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RESPONSE TO TSUNAMI WARNING:

THE MARCH 1964 PRINCE WILLIAM SOUND EARTHQUAKE

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Abstract

Following the Alaska earthquake the Seismic Sea Wave Warning System issued a first advisory message indicating the possibility of a tsunami not quite 1½ hours after the earthquake, and a formal tsunami warning just over 3 hours after the earthquake.

By the time the initial advisory message was issued, all affected Alaskan communities had already been struck by the locally generated tsunamis or the initial waves of the major tsunami. Unofficial warnings led to some saving of life; more lives could have been saved if the earthquake itself or initial waves had been perceived as warnings, but at some places the waves arrived too soon for any warning to be effective.

SSWWS warnings were received early enough at affected communities outside of Alaska to have induced appropriate response (except in Canada which was not part of the system). The responses varied greatly, however, from community to community, depending on the experience and understanding of system officials and of the public.

Fatalities from the tsunamis totalled 103 in Alaska and 15 elsewhere.

This brief summary of the warnings of tsunamis associated with the 1964 Alaska earthquake and of human responses to these warnings, is not intended to be comprehensive or particularly detailed. Its focus is on the general description of the range of warnings and of responses among the several communities in Alaska and elsewhere that were struck by the tsunamis or warned of possible

tsunami effects. Greater detail may be found in the Geography volume of this series, in which Norton and Haas (in press) have discussed the warnings and responses in various Alaskan communities and Anderson (in press) has compared the warnings and responses at Crescent City, California, and Hile, Hawaii.

Warnings and Responses in Alaska

The earthquake struck at 03:36 Greenwich Mean Time (GMT). For some Alaskan communities where local subaqueous slides generated tsunamis in the immediate vicinity, the quake was the only possible warning of the coming waves. For others, more remote from tsunami origin areas there was a little more time. In no case did an Alaskan community have sufficient time before initial impact to profit from Seismic Sea Wave Warning System (SSWWS) messages. The Honolulu Observatory completed its preliminary location of the epicenter at 04:52 GMT and issued its first advisory message of a possible tsunami at 05:02 GMT (Spaeth and Berkman, 1967 and this volume). Before then, all of the damage caused by the tsunamis generated locally in Alaskan fjords and straits had already occurred and at least the initial waves of the major tsunami generated in the Gulf of Alaska had struck all of the Alaskan communities that it was to affect (Wilson and Trum, 1968; Berg and others, 1970).

For many Alaskans there was no warning. For others experience with the sea provided visual cues sufficient to make escape possible. In several cases the nature of the first wave action was mild enough to provide warning of subsequent, more powerful action. It was rare that communications technology provided warning either through mass media or private broadcasts. For the most part public officials and public organizations, which were intermediate agents in the warning process at points further from the epicenter, did not have sufficient time to mobilize to assist in evacuation and other precautionary actions.

At Valdez, a town of 1,200, 45 miles east of the epicenter of the earthquake and at the head of Valdez Arm which opened on Prince William Sound, there was no possibility of warning. Before the quake there were 28 people on the dock watching or participating in the unloading of the coastal freighter Chena. With the advent of the quake and the reaching of its highest intensity, a huge land mass slid from the face of the delta on which Valdez was situated, carrying away the dock area and generating severe destructive water action in the harbor. All 28 persons on the dock perished. Four other deaths occurred in the vicinity of Valdez. Of the 32, apparently only one, a resident who left Valdez by small boat after the initial wave, could have been saved. (One Valdez resident drowned near Port Ashton and is not considered in the above totals.)

Similarly, at Chenega, a native village of 76 residents on Chenega Island in Prince William Sound, there was hardly any opportunity to escape a massive wave which arrived no later than 10 minutes after the onset of the earthquake. There was a slight recession of the sea level before the wave, but it was followed so quickly by an inward flood that few could react to the warning. Caught in their homes or along the beach, 23 Chenegans were killed.

About 40 miles southwest of the epicenter of the earthquake on a long narrow bay off Prince William Sound was the rail and harbor installation of Whittier. At the time of the disaster there were only 70 people in the once-larger, Army-built installation. At Whittier three tsunami waves struck within minutes after the earthquake. The first was low and not particularly destructive, but the second and third which immediately followed were 30 to 40 feet high accirding to local witnesses. Thirteen residents among those closest to the water front were killed, all but one as a result of the waves. No warning was possible.

