STATE/FEDERAL NATURAL RESOURCE DAMAGE ASSESSMENT

PRELIMINARY STATUS REPORT

Project Title: INJURY TO PINK SALMON EGG AND PREEMERGENT FRY IN THE KODIAK AND CHIGNIK MANAGEMENT AREAS

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EXECUTIVE SUMMARY

In 1989, as a consequence of the Exxon Valdez oil spill, the Kodiak Management Area (KMA) experienced pink salmon escapements which were 4.3 times the desired escapement goal. For KMA preemergent index streams 33 of 44 streams had escapements which were in excess of desired escapement requirements. Within the Chignik Management Area (CMA) pink salmon escapement in 1989, was 2.1 times the desired goal.

Using Kodiak and Chignik Management Area pink salmon index stream preemergent fry data collected in 1990, and from a historic database (spanning 20 years) a model that examines fry survival was developed to identify index streams possibly impacted by the escapements observed in 1989 due to the oil spill. Of 25 Kodiak streams analyzed to date, 18 had significantly depressed egg to fry survival in 1990, and a significant negative impact on fry density was demonstrated for 7 of these 18. Of the remaining index streams approximately 15 Kodiak and 12 Chignik streams can, and will be subjected to this analysis. A separate statistical comparison of 1990 fry densities in "control" (cumulative 1989 spawner density less than the optimum 1.3 fish/M^2) index streams versus "treatment" streams (cumulative spawner density greater than 1.3 fish/M^2) did not provide evidence that control streams had significantly greater fry density than treatment streams.

A majority (18 of 25) of the streams analyzed using the egg to fry survival model have spawner densities above the optimum based upon escapement goals. With the data evaluated thus far, an attempt to predict what form final impact analyses will take, and whether observed impact at the freshwater stage will manifest itself in depressed levels of returning adults in 1991, cannot be stated at this time.

Of the 25 Kodiak preemergent streams analyzed to date, 19 had 1990 live fry density values well above the mean for odd brood year pink salmon.

Until all index streams and further comprehensive modeling inclusive of 1989 observed spawner density, historic escapements by stream, and population estimates of fry and adults are conducted, the results indicate that negative impact has occurred within a select group of streams. Fry densities from 1990 (1989 brood year) when viewed on a management area wide scale are the largest on record, however due to the inordinately large escapements this would be expected, as more spawning area was utilized and therefore more fry were found. This should not be construed as meaning that egg to preemergent fry survival was greater than average. The results presented above indicate survival was in fact lower than average for at least 7 of the streams examined.

OBJECTIVES

A. Estimate potential egg deposition for all Kodiak and Chignik preemergent index streams.

   1. Estimate average number of fry/M^2 for Kodiak and Chignik index streams in 1990.

B. Determine survival of pink salmon eggs from potential egg deposition to preemergent fry in 1990.

C. Assess changes in production, if any, of pink salmon preemergent fry due to the oil spill.

INTRODUCTION

During the 1989 commercial salmon season numerous harvest opportunities were forgone within the KMA and CMA due to the Exxon Valdez oil spill. A major repercussion from this event were pink salmon escapements in excess of desired escapement goals and observed spawner densities in excess of optimums (see Fish/Shellfish study 7b preliminary status report 1990). In the spring of 1990 preemergent fry sampling was conducted on KMA and CMA streams with a historic database of preemergent fry digs to determine if fry survival was negatively impacted by the 1989 escapements.

There are 451 anadromous salmon streams within the KMA of which 44 are preemergent index streams (Figure 1). Within the CMA there are 107 anadromous salmon streams of which 18 are preemergent fry index streams (Figure 2). Damage caused by excessive escapements can be evaluated by: 1) Egg deposition to Preemergent fry survival by stream; 2) Examination of observed versus predicted numbers of fry/M^2 produced from total observed progeny/M^2; 3) Evaluation of numbers of live fry/M^2 for streams with optimum spawner density versus streams with spawner densities above optimum. These analyses constitute evaluation of impact at the second life history stage(egg deposition to preemergent fry) and incorporate findings from Fish/Shellfish study 7b.

