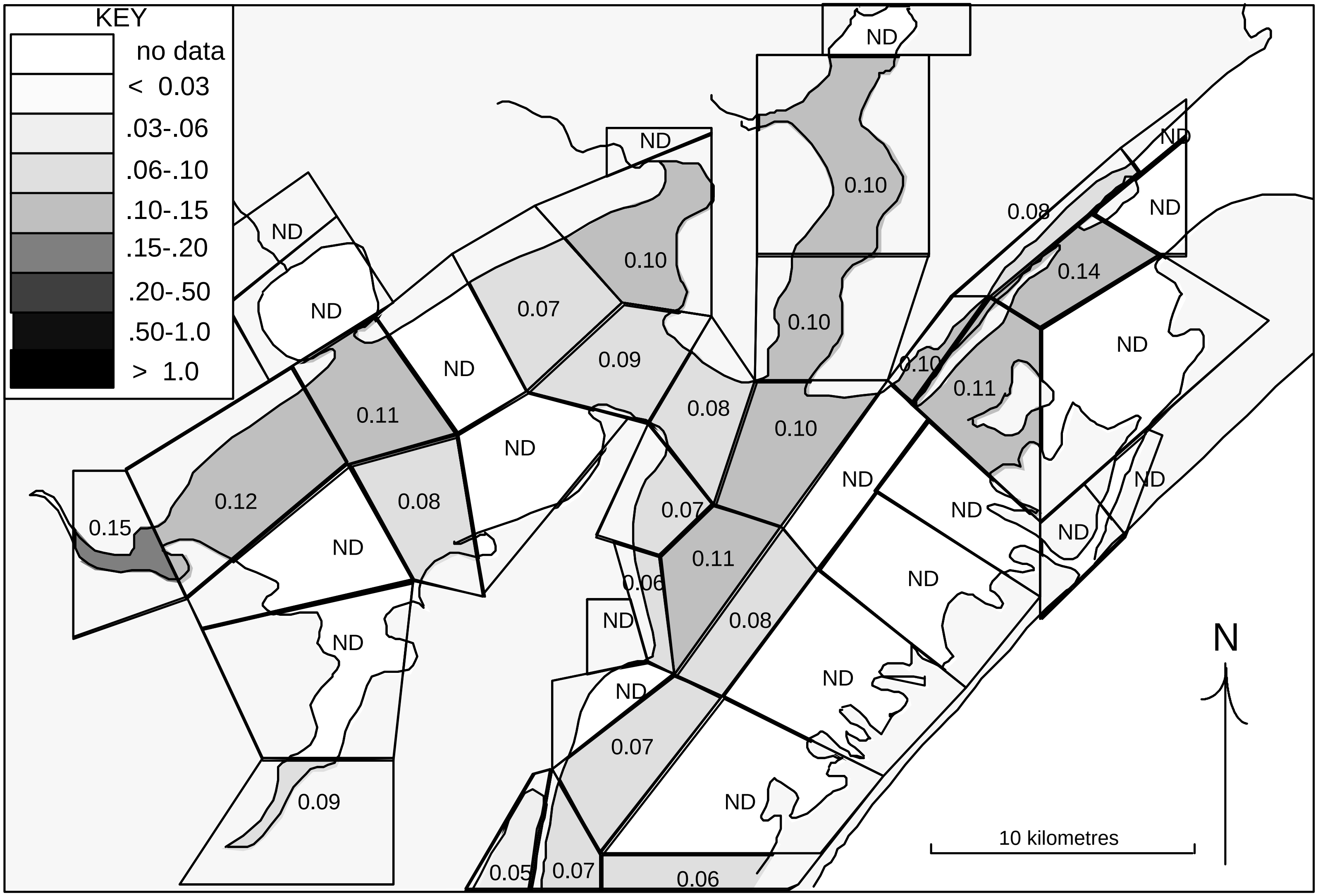

Figure 3-21. Period-of-record means of WQTOTP for Aransas-Copano system

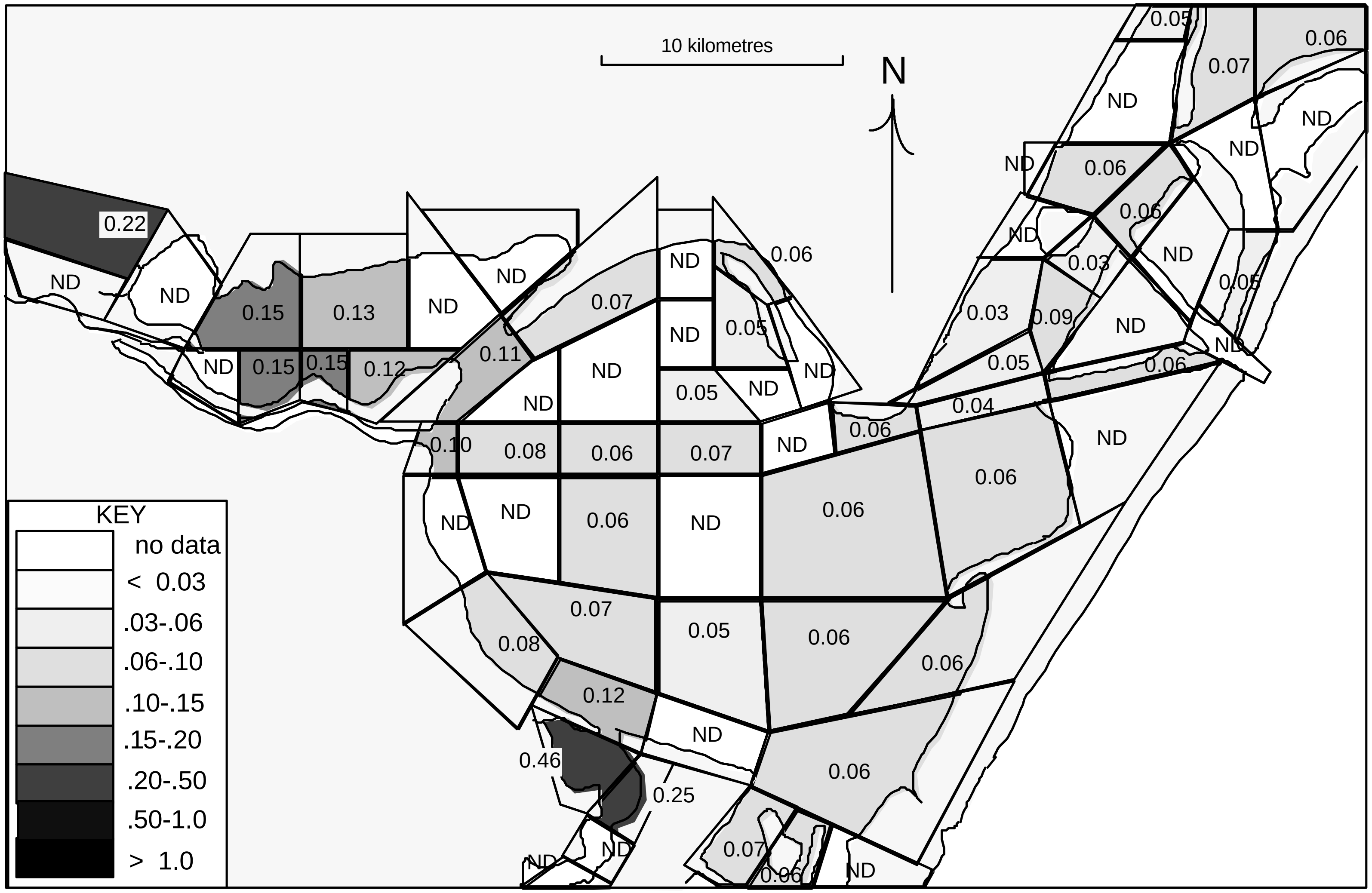

Figure 3-22. Period-of-record means of WQTOTP for Corpus Christi system

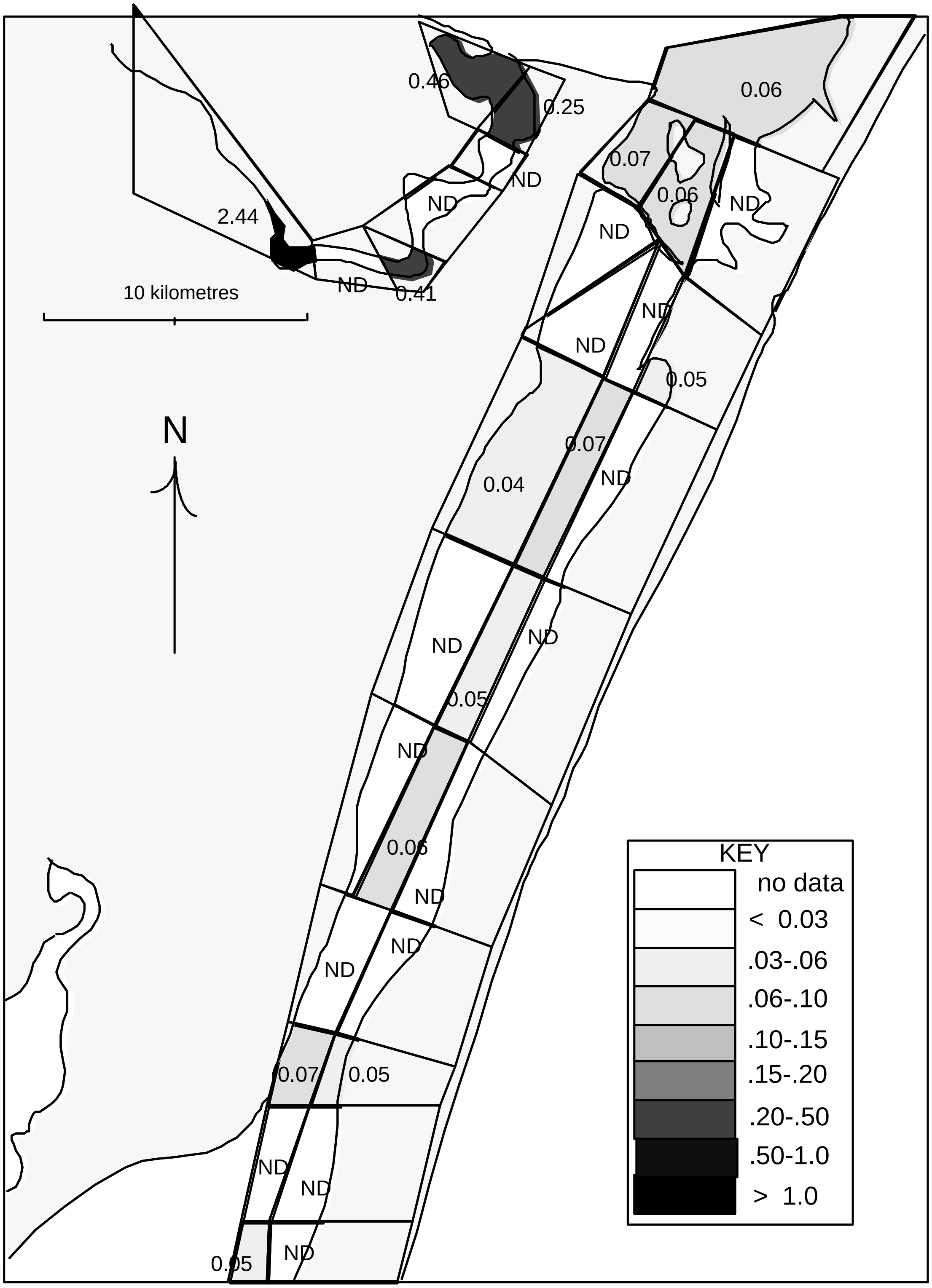

Figure 3-23. Period-of-record means of WQTOTP for Upper Laguna Madre and Oso Bay