The city of Seward with a population of about 2,300 was another community hit almost without warning. A rail and harbor facility located on the southeastern coast of the Kenai Peninsula at the head of Resurrection Bay, Seward suffered immediate damage as the earthquake caused the collapse of a fuel storage complex on the waterfront leading to explosions and fire. As the quake ended, sections of the waterfront and dock facilities slid into the bay. These and other local slides set the water in the bay into a circular motion, culminating in a wave which struck the already damaged waterfront of the town, causing some additional damage, but reportedly no loss of life. The townspeople for the most part took warning and left low areas, but after another 20 minutes a second wave estimated at 30 to 40 feet in height swept into the city. Eleven of the 12 people to lose their lives in Seward were swept away by this wave (the other death was not attributed to wave action). Tsunami action continued for about five hours, but security measures taken by local officials prevented return of the townspeople to the lower, dangerous areas of the city.

On the southeastern shore of Kodiak Island at the head of small Kaguyak Bay, the 45 people of the native village of Kaguyak were more fortunate. One member of the community foresaw the possibility of a tsunami resulting from the quake. While there was no immediate attempt to evacuate to higher ground, he did communicate his fears to a few others. Soon he sighted a seismic swell approaching the village. Warnings were shouted as others became aware of the danger. The height and force of the first wave were not sufficient to reach even the slowest of those to respond. At intervals of about 50 minutes there was subsequent wave action of similar mild effect. Warned, but lulled by the low power of the waves, some people began moving to their boats, homes and other low lying areas. The fourth wave, however, was more powerful. It was estimated to

have been between 30 and 50 feet high and caught many who had left high ground, killing 3, while others narrowly escaped.

A few miles northeast of Kaguyak along the shore of Kodiak Island the 200 residents of Old Harbor had more complete warning. After the quake, a few of the villagers told others to anticipate "tidal" waves. Additionally, two warning messages were received over shortwave radio from Kaguyak and a nearby cannery, both of which were hit before Old Harbor. Shortly after the radio messages, the first wave action occurred, being more similar to a swift, high tide than a wave. It caused little damage and no injury. The second wave was stronger, but still weak enough to serve more as warning than threat. After this wave, the last of the people left for higher ground. The village, finally emptied after several "warnings" was nearly destroyed by the third (8:00 p.m. Alaska Standard Time /AST/) and fourth (10:00 p.m. AST) waves. No one in the village was killed although one person on Sitkalidak Island across a narrow strait was drowned (Kachadorrian and Plafker, 1967).

North of Kodiak Island on small Spruce Island was Ouzinkie, another native village of about 200. Shortly after the earthquake, Ouzinkie's inhabitants noticed the water off shore begin to act strangely, and within a half an hour a cycle of surging waves and ebbs began. No deaths occurred in the village despite the eventual destruction of several homes and the local cannery. The highest crests were not experienced until 11:00 p.m. AST; thus, the action of the water served as sufficient warning, the natives having long since evacuated the village for higher ground.

On Afognak Island, another larger island north of Kodiak Island, was Afognak village of some 180 natives. There, as in most native villages, damage from the earthquake was slight, and after the shaking stopped, the people went

about their planned activities for the evening. A few soon noticed a great recession of the water in the bay before the village. Additionally, radio reports of "tidal" waves at nearby points were received and while there was no organized or systematic warning, many began to evacuate the village. Within a half hour of the quake a low wave hit the beach coming into the village. Only a few of the slowest to leave were caught by the wave, but all escaped safely. Subsequent wave action was stronger, but the people were safe since for the most part they remained on high ground until the next morning.

The 4,200 people who lived in the area in and around Kodiak on the north-eastern coast of Kodiak Island received a variety of warnings. However, there is wide dissensus over the relative utility of the particular warning cues in persuading the inhabitants to take precautionary action. For some minutes after the earthquake, people were occupied partly by contending with the moderate earthquake damage and partly by returning to routine activities of the day. The city telephones were out as was electrical power. Events related to warning are somewhat confused and therefore cannot be given in strict chronological order. Between the time of the quake and the arrival of the first tsunami, however, several warning events took place.

Evidence shows that some Kodiak residents, including some city officials, were aware of the potential tsunami-generating power of the earthquake. However, no warning action was taken solely on this basis. Kodiak's mayor, city manager and police chief met shortly after the quake and discussed the possibility of issuing a warning, but no action was taken until radioed warnings were received.