METHODS

Potential Egg Deposition

Potential egg deposition (PED) for each of the 62 Kodiak and Chignik Management Area streams will be determined using total escapement data for each stream extracted from Barrett et. al. (1990) and pink salmon fecundity data collected in 1989. The PED estimates will be calculated using an assumed 1:1 male to female

ratio, and a simple linear regression equation of fish length and number of eggs carried.

Preemergent fry Sampling

Preemergent fry samples were collected from 43 Kodiak and 16 Chignik index streams initiating in late February and ending in mid March, 1990. Fry digs were completed using a .186 M^2 collection frame and hydraulic pump. Depth of stream bed sampled was 15.2-45.7cm for a duration of 1-3 minutes. All pink salmon eggs and fry both live and dead were enumerated. Ten individual digs in an X configuration were completed per sampling site with number of sites per stream dependant upon historic sampling levels (based upon stream size and productivity). Ancillary information recorded include stream temperature, predator presence, stage of fry development, quantities of egg fragments and evidence of stream bed scouring.

Fry Survival

Egg to fry survival as it was initially intended (Fish/Shellfish detailed study plan 8b) is relating PED (calculated from total escapement and fecundity data from 1989) to total live preemergent fry produced (incorporating preemergent index site habitat estimates and fry dig data). This study component is still being pursued in its original form and will be completed in the future.

Presently, an index of fry survival (total progeny, live and dead fry and eggs/m^2 versus live fry/M^2) has been developed to investigate negative impact for each preemergent index stream (including both odd and even year fry dig data). Fry survival indices were developed using historic fry dig data and a least squares simple linear regression model. A specific model was derived for each stream excluding the 1990 data and a predicted 1990 live fry value determined from the model. Also 90% and 95% (1 tailed) critical values were determined for the predicted live fry/M^2 value for comparison. Additionally, a mean live fry/M^2 and 90% critical value were derived using odd brood year data only. In addressing impact at this life history stage, several categorical strata were developed in order to structure analyses and define impact. The strata are: 1) Is the 1990 observed live fry/M^2 value less than the model predicted value and also less than the 90% critical value (1 tailed); 2) Is the observed 1990 fry/M^2 value less than the mean (odd brood year) live fry/M^2 value; 3) Is the observed 1990 fry/M^2 value less than the 90% critical value of the historic mean.

RESULTS

As previously mentioned, a preemergent fry survival index was investigated to evaluate the second stage of pink salmon life history for impact induced by excessive escapements experienced in

1989. Using the categories defined previously, if the observed fry/M^2 value from 1989 was less than the predicted value and 90% critical value, this was termed depressed fry survival. Of the 25 KMA streams analysed thus far, 18 have shown depressed fry survival (Table 1). All of these streams have spawner densities, as observed in 1989, greater than optimum. Impact was defined as streams which had observed fry densities below both the odd year historic mean and below the 90% critical value of the mean. Impact as defined above, was found in 7 of these 18 streams, all of which had spawner densities in excess of the defined optimum spawner density of 1.3 fish/m^2 (Fish/Shellfish detailed study plan 7b 1990). Evidence that the observed impact was caused by the Exxon Valdez oil spill can be substantiated by review of Table 4 (Fish/Shellfish preliminary status report 7b 1990) and by total escapements by stream presented in Barrett et. al. (1990).

Approximately 15 and 12 additional KMA and CMA preemergent index streams respectively, are presently being submitted to the above analyses and this should reveal further streams which show signs of impact based, upon their observed 1989 spawner densities.

The control versus treatment analysis was conducted on all streams with 1990 preemergent fry data. Kodiak and Chignik streams were combined due to sample size considerations. Using the nonparametric ann-Whitney test with a significance level of 0.1 and data represented in Table 2, results confirm that using this approach, fry/M^2 values for control streams were not significantly different then treatment streams using a 1 tailed test.

STATUS OF STUDY

Addressing the stated objectives, at this date average number of fry/M^2 estimates have been derived for each of the Kodiak and Chignik preemergent index streams. Estimates of potential egg deposition and assessing changes in production will be completed by June 1991.

Analyses using the total progeny versus live fry/M^2 provides the most promising analytical approach for objectively assessing impact caused by observed 1989 escapements. A multiple regression model employing an additional variable (proportion of fry digs yielding progeny) is also being evaluated for usefulness in identifying impacted streams. The next stage after identifying impacted index streams will be to develop models and analyses which will allow for quantifying what the impact to the 1989 brood year return will be in numbers of adults and possibly to subsequent brood year returns.