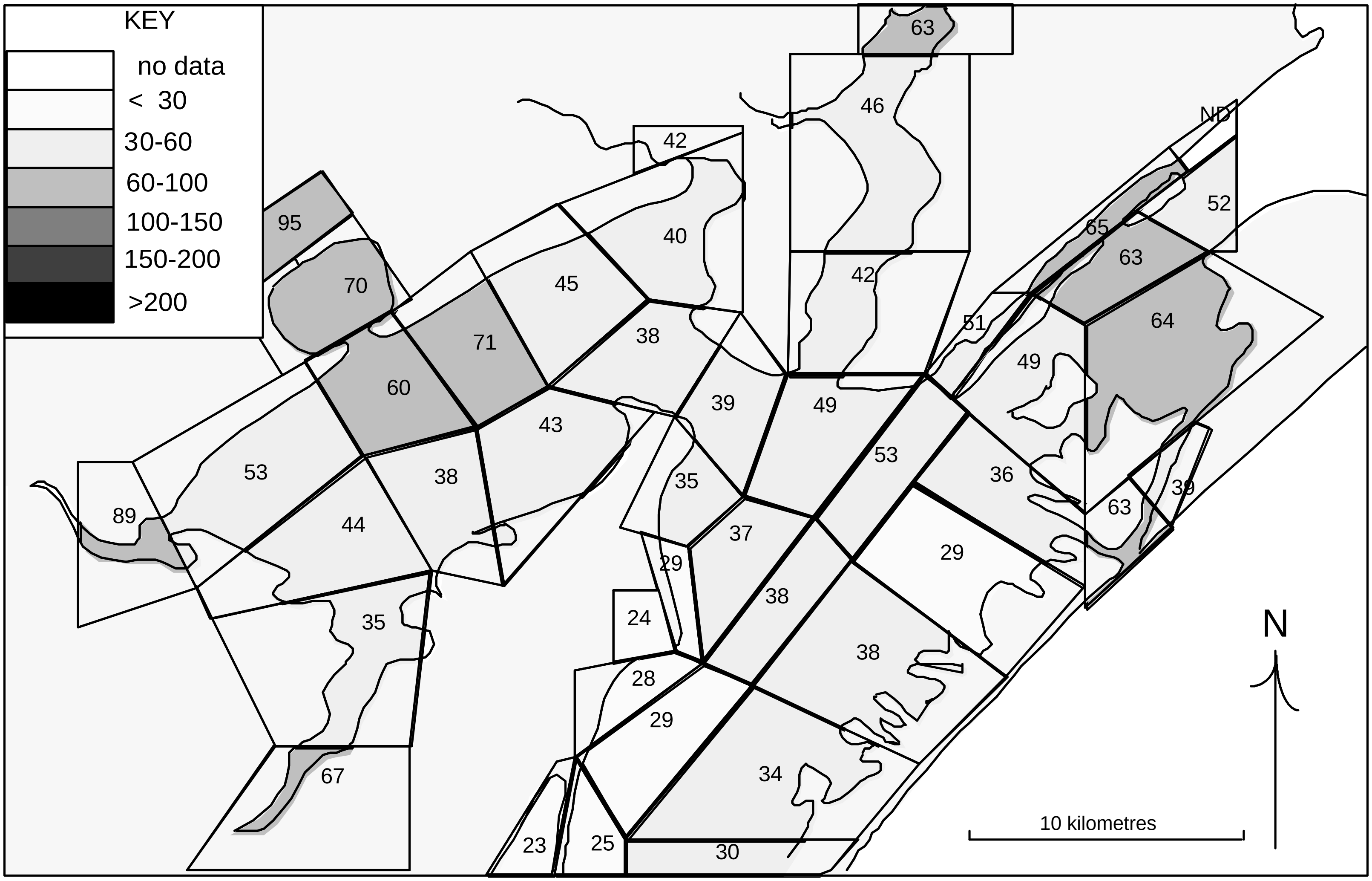

Figure 3-24. Period-of-record means of WQXTSS for Aransas-Copano system

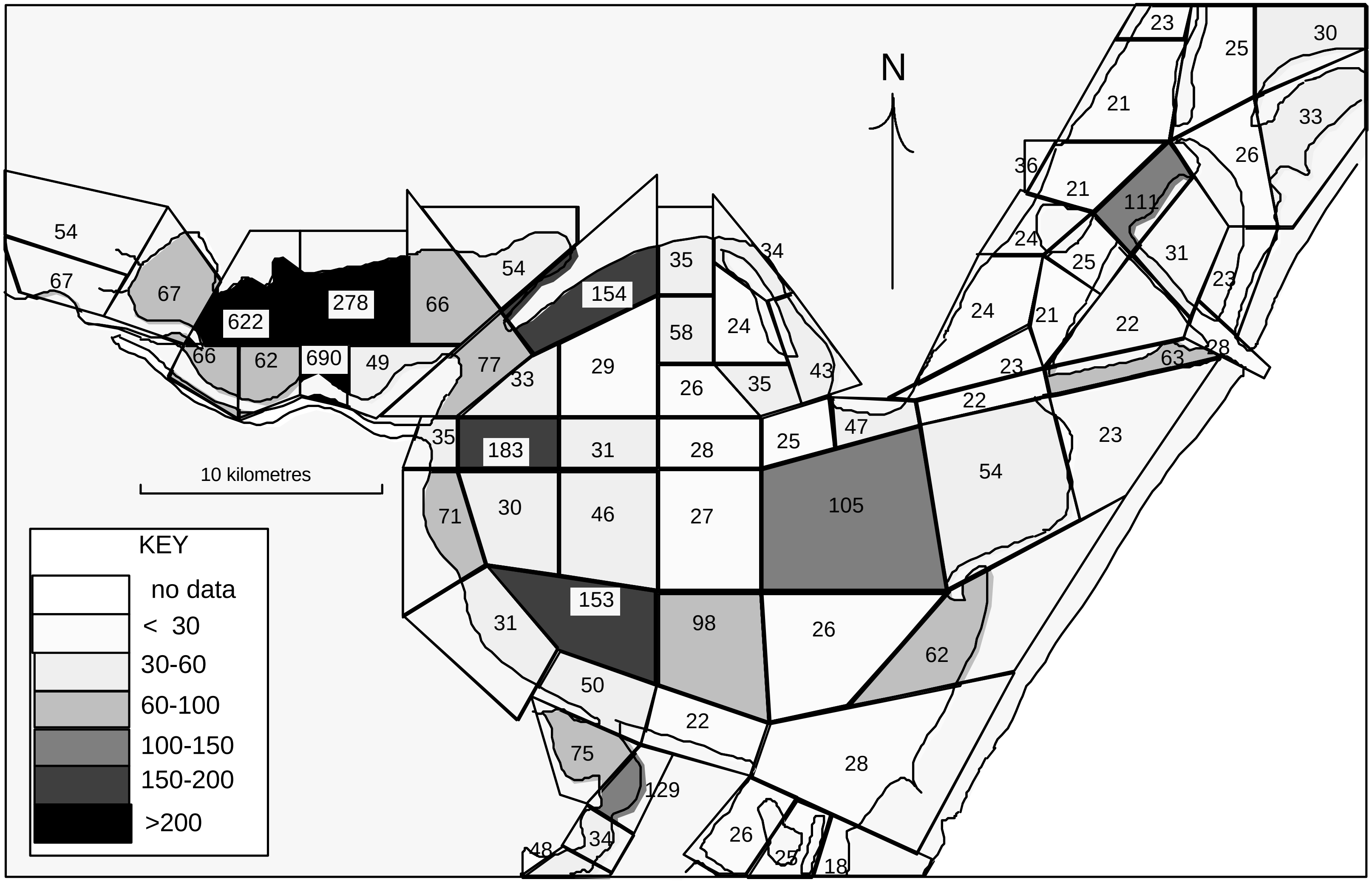

Figure 3-25. Period-of-record means of WQXTSS for Corpus Christi system

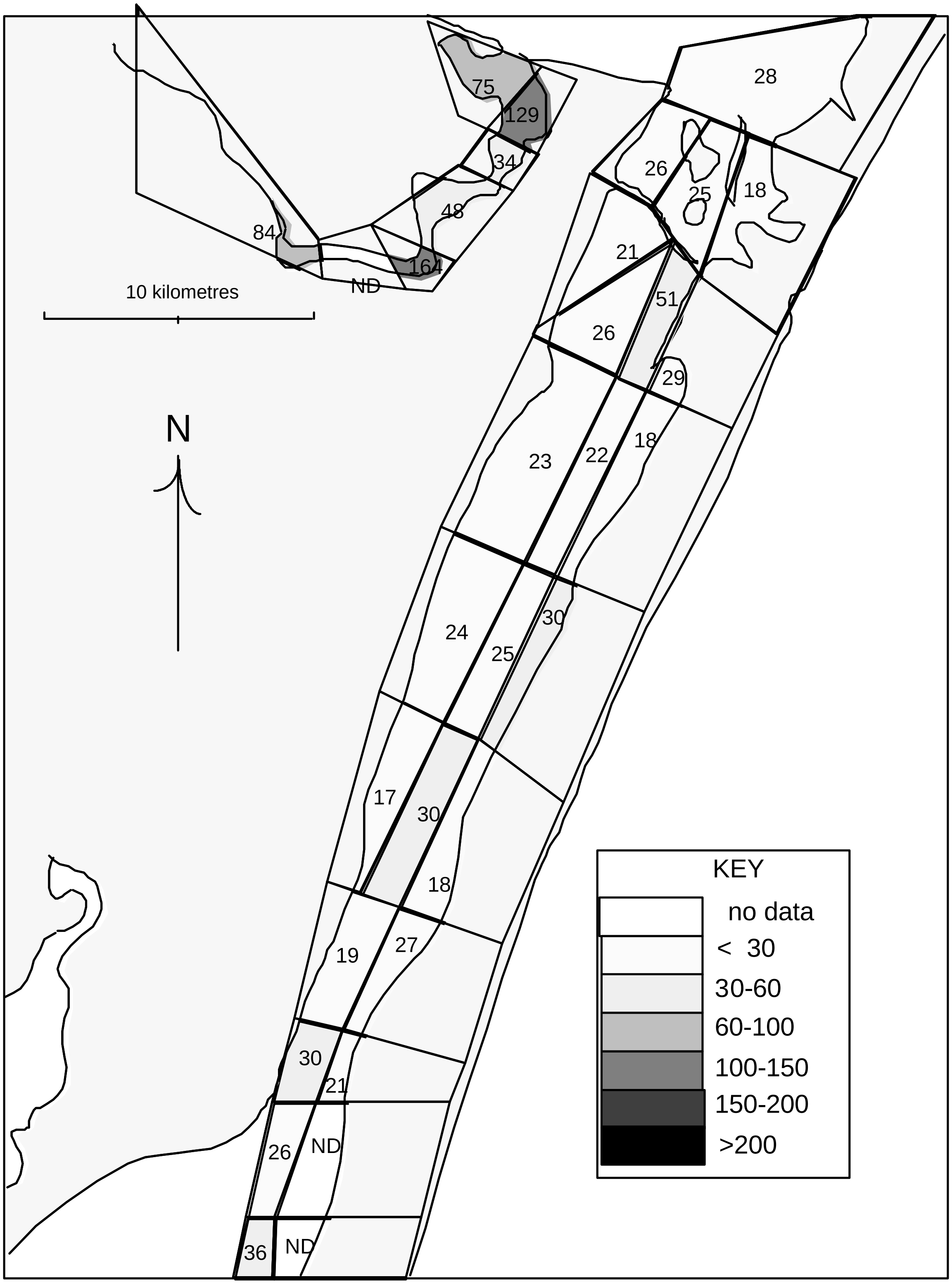

Figure 3-26. Period-of-record means of WQXTSS for Upper Laguna Madre and Oso Bay