At approvimately 6:10 AST (04:10 GMT) an Air Force installation at Cape Chiniak, some 20 miles southeast along the shore of Kodiak Island, experienced a tsunami. This information was radioed by shortwave and was received by

Fleet Weather Central on Kodiak Naval Base and by an undetermined number of short-wave sets in Kodiak City, including one at police headquarters. The officer at Fleet Weather Central telephoned the Armed Forces Radio Station on the base, which in turn broadcast the warnings. Reportedly, an orderly and successful evacuation of the Naval base followed (Spaeth and Berkman, 1967, and this volume). Since electrical power was off in Kodiak City, receipt of the warning was limited to those with auxiliary or battery-powered radio sets.

In addition to the direct reception of warning from Cape Chiniak and Armed Forces Radio, Kodiak residents were warned by the sound of fire sirens. Upon receiving Cape Chiniak's message city officials at police headquarters sounded the sirens even though no pre-arranged tsunami warning procedure was in effect. Public response was generally to go to the streets to see why the sirens were sounded. A police cruiser and a Shore Patrol truck (manned by a civilian) went into the lower areas of the city to spread the tsunami warning orally.

Response to these warnings was not uniform. In many cases people were slow to leave dangerous areas, and when the first tsunami reached Kodiak, many were caught. Fortunately, the water action was not violent and all were able to wade free.

Even after the first wave, with the various radio sources and public agencies continuing to warn of subsequent waves, many remained in dangerously low areas. Fishermen, particularly, remained in danger as they went to the boat harbor, attempting to save their boats. Although several rode out all the waves in their boats, more than half of the 15 deaths that occurred in and near Kodiak occurred among those on boats in the harbor or at nearby Spruce Cape.

Warnings and Responses Outside Alaska

For communities along coasts of the Pacific outside Alaska, greater distance from the area of generation of the tsunamis allowed time for adequate warning of threatened populations. However, the variation in warnings and responses to tsunami threats indicates that preservation of life is not predicated solely on the availability of time and the issuing of SSWWS warnings.

The first bulletin of the SSWWS, issued at 05:02 GMT which indicated the possibility of tsunamis was followed by a second at 05:30 GMT which reiterated the possibility and gave estimated arrival times for each locale, and by a third at 06:37 GMT which reported that a tsunami had been generated and repeated estimated arrival times. (Spaeth and Berkman and this volume.) These messages were transmitted to states and participating nations bordering the Pacific. Although the warnings received were identical for all participants, there were wide variations in the responses they elicited.

Canada was no longer a participating member of the Seismic Seawave Warning System, (Spaeth and Berkman, 1967 and this volume) but approximately 25,000 people of the twin cities of Alberni and Port Alberni on Victoria Island, British Columbia had mass media reports that tsunamis generated by the Alaskan earthquake might strike the Canadian coast. ("Report on the Alberni Tidal Wave Disaster," Office of Provincial Civil Defense Co-ordinator, Victoria, B.C., n.d., Part II, p.7) The twin cities are located 40 miles from the open sea at the head of narrow Alberni Inlet. Thus, normal danger from tsunami action on the open ocean might seem negligible, but the tsunami's period "apparently matched the natural frequency of the inlet, causing amplification of the waves." (Spaeth and Berkman, p. 39; Wilson and Trum, 1968, pp. 91-92) Accordingly, Alberni and Port Alberni were unprepared for the series of seismic sea-waves commencing at

approximately 08:00 GMT (12:00 p.m. local time). (Spaeth and Berkman, p.39) Soon after the first crest Royal Canadian Mounted Police (RCMP), a local volunteer rescue squad, and a number of citizens were at the scene of the impact. There was no certain knowledge that further crests were expected, but those at the scene were aware of this possibility. At the request of the RCMP, the rescue squad and others went from house to house, waking people and warning them to be ready for further emergency. Ninety-seven minutes after the first crest, a second, the largest to hit the Albernis, struck. Tsunami activity recurred for approximately 18 hours. Although millions of dollars of damage was sustained, none were killed and few were injured. The initial crest coupled with rapid local response was sufficient warning. ("Report on the Alberni Tidal Wave Disaster," p. 7)

The third tsunami bulletin released by Honolulu Observatory at 06:37 GMT was received by the Washington State Department of Civil Defense at about 07:13 GMT; the Oregon State Civil Defense received the warning bulletin at 07:00 GMT. Both immediately disseminated warning for the first time to all of their coastal counties. (Spaeth and Berkman, pp. 40-43) The response of local officials in these states prior to the passage of the tsunami front between 07:15 and 08:00 GMT is unknown. Tsunami damage was comparatively light in both Washington and Oregon. There are no reports that indicate local warning took place where tsunamis did occur. Spaeth and Berkman (1967) state: "By 07:18 all coastal counties (Washington) had been advised that the tsunami warning had been received."