LITERATURE CITED

Barrett, B.M., Swanton, C.O. and Roche, P.J. 1990. An estimate of the 1989 Kodiak Management Area salmon catch and escapement numbers had there been a normal fishery without the Exxon Valdez oil spill. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report, No. 4K90-

Table 1. Survival index and associated statistics from Kodiak Management Area preemergent fry index streams collected in 1990 along with data from historic database.

District / Stream Name	Stream Number	1989 Spawner Density (#/M^2)	Regression Output (TP/M^2 vs. LF/M^2)[a] N	Coef.[b]	r^2	MSE	Live Fry per M^2 1990 Pred.	90%[c] C.V.	95% C.V.	1990 Obser.	Average (Odd yrs.)	90%[d] C.V.
Afognak District												
Paramanof	251-404	0.485	20	0.441	0.77	2125.1	220.9	153.9	133.9	278.3	21.2	
Waterfl.	251-822	10.21	8	0.482	0.86	48949.8	510.7	176.7	93.5	70.1	484.2	277.98
B.Danger	252-332	-----	18	0.847	0.79	2378.8	244.4	174.8	153.8	292.3	89.8	
Seal Bay	251-801	9.828	13	0.847	0.85	5242.8	701.3	582.7	550.5	459.2	315	
Peranosa	251-830	3.274	20	0.577	0.64	9898.9	285.1	200.8	176.4	72.2	218.7	189.23
Northwest District												
Sheratin	259-371	1.77	18	0.445	0.8	4378.3	181.2	88.3	40.3	39.8	38.3	
Terror	253-331	5.97	20	0.21	0.26	528.6	82	28.2	17.97	0.75	11.4	6.39
Uganik	253-122	16.96	20	0.452	0.71	2854.4	132.6	58.5	38.1	9.42	67.3	40.82
Baumans	253-332	7.91	20	0.805	0.91	5112.3	698.8	584.9	543.2	240.7	313.4	224.71
Uyak-202	254-202	6.59	20	0.813	0.98	544.7	940.6	888.6	886	1070	257.6	
Uyak-203	254-203	----	10	0.985	0.89	5	252.7	249.8	248.8	238.02	207.6	
Zachar	254-301	0.89	20	0.58	0.56	483.4	103.5	71.1	61.4	12.08	10.2	
Alitak District												
Narrows	257-401	0.09	18	0.71	0.66	1525.9	258.4	200.8	183	264.7	91.7	
Deadman	257-502	9.81	20	0.9	0.87	1752.1	666.2	607.4	589.7	548.9	432.6	
Dog Sal.	257-403	2.29	20	0.833	0.99	413.7	241.6	214.3	206	269.5	104.7	
Humpy	257-701	10.38	20	0.758	0.86	5513	740.3	631.6	595.7	464.7	220.6	
Eastside District												
Kiliuda	258-207	3.07	20	0.844	0.95	317	80.7	56.7	49.4	77	34.6	
Barling	258-522	1.96	20	0.481	0.77	1380.9	132.4	81.7	66.3	51.6	99.5	60.86
Kiugnak	258-542	15.12	20	0.71	0.91	8252.7	800.9	683.1	647.6	736.6	241.3	
Seven R.	258-701	60.68	20	0.57	0.81	14878.2	589.9	418.4	366.8	383.5	284.7	
Northeast District												
American	259-231	----	20	0.854	0.88	457.1	324.8	294.6	285.4	286.9	143.4	
Buskin	259-211	5.69	20	0.539	0.87	12228.5	279.7	130.3	85.2	89.7	143.9	98.0
Hurst	259-414	4.38	20	0.76	0.76	308.8	273.3	232.5	219.3	102.8	49	
Saltery	259-415	3.99	20	0.348	0.34	1547.3	382.8	308.3	285.9	521.5	84	
Sid Olds	259-242	----	20	0.721	0.72	476.8	103.7	74.3	66.4	116.4	83	

[a] TP represents total progeny (live and dead fry, live and dead eggs); LF depicts live fry.
[b] Coef. is the X coefficient within the simple linear regression equation. Note that the regression line was forced through the origin, thus no Y coefficient.
[c] Note that the 90% and 95% values represent the lower bounds of a one tailed test.
[d] 90% lower bound critical value of mean fry density using odd year brood line data.