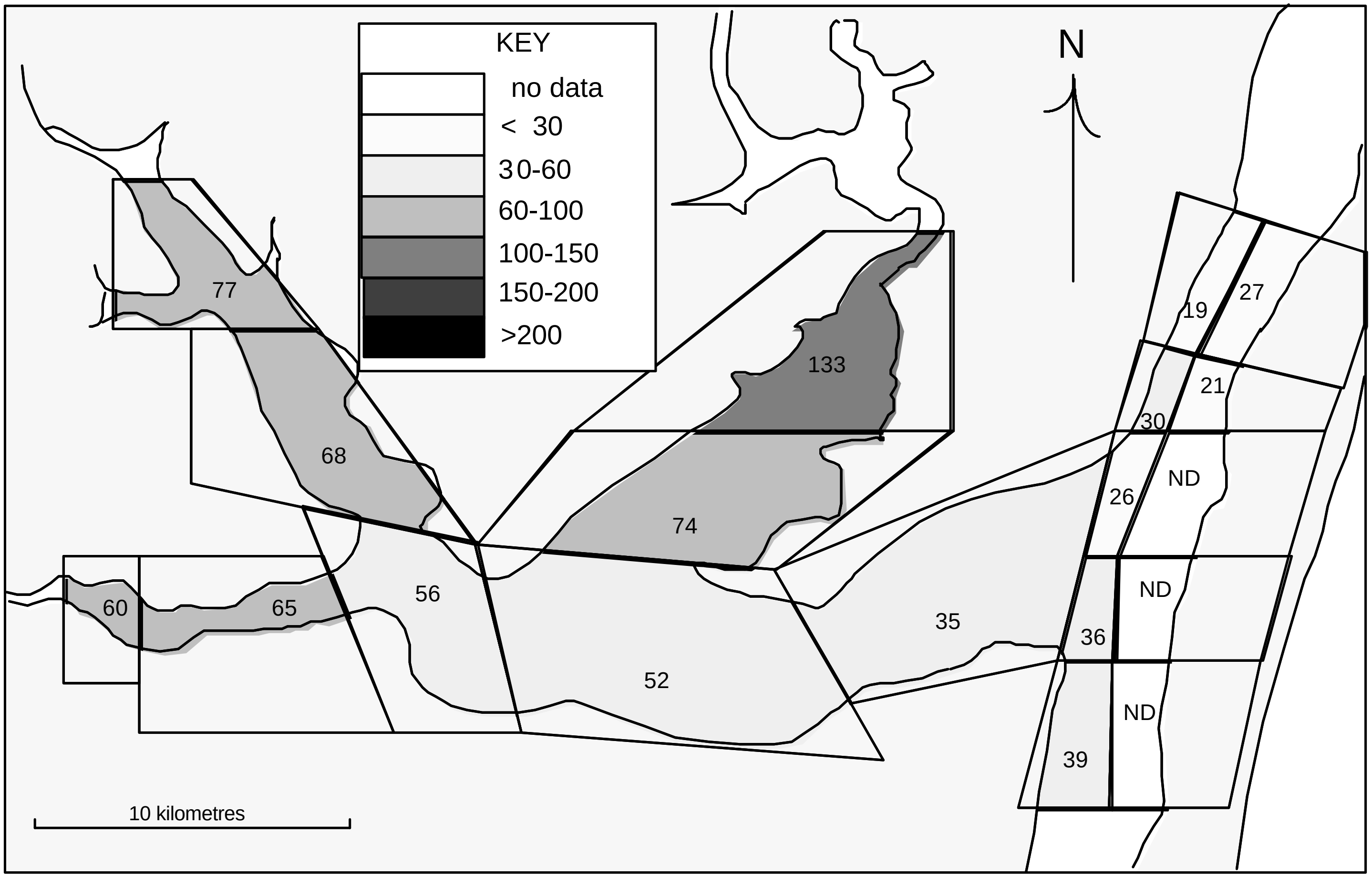

Figure 3-27. Period-of-record means of WQXTSS for Baffin Bay region

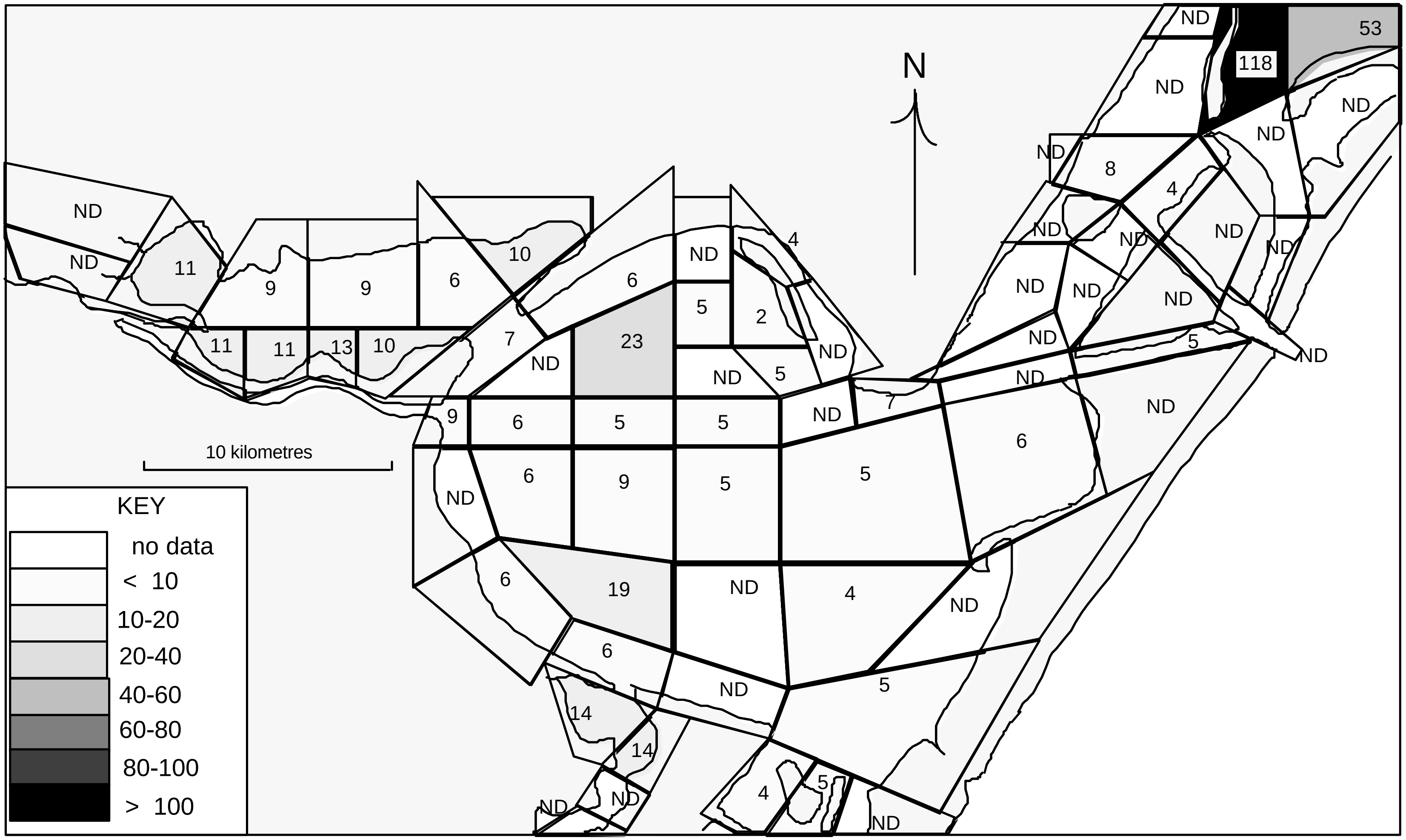

Figure 3-28. Period-of-record means of WQCHLA for Corpus Christi system

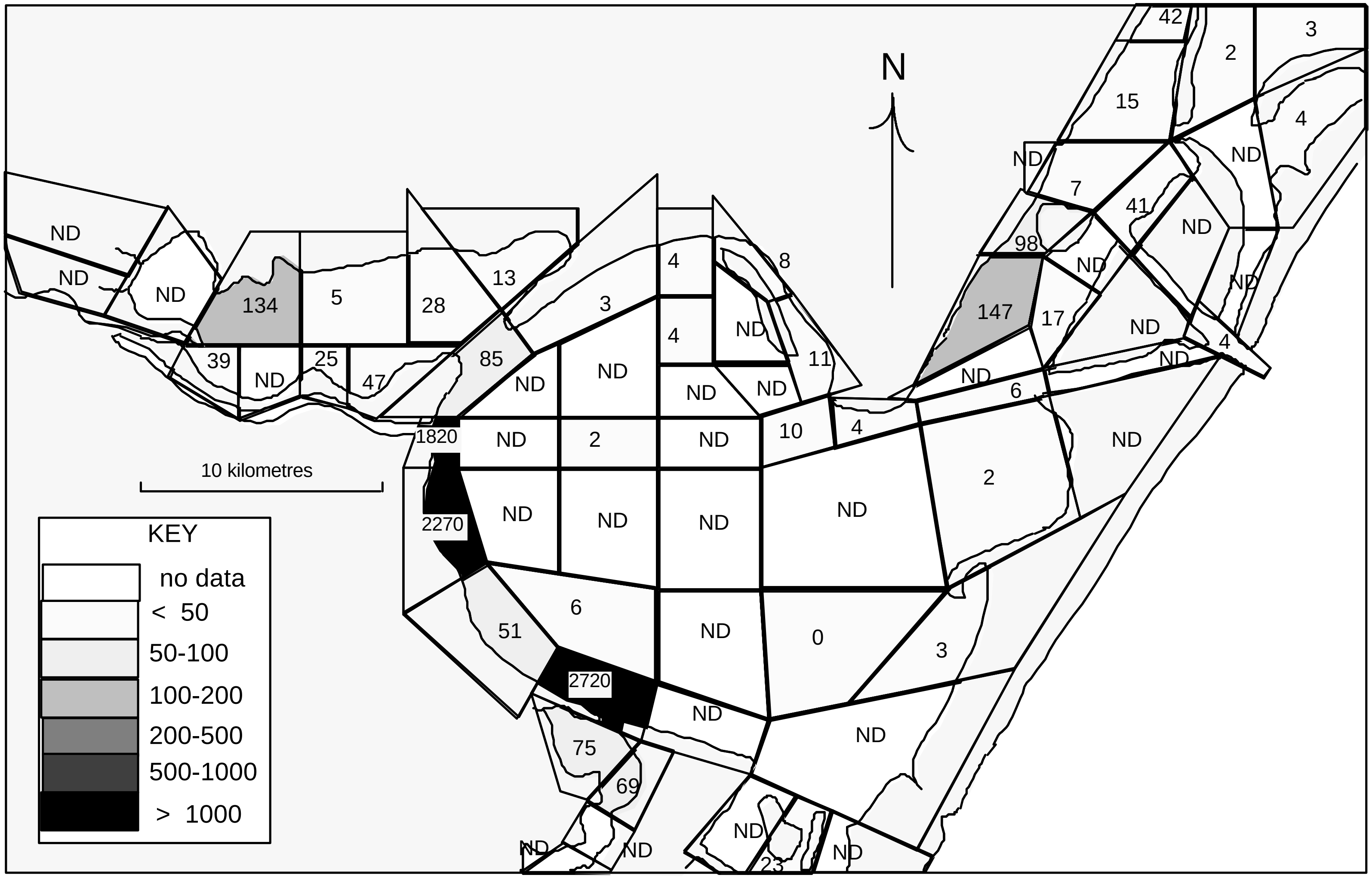

Figure 3-29. Period-of-record means of WQFCOLI for Corpus Christi system