In Grays Harbor County at resort areas west of Aberdeen, Washington, tsunamis flooded a trailer court area, some permanent residences and a shopping center. Several people who had retired for the night awakened to find themselves

surrounded by water. The only warning before the wave reported by newspaper accounts was received over shortwave radio on the marine band. A man who heard the marine band radio broadcast telephoned a local fire department which in turn sounded its sirens. Apparently, the sirens sounded almost concurrently with the arrival of the wave, alerting those not already aware of the cresting water. (The Seattle Sunday Times, March 29, 1964, vol. 87, no. 89, sec. A, p. 14, col. 1)

In Oregon 10 to 15 foot wave crests were reported in several places, but no details are available on local warning. (Spaeth and Berkman, p. 41) Four children who were sleeping with their parents in a state park near Depoe Bay, Oregon were killed when struck by a tsunami without warning. (The Seattle Sunday Times, p. 2, col. 3) No other deaths were reported, but at Seaside, Oregon low areas were flooded, damaging 10 to 12 houses and 4 trailer houses. (Spaeth and Berkman, 1967 figure 7)

The California Disaster Office (DCO) in Sacramento received its first tsunami advisory information via the National Warning System (NAWAS) from the 28th Warning Center, Hamilton AFB at 05:36 GMT, March 28 (local time was 9:36 p.m. Pacific Standard Time, March 27). CDO received the second bulletin at 06:44 GMT (10:44 p.m. PST) and the third at 07:13 GMT (11:13 p.m. PST) from the same source. Presumably because of the tentative nature of the first dispatch, CDO did not disseminate the information to areas in California vulnerable to tsunamis. However, the second and third messages were transmitted via the State Department of Justice (DOJ) Teletype System as an "All Points Bulletin" to all sheriffs, chiefs of police and Civil Defense directors of coastal counties and cities. They were transmitted by DOJ Teletype at 07:03 GMT (11:03 p.m. PST) and 07:25 GMT (11:25 p.m. PST) respectively. The second and third messages, those communicated to the localities, contained the Honolulu Observatory's estimates of arrival

times for various points along the California coast. ("Receipt and Dissemination of Sea-wave Warning - California Disaster Office," California Disaster Office, n.d., p. 1) The two "All Points Bulletins" transmitted for CDO via DOJ Teletype were received by local officials of the several coastal political subdivisions simultaneously at 07:08 GMT (11:08 p.m. PST) and 07:50 GMT (11:50 p.m. PST). Additionally, Los Angeles and San Diego counties received the second transmission sent by 28th Warning Center directly via NAWAS at 07:25 GMT (11:25 p.m. PST).

The bulk of California's tsunami damage as well as all its recorded deaths occurred in Crescent City. There local Civil Defense officials and the Del Norte County Sheriff were notified and arrived at the sheriff's office by 11:20 p.m. PST. Although the first message estimated the time of arrival for Crescent City as 12:00 p.m. PST, no action was taken to notify the public until the second formal warning arrived at 11:50 p.m. PST. Then sheriff's deputies and local police were sent into waterfront areas to warn residents. Before they had completed their door-to-door alert, the first crest reached Crescent City on schedule at about 12:00 p.m. PST. Fortunately, it was a mild surge causing little damage. Subsequently, two other mild crests were experienced at 12:40 a.m. and 1:20 a.m. PST. In the meantime the door-to-door warning was completed and using fire department personnel, policemen, specially deputized volunteers, and his deputies, the sheriff set up a cordon to guard damaged areas. This was successful in keeping people from outside the waterfront area away, but because of the mild action of the water some residents, businessmen, and tourists returned to lower areas. (Yutzy, 1964)

At about 1:45 a.m. PST the fourth wave hit Crescent City. It was by far the most destructive, catching many of those who had returned to the waterfront area. There were 12 verified deaths and 35 injuries or illnesses, of which 14 were hospitalized, attributed to the disaster. (California Disaster Office, p. 3)

The measured response of public officials to the tsunami warnings they received was reportedly based on (1) the fact that warnings indicated that tsunamis were only probable, (2) the lack of information about how large a wave was to be expected, and (3) information that coastal areas to the north with earlier estimated arrival times had not experienced tsunamis. (Yutzy, 1964 pp. 5-6) That these considerations had little predictive value for determining whether destructive waves would occur in Crescent City was apparently not known by public officials responsible for deciding the nature and extent of local warning. Further, it was assumed by local residents that this tsunami danger would be comparable to past experiences in alerts where Crescent City experienced only mild surges. Thus, loss of life in Crescent City can be attributed in part to public and private actions based on inadequate knowledge of tsunamis.