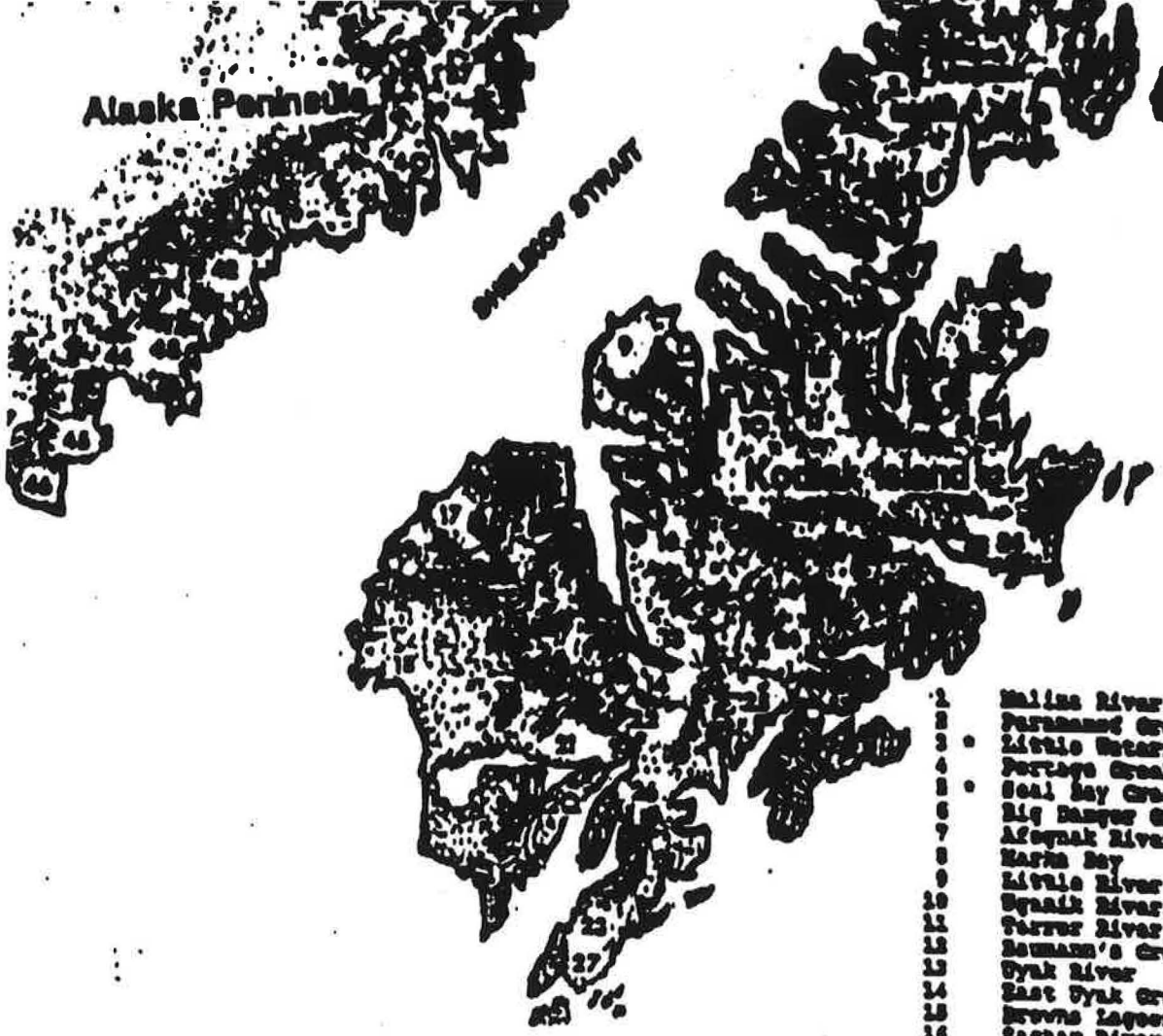
Table 2. Spawner densities from the 1989 escapement event, 1990 live preemergent fry and ranks used for the Mann-Whitney nonparametric test of of Control (cummulative spawner denstiy less than 1.3 fish/M^2) versus treatment (cummulative spawner density greater than 1.3 fish/M^2) streams inclusive of Kodiak and Chignik index streams with fry data collected in 1990.