Figure 3-30. Period-of-record means of SEDTOC for Aransas-Copano system

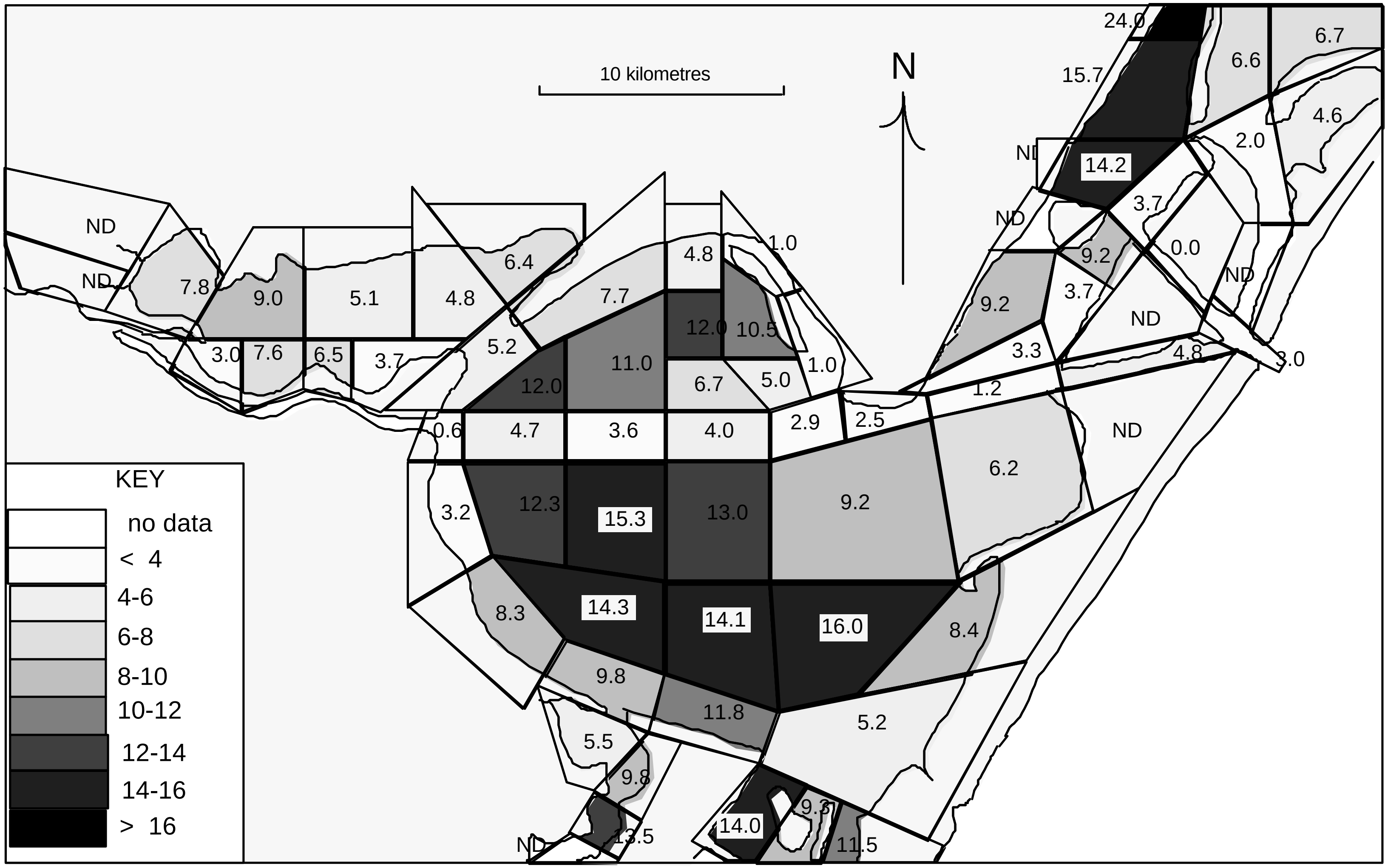

Figure 3-31. Period-of-record means of SEDTOC for Corpus Christi system

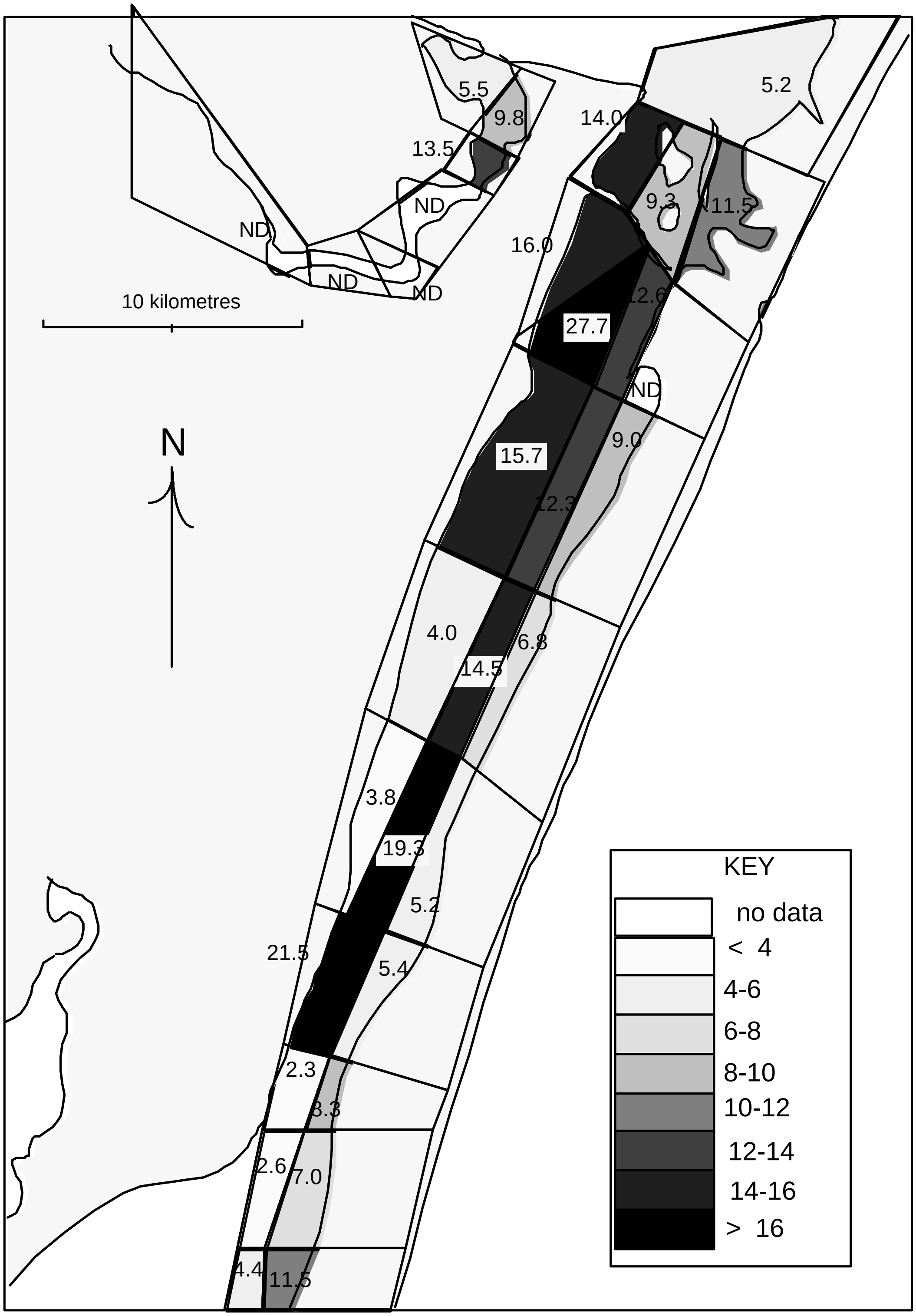

Figure 3-32. Period-of-record means of SEDTOC for Upper Laguna Madre and Oso Bay