In California local decisions were crucial in determing response to SSWWS warnings. Despite receiving the same warning, local officials responded quite differently in various coastal areas. For instance, in Humboldt County officials reacted immediately to the first message received at 11:08 p.m. PST. Fire and police personnel in various municipalities and county government personnel were notified and responded according to their "standard operating procedures for tidal wave alerts." (California Disaster Office, p. 3) By 11:40 p.m. evacuation of beaches and homes in low-lying areas had been completed and road blocks to the areas established. No tsunami action was reported. Elsewhere, response ranged from partial evacuations similar to Crescent City to almost no

response. Public response also varied. Some counties reported no difficulty in gaining public cooperation with precautionary measures, but in San Diego curious citizens created problems as they came to observe the sea. (California Disaster Office, n.d., p. 6) In San Francisco where no deaths and slight damage occurred, a reported 2,500 persons were evacuated from low areas. (Seattle Times, p. 2, col. 7) However efforts to protect the population were thwarted by an estimated 10,000 curious inhabitants who went into dangerous areas in hopes of seeing a tsunami. (Spaeth and Berkman, 1967, citing newspaper estimates)

Hawaii, unlike the states on the western coast of the continental United States, is supplied tsunami warnings directly from Honolulu Observatory. Shortly after 04:00 GMT the Observatory notified the Acting Tsunami Advisor of the State of Hawaii and the Vice Director of the Hawaii State Civil Defense of the earthquake. These personnel in turn notified other members of their organizations including the Civil Defense officials of all Hawaiian counties; within a half an hour the state Emergency Operations Center was activated. At 06:43, following receipt of the third tsunami bulletin, the formal warning, personnel at the Emergency Operations Center decided to sound all coastal sirens and activate the state's Civ-Alert Radio Broadcast system. Accordingly, the sirens and Civ-Alert systems were activated at 07:00 GMT in all counties. Again at 08:00 and 08:30 GMT the sirens were sounded. The earliest recorded crest reached the islands at 08:33. (Spaeth and Berkman, 1967) Fixed siren signals were supplemented by police car sirens. Also the police supervised the evacuation and prevented return to dangerous areas. The public cooperated with the efforts of agencies responsible for the evacuation. All communities on the Hawaiian coast were reported to have been evacuated by 8:28 GMT (Hawaii State Civil Defense Division through D. C. Cox, personal communication.) Although there was only slight

damage from the generally mild tsunamis that struck the Hawaiian shore, the response of both officials and the public would have prevented loss of life in even a greater disaster. (Anderson, 1967 and Geography volume)

Elsewhere on the perimeter of the Pacific, other participating members of the SSWWS responded to warnings. A Vera Cruz, Mexico warning reportedly led to the evacuation of parts of the city at 3:00 a.m. local time. At Mazatlan, Mexico a reported 80,000 were evacuated (The Seattle Times, sec. A, p. 2 col. 6) Low areas on the Chilean coast were evacuated prior to the arrival of weak tsunamis. (Spaeth and Berkman, p. 49) The eastern shores of the Philippine Islands were evacuated, but only small, undestructive waves were experienced (The Seattle Times, p. 2, col. 7). Likewise, Kushiro on the island of Hokkaido was evacuated for a four-hour alert, but again the tsunami action was mild, (The Seattle Times, sec. A, p. 2, col. 3; and The New York Times, 3/29/64, no. 38, sec. 1, p. 48, col. 8). In Japan the responsibility for evaluation of warning messages and implementation of local alerts and protective actions based on SSWWS warnings is given to a national agency. Thus, response is more uniform than in the United States where various local officials have the responsibility.

Conclusions

Although tsunami warnings were issued by the Seismic Sea Wave Warning System and by unofficial sources on the occasion of the Alaska earthquake of 1964, the tsunamis caused 118 fatalities, 103 in Alaska and 15 in California and Oregon. The distribution by place and by type of tsunami is shown in Table 1.