Stream Name	Stream Number	1989 Spawner Density	Live Fry (Fry/M^2)	Rank
Portage	273-842	0.063	64.216	22
Spoon	273-823	0.072	0	2.5
Narrows	257-401	0.097	264.764	40
Karluk	255-101	0.132	0.077	5
Ivan	273-722	0.17	13.678	17
Kukak	262-271	0.179	6.731	13
North Fk.	272-514	0.197	0	2.5
Amber	272-702	0.265	0	2.5
Hook	272-302	0.294	0	2.5
Marka	252-343	0.354	10.321	15
Humpback	275-502	0.462	65.59	23
Paramanof	251-404	0.485	278.271	41
Foot Bay	272-802	0.598	227.787	38
Ivanof	275-406	0.656	200.646	36
Agripina	272-962	0.714	279.663	42
Zachar	254-301	0.889	12.062	16
Chig-905	272-905	1.64	180.847	34
Chig-904	272-904	1.66	0.18	6
Sheratin	259-371	1.77	39.849	20
Dakavak	262-551	1.9	0.359	7
Barling	258-522	1.96	51.696	21
Dog Sal.	257-403	2.29	179.86	33
Kashvik	262-604	2.4	0.808	9
Kinak	262-451	2.49	161.659	32
Kiliuda	258-207	3.06	77.006	26
Little R.	253-115	3.09	5.627	12
Peranosa	251-825	3.27	72.294	25
Miam	259-412	3.65	118.56	29
Kumliun	272-501	3.69	2.558	11
Saltery	259-415	3.99	521.486	46
Jute	262-801	4.25	14.54	18
Hurst	259-414	4.38	102.854	28
Buskin	259-211	5.68	89.75	27
Terror	253-331	5.97	0.754	8
Uyak	254-202	6.59	1070.005	50
Missak	262-402	6.76	131.754	30.5

-Continued-

Stream Name	Stream Number	1989 Spawner Density	Live Fry (Fry/M^2)	Rank
Kanatak	262-802	6.88	186.681	35
Baumans	253-332	7.91	240.711	39
Seal	251-901	9.68	869.79	49
Cummulative		1.101		913.5(r1)*
Deadman	257-502	9.81	546.94	47
Waterfl.	251-822	10.21	70.005	24
Humpy	257-701	10.38	464.788	45
Oil	262-751	10.54	225.902	37
Kaiugnak	258-542	15.12	736.78	48
Uganik	253-122	16.96	9.424	14
Big	262-851	26.74	131.754	30.5
Portage	262-702	30.56	2.334	10
Danger	252-332	46.69	292.542	43
Seven R.	258-701	60.88	383.534	44
Alinchak	262-651	163.34	27.284	19
Cummulative		15.656		361.5(r2)*

* r1 and r2 are used for calculating test statistics for the M-W test.



1	Malina River	251-100
2	Permanent Creek	251-404
3 •	Little Waterfall	251-422
4	Portage Creek	251-438
5 •	Seal Bay Creek	251-501
6	Big Danger Creek	251-338
7	Afognak River	251-342
8	Marka Bay	251-343
9	Little River	253-115
10	Spaulk River	253-122
11	Terror River	253-231
12	Neumann's Creek	253-232
13	Dyak River	254-202
14	East Dyak Creek	254-203
15	Browns Lagoon	254-204
16	Saltar River	254-301
17	Karluk River	255-101
18	Red River	256-101
19	Sturgeon River	256-401
20	Barrows Creek	257-401
21	Dog Salmon River	257-403
22	Saltman River	257-602
23	Buggy River	257-701
24	Hillside Creek	258-207
25	Darling Creek	258-602
26	Kujeynak Lagoon	258-642
27	Seven Rivers	258-701
28 •	Monashka	259-101
29 •	Pillar Creek	259-102
30	Buskin River	259-111
31	American River	259-121
32	Olds River	259-142
33	Sharatin River	259-171
34	Miam River	259-412
35	Burnt Creek	259-414
36	Saltary River	259-415
37	Ekak River	262-271
38	Misnak Creek	262-402
39	Minak Creek	262-451
40	Geographic Creek	262-601
41	Dakavak River	262-681
42	Kashvik Creek	262-684
43	Big Alinchak	262-681
44	Portage Creek	262-782
45	Oil Creek	262-781
46	Juta Creek	262-681
47	Kanatak Creek	262-682
48	Big Creek	262-681

*Non-Index Stream

Figure 1 Diagram depicting the Kodiak Management Area presmergent streams and approximate locations.