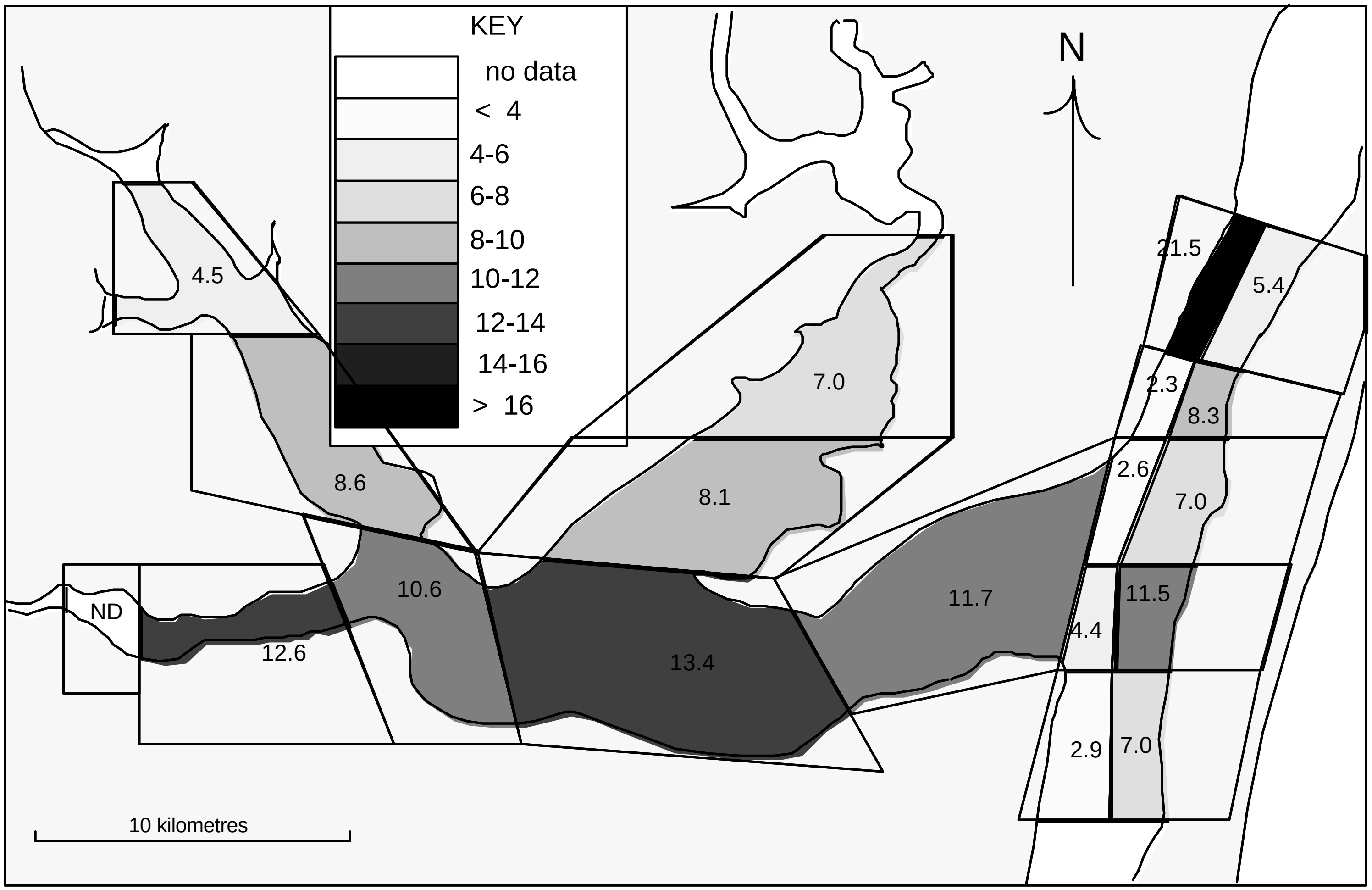

Figure 3-33. Period-of-record means of SEDTOC for Baffin Bay region

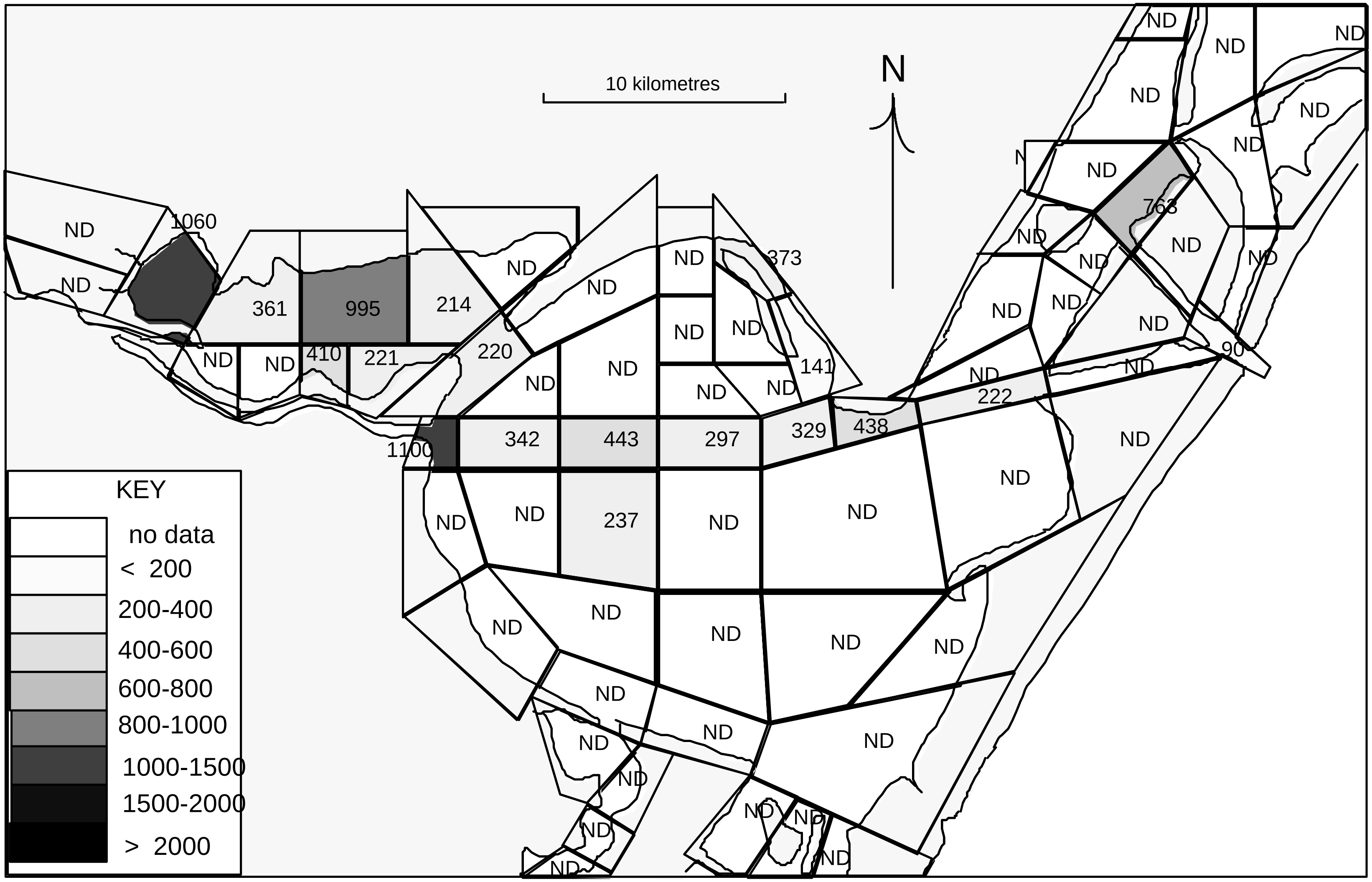

Figure 3-34. Period-of-record means of SEDO&G for Corpus Christi system

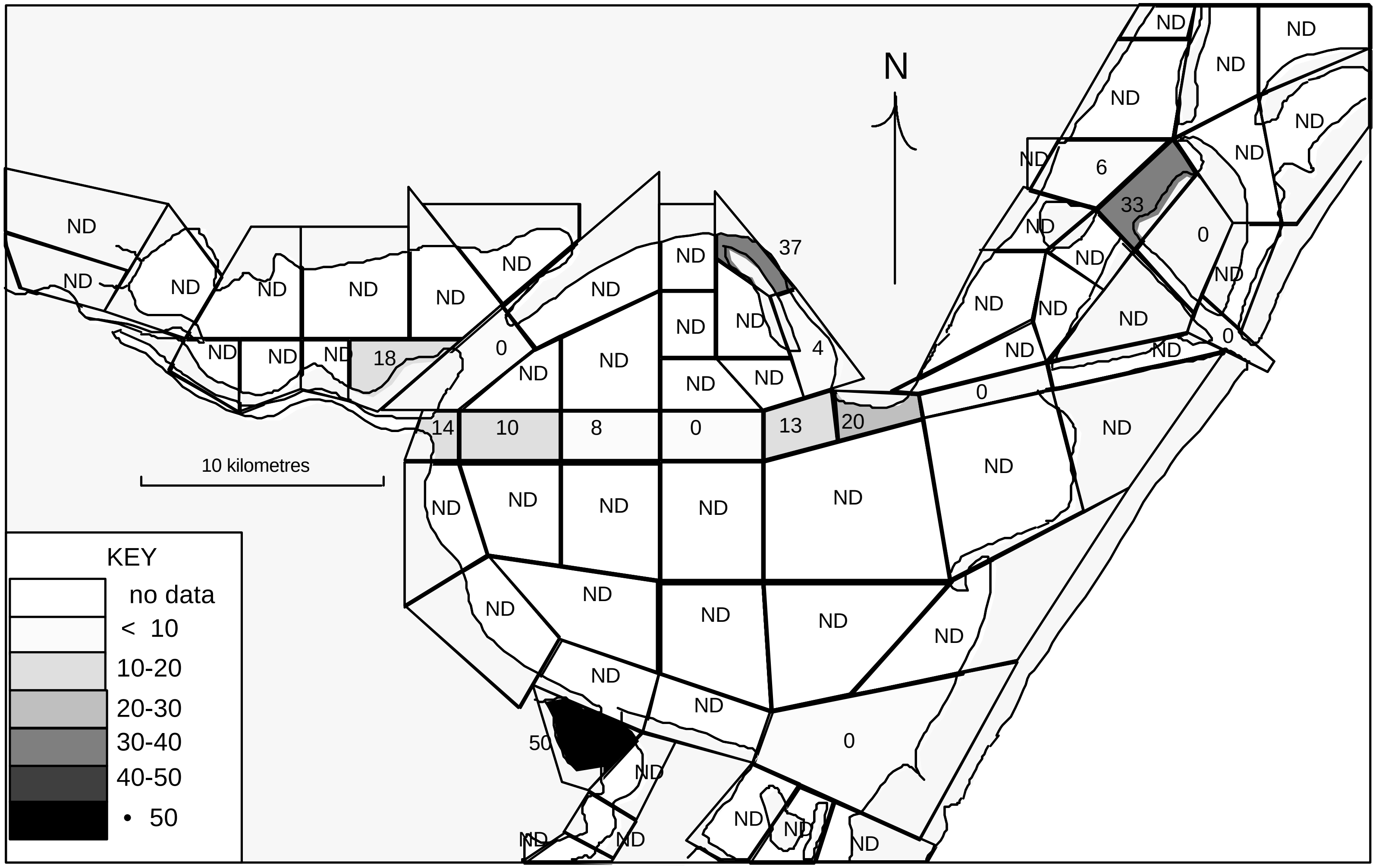

Figure 3-35. Period-of-record means of WQMETCUT for Corpus Christi system