In general there was little possibility of warning for most Alaskan communities struck by the tsunamis. Since all the communities struck by tsunamis first experienced the earthquake, some lives could have been saved if the earthquake itself had been perceived as a warning. However, except at

Valdez, Chenega, and Whittier, which were hit immediately by locally generated tsunamis, most loss of life could have been avoided, if once warned -- by initial wave action, radio, or public officials -- the public had uniformly responded by going to high ground and staying there.

Despite the availability of SSWWS warnings in all communities outside Alaska (except those in Canada) wide variations in response were found. Apparently the most crucial variable involved in determining the nature of warning received by the public was the judgment and experience of officials responsible for determining the measure of response to be taken within their political subdivisions. Similarly, the response of the public to measures taken by officials seemed to depend on their experience with and understanding of tsunamis and tsunami warnings.

Table 1. Fatalities due to tsunamis associated with the Alaska earthquake.

Place	Earthquake Fatalities			
	Local tsunamis	Major tsunami	Other causes	Notes
Alaska				
Prince William Sound and connecting fjords				
Crab Bay (near Port Ashton), Evans I.	1			b
Chenega, Chenega I.	23			c
Point Nowell, Knight I. Passage	1			
Point Nellie Juan, McClure Bay	3			
Whittier, Passage Canal	12		1	d
Valdez, Port Valdez	30		1	e
Anderson Bay, Port Valdez	1			
Kenai Peninsula				
Seward, Resurrection Bay	11		1	f
North coast of Gulf of Alaska				
Cape St. Elias, Kayak I.		1		
Point Whitshed, W. of Cordova		1		
Kodiak Island group				g
Kodiak (incl. Spruce Cape), Kodiak I.		9		h
Kalsin Bay, Kodiak I.		6		
Sitkalidak I. (near Old Harbor, Kodiak I.)		1		i
Kaguyak, Kodiak I.		3		
Cook Inlet				
Anchorage			9	
Totals for Alaska	82	21	12	
Oregon				
Depoe Bay (N. of Newport)		4		
California				
Crescent City		12		j
Klamath		?		k
Bolinas Bay		?		k
Totals, all states	82	37	12	
Total, all tsunamis		119		
Grand Total, all fatalities			131	

Table 1 (continued)

Notes:

a) Compilation by Deak C. Cox, University of Hawaii. Enumerations and attribution to specific causes for Alaska are based on manuscript tabulations from death certificates by Margaret Lantis, University of Kentucky and by Francis E. Kester, Alaska State Registrar of Vital Statistics, Juneau, Alaska, for the Geography Panel, Committee on the Alaska Earthquake, and on other sources cited below. Enumerations outside Alaska are based on sources cited.

Fatalities attributed to tsunamis include all drowned and missing and presumed drowned.

b) The presumed drowning of a Valdez resident identified in many reports as occurring at Port Ashton actually occurred at Crab Bay (Plafker and others, 1969, p. 30)

c) At Whittier the total of 13 tsunami fatalities given in several reports includes one fatality due to other causes according to death certificate.

d) At Valdez the total of 33 fatalities given in several reports probably includes one missing and presumed drowned at Crab Bay (note b), one missing and presumed drowned at Anderson Bay (note e), and one killed by skull fracture on the dock listed here as a fatality by other sources. Twenty missing in collapse of dock and presumed drowned, one death on ship from heart failure, and one death on ship from broken neck are included here in deaths from tsunami.

e) The presumed drowning of one of Valdez residents commonly included among Valdez fatalities actually occurred at Anderson Bay (Plafker and others, 1969, p. 13)

f) At Seward a total of 13 fatalities is given by some sources. Of the 12 fatalities listed by the Registrar of Vital Statistics one resulted from other causes than the tsunami.

g) The fatality totals reported for Kodiak and vicinity have varied widely, apparently because of incomplete lists used by some authors and double listings by others.

h) At Kodiak estimates of fatalities have ranged from 9 to 11, including 8 or 9 drowned or missing and presumed drowned from boats in the small boat harbor or at Spruce Cape.

i) Death presumed by drowning included in most lists as occuring at Old Harbor actually occurred on Sitkalidak 1. (Kachadorrian and Plafker, 1967, p 36).

Table 1 (continued)

j) Total of 12 fatalities at Crescent City is given by Hansen and others (1966). Spaeth and Berkman (1967) relying on a California Disaster Office report give the number as 11.

k) Cloud and Scott (1969, p. 43) report one death each at Klamath and Bolinas Bay.

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