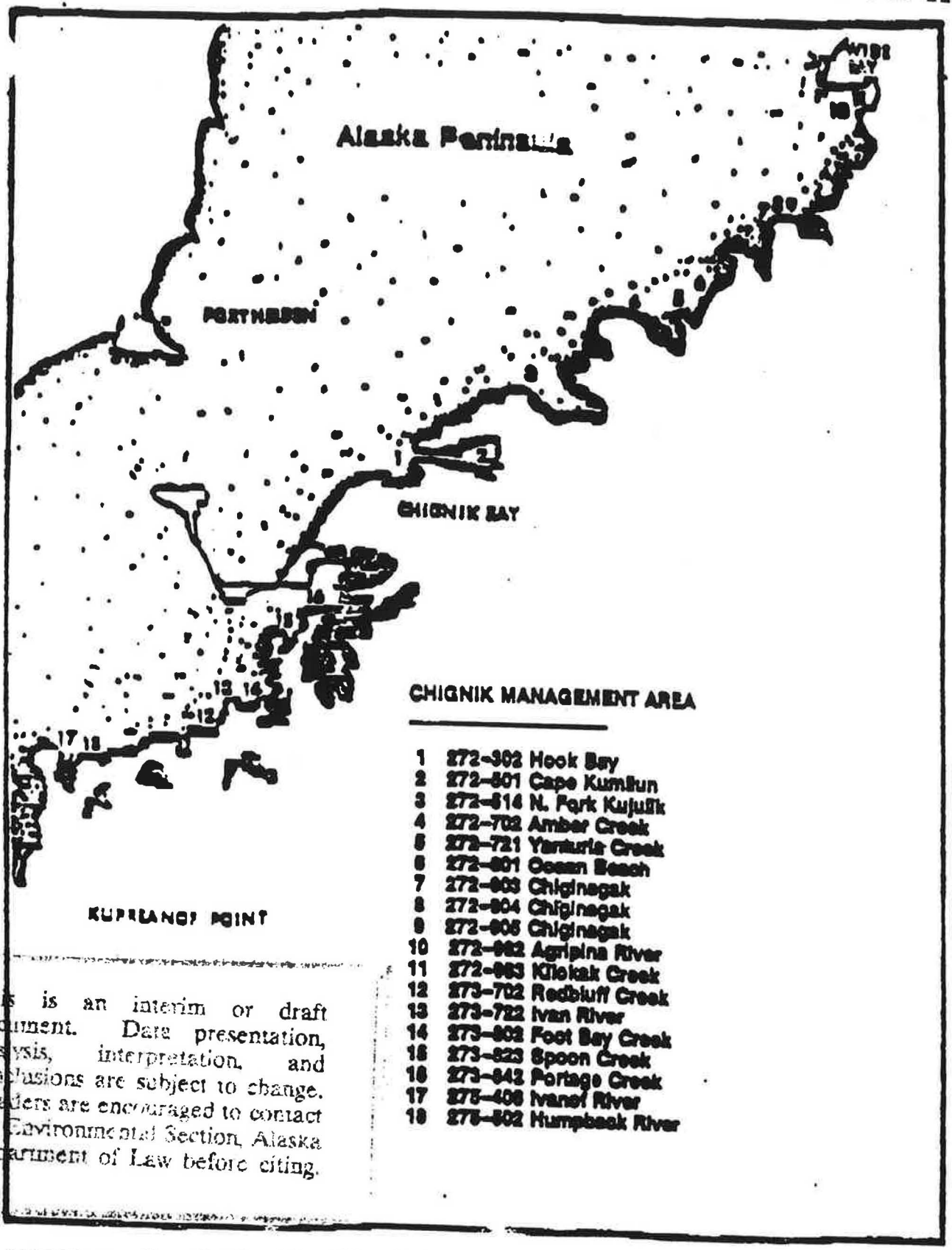


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Figure 2 Map showing the Chignik Management Area escapement index streams and approximate locations.