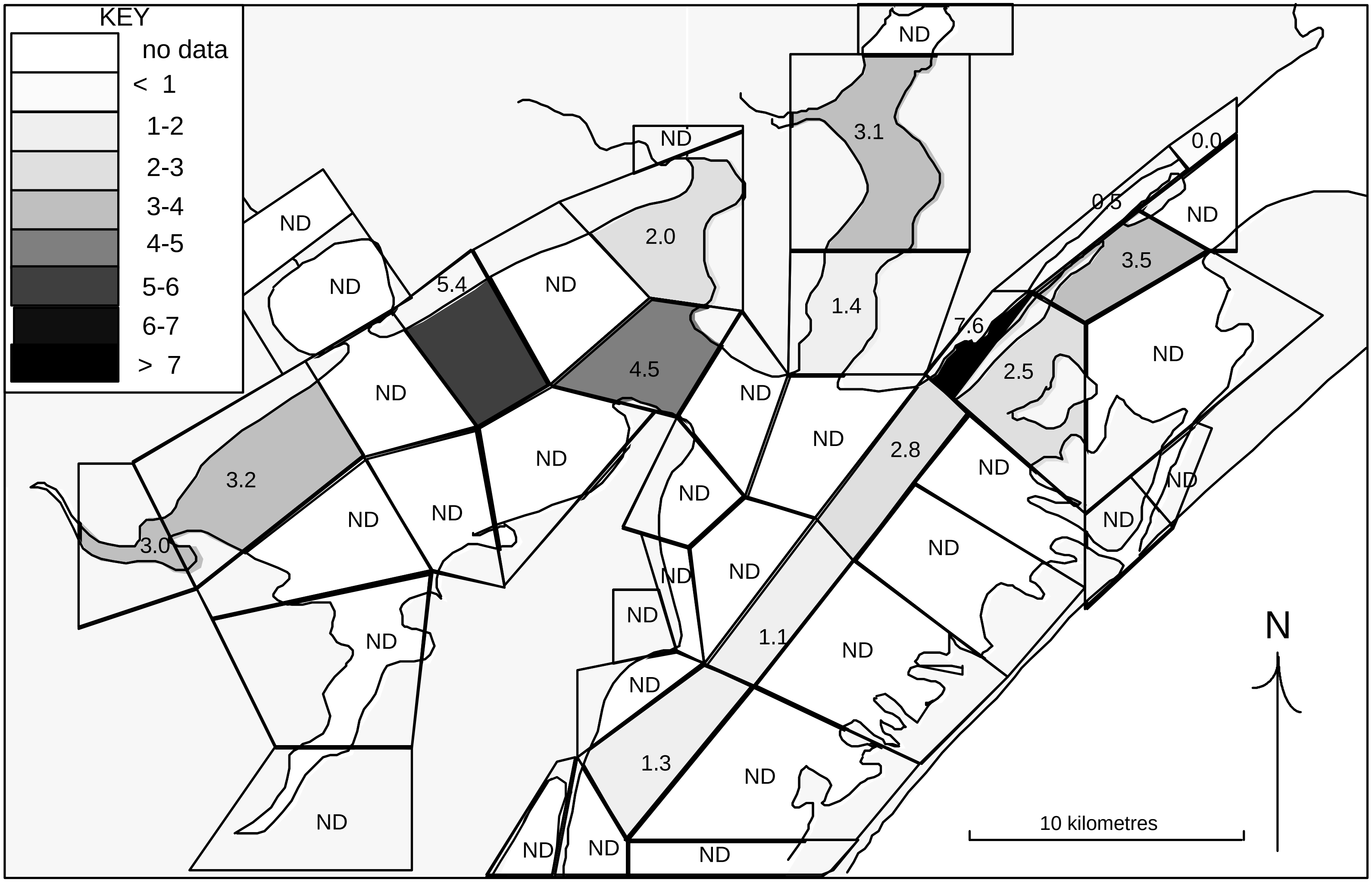

Figure 3-36. Period-of-record means of SEDMETAS for Aransas-Copano system

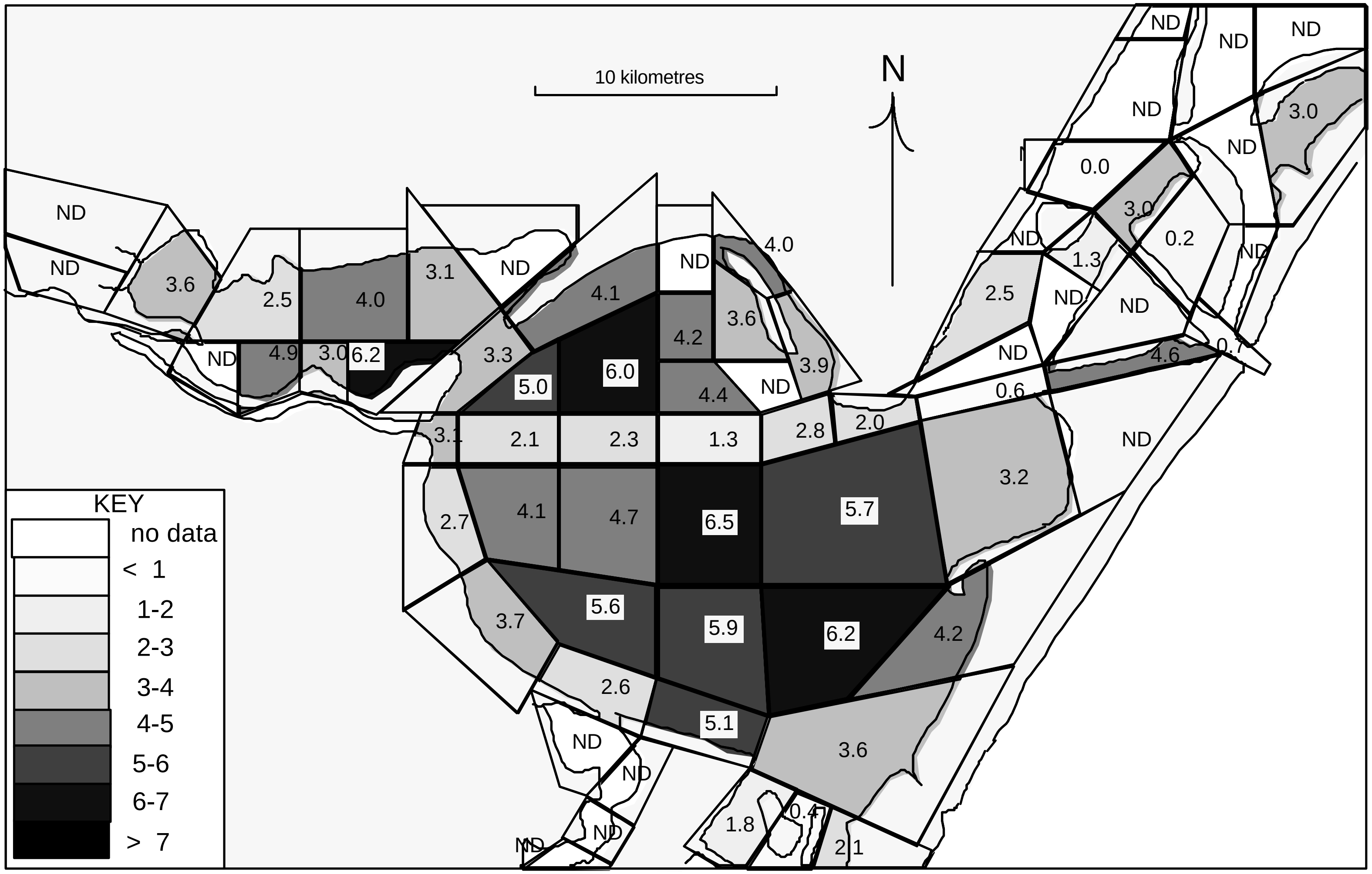

Figure 3-37. Period-of-record means of SEDMETAS for Corpus Christi system

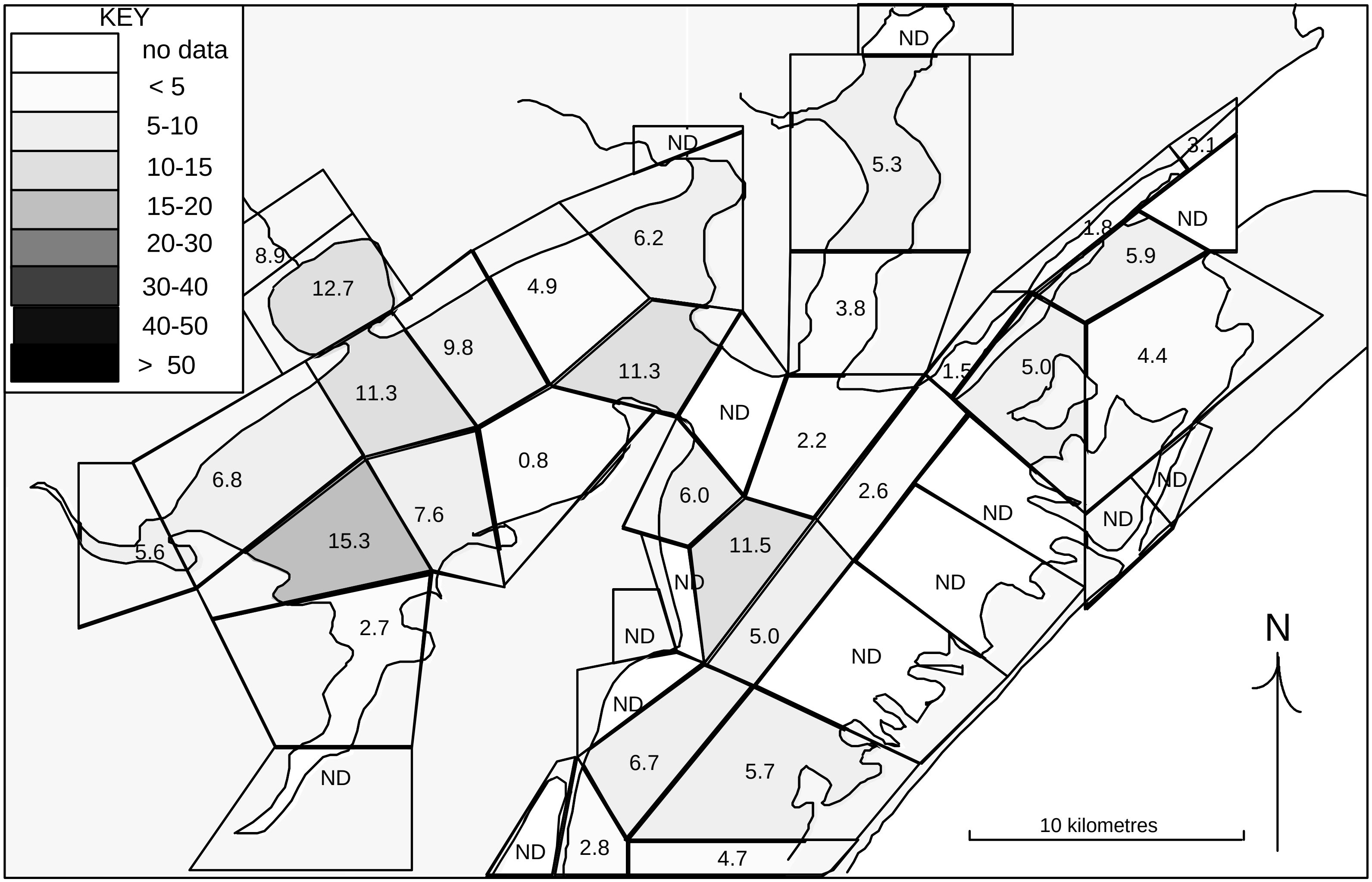

Figure 3-38. Period-of-record means of SEDMETCU for Aransas-Copano system

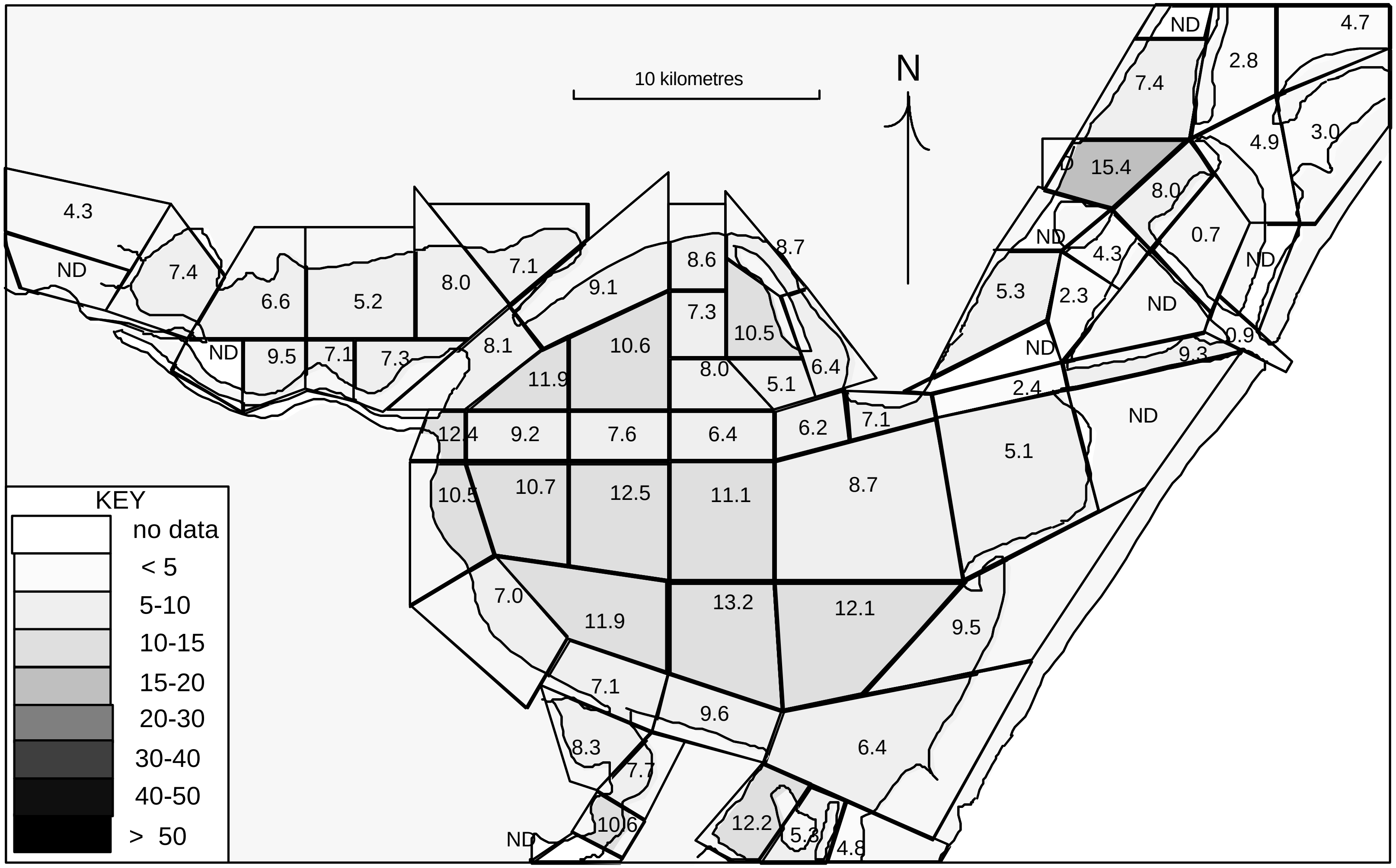

Figure 3-39. Period-of-record means of SEDMETCU for Corpus Christi system

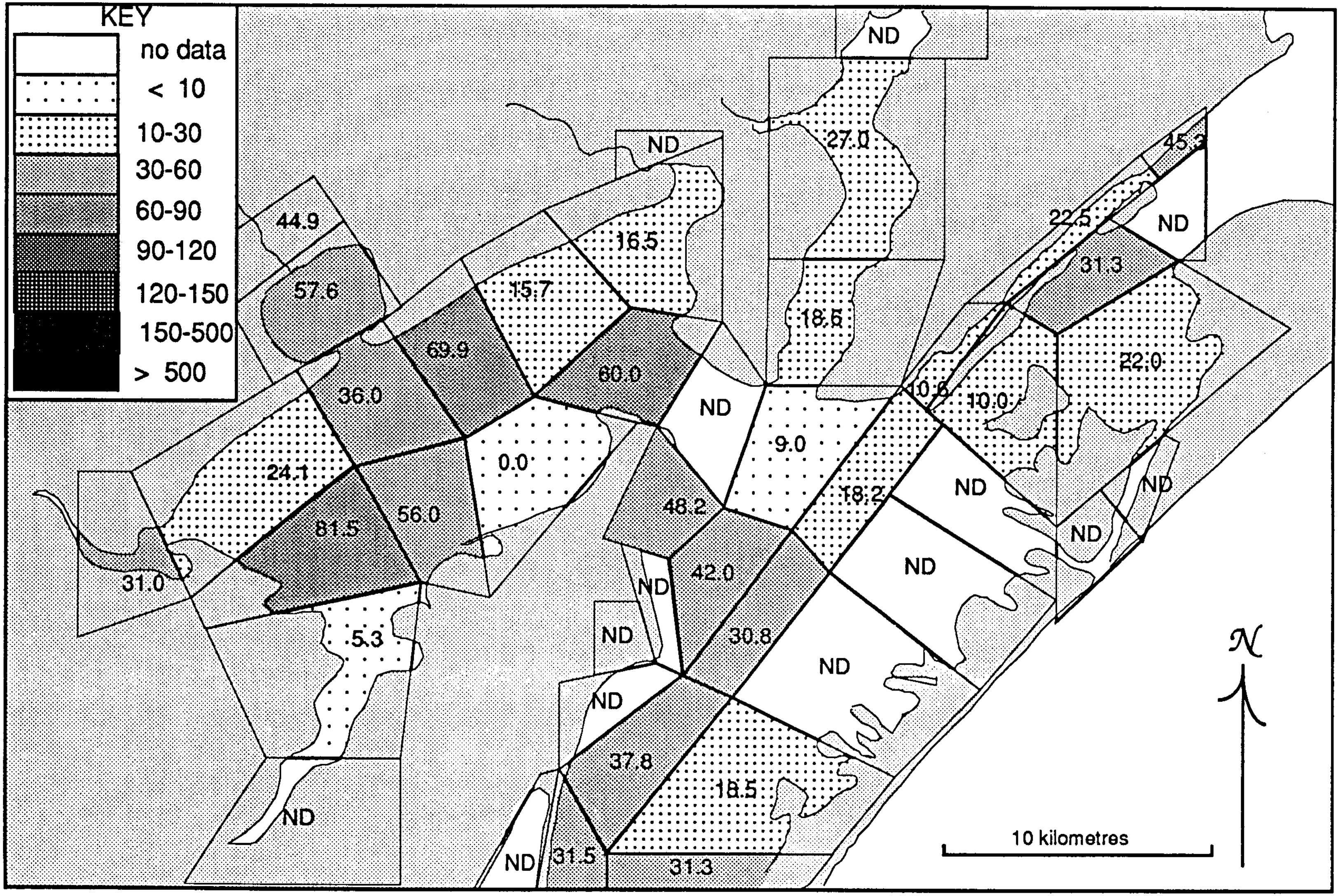

Figure 3-40. Period-of-record means of SEDMETZN for Aransas-Copano system

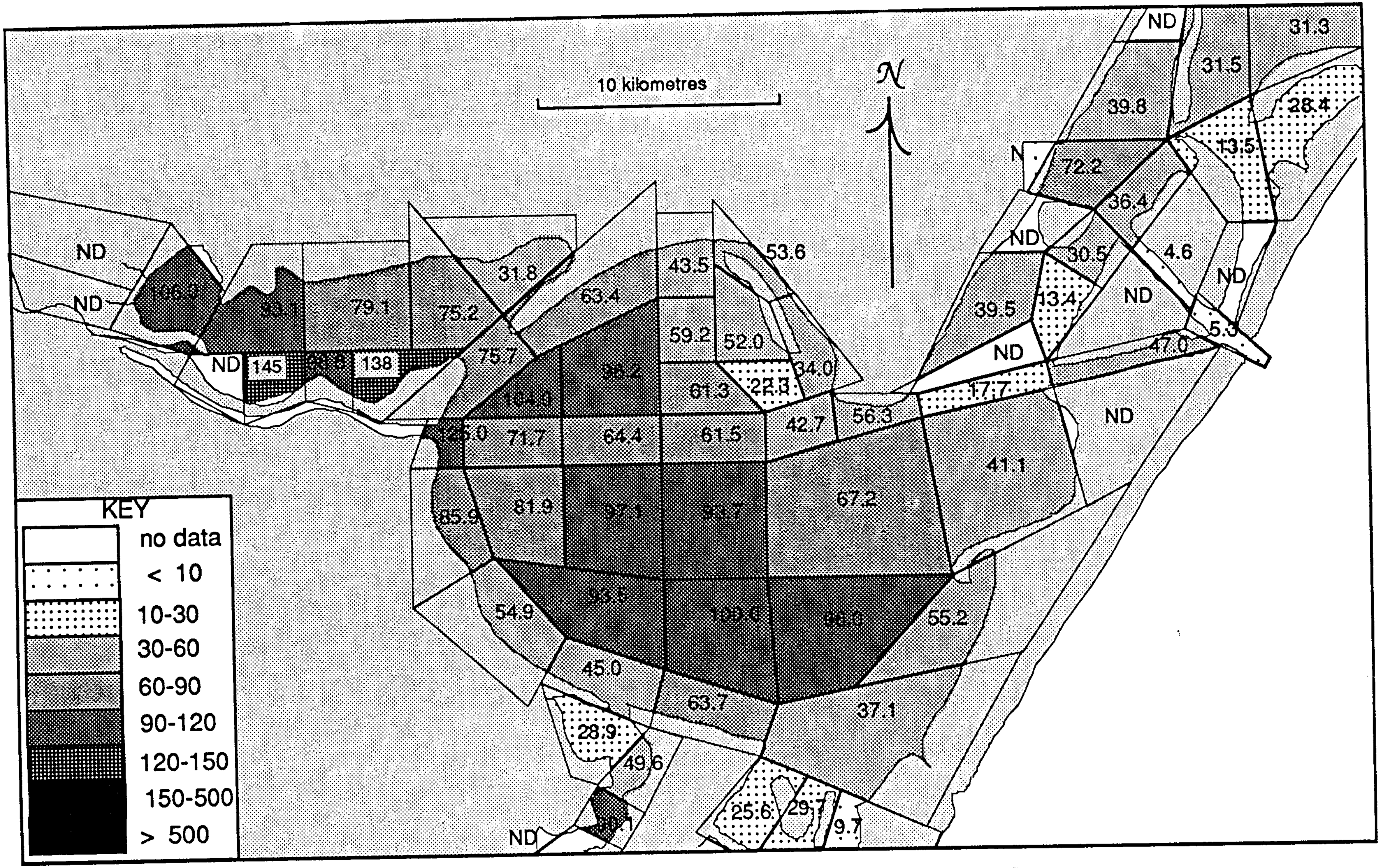

Figure 3-41. Period-of-record means of SEDMETZN for Corpus Christi system

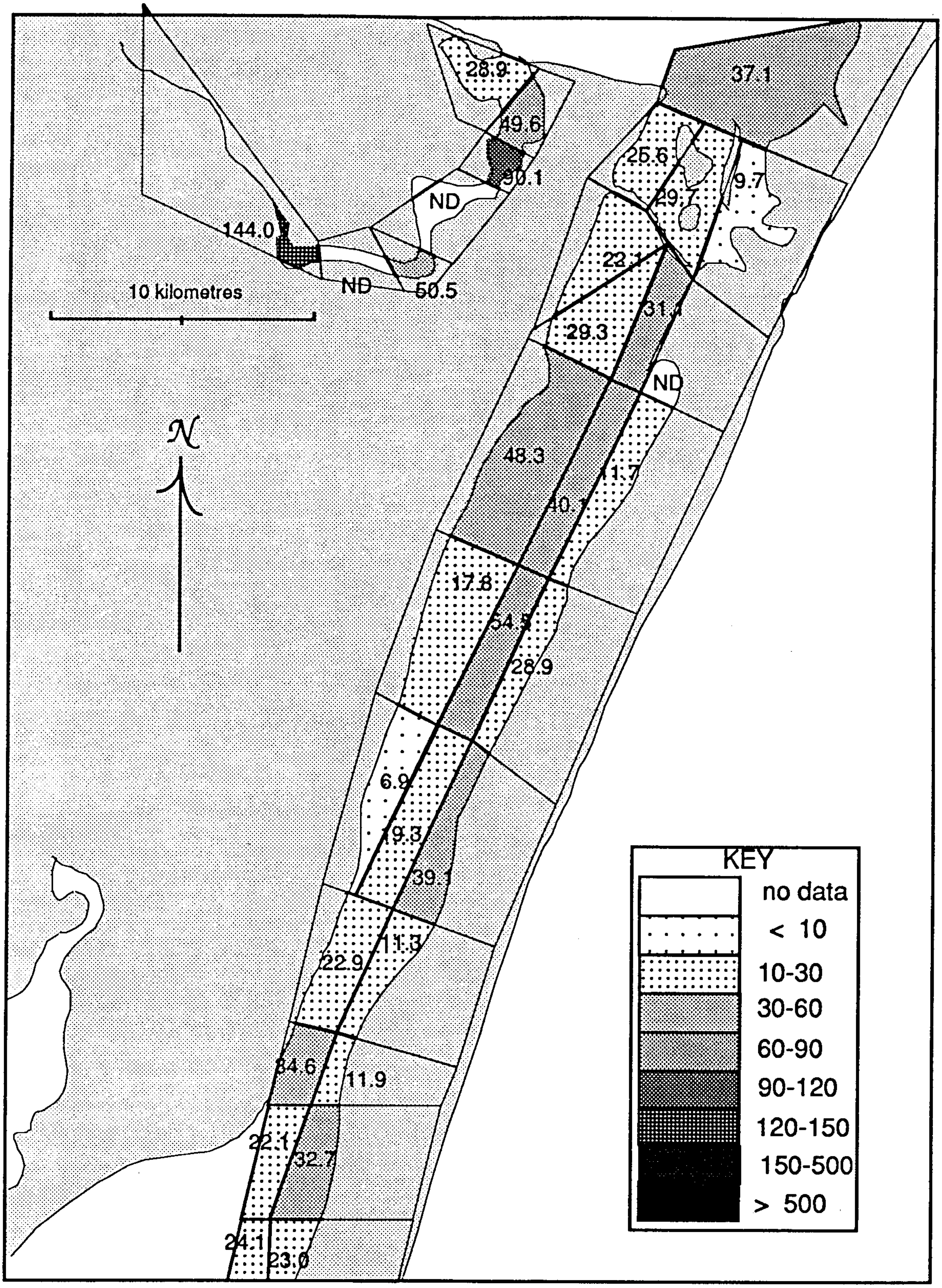

Figure 3-42. Period-of-record means of SEDMETZN for Upper Laguna Madre and Oso Bay

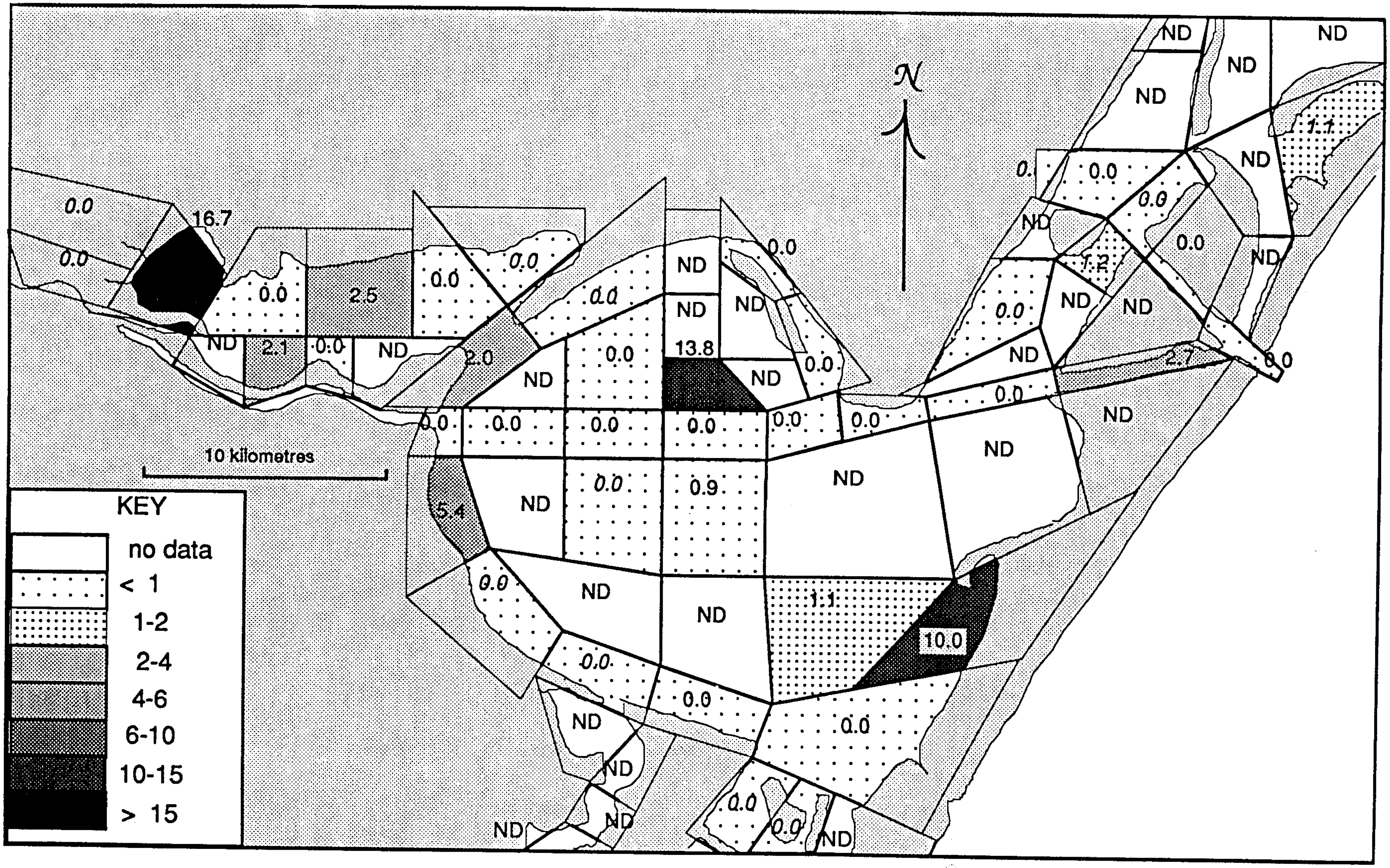

Figure 3-43. Period-of-record means of SED-NAPT for Corpus Christi system

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