4. THE SPILLAGE OF OIL BY TANKERS AND TANK BARGES IN U.S. HARBORS IN 1973-1975

The PIRS data format was revised in 1973. One result of this revision is that it is now possible to distinguish between a number of petroleum-related spill substances, whereas in the 1970-1972 data the substances were grossly aggregated. Table 4.1 lists the various categories now available to the encoder when selecting a name for the pollutant.

Many of these substances can be spilled by vessels other than tankers and tank barges. Fishing vessels, for example, might spill diesel oil, waste oil, or lube oil. Freighters might spill No. 6 fuel oil (this presumably includes Bunker C), as well as waste and lube oils. However, "light" or "heavy" crude oil would be spilled only by tankers and tank barges (among the vessel-related source selections). Thus, it is possible with the 1973-1975 PIRS data to relate a subset of the reported spill incidents to this particular class of vessel (i.e. crude carriers). Such a list is not exhaustive of the spills occurring with this class of vessel because crude-carrying tankers or tank barges might spill oils other than crude, like lube oil or No. 6 fuel oil. An analysis based on this data serves therefore only to determine a lower bound on the spillage from this class of vessel. However, it is readily done with the data at hand, and it is about as close as we can come to tying the PIRS data to any particular traffic flow.

TABLE 4.1

POLLUTANT CATEGORIES

"Light" crude oil
"Heavy" crude oil
Natural (casinghead) gasoline
Gasoline (aviation or automotive)
Jet fuel (JP-1 through JP-5)
Kerosene
Light diesel oil
Naphtha
Heavy diesel oil
#4 fuel oil
Other distillate fuel oil (presumably #2)
Mineral spirits
Other petroleum solvents
Unidentified light oil
Liquefied petroleum gas
Hydraulic fluid
Mixture of two or more products
#5 fuel oil
#6 fuel oil
Creosote
Asphalt or road oil
Coal tar or pitch
Animal oil
Vegetable oil
Waste oil
Lube oil
Oil-based pesticides
Unidentified heavy oil
Other oil
Lacquer-based paint
Paraffin wax
Grease

In a previous study (Devanney and Stewart, 1974) we reported the results of a similar analysis of crude oil spills in the U.S. in 1971 and 1972. Unfortunately, the statistics we used were in error. The number of spills, for example, was too large. This might have been associated with the substance aggregation in the pre-1973 PIRS data. To set the record straight, we summarize here the number of crude oil spills from tankers and the volume of crude oil inports for the period 1973-1975. The data in this form is aggregated over the entire U.S. The total number of spills (392) for this three-year period and the total throughput volume (4.246×10^9 BBL) should be compared with our earlier and incorrect estimates of 624 spills and 1.412×10^9 BBL (for the preceding two-year period). In Table 4.2, the number of spills is broken out in terms of both all spills and spills over 100 gallons because as we show below, it appears that the reporting of spills under 100 gallons is subject to systematic variations depending upon the local district in the PIRS system.

The data in this form is far too grossly aggregated to deal with except on the most superficial level. For example, with the small changes in throughput from one year to the next we cannot verify that the volume throughput is an appropriate exposure parameter. Moreover, not all crude oil carried by tanker is of foreign origin and so our exposure parameter may be understated. We need to disaggregate the data to the point where the individual

TABLE 4.2

CRUDE OIL SPILLS FROM TANKERS 1973-1975

Year	Number of Spills (>100 Gal / All Sizes)	Crude Oil Imports (BBLS)[a]	Rate of Spillage (Number/100 MM BBL)	
			All Sizes	>100 Gal
1973	48/123	1.295×10^9	9.5	3.7
1974	59/167	1.367×10^9	12	4.3
1975	27/102	1.584×10^9	6.4	1.7
1973-1975	134/392	4.246×10^9	9.2	3.2

[a]Source: Bureau of the Census Foreign Trade summaries, 1974, 1975, 1976 (FT 900 Series)

flows of crude oil are simply understood. This allows a meaningful analysis of the exposure data, as well as a deeper review of the oil spillage data.

The most readily available exposure data is that provided by the Corps of Engineers' annual summary, Waterborne Commerce of the United States. In order to use this data, we found it necessary to consider only those regions where the crude oil was brought in from outside the region and simply offloaded at the receiving terminal. This was because regions that had extensive internal transshipment of crude oil via tanker or tank barge (like the Gulf of Mexico) had petroleum flows that were far too complicated to allow proper disaggregation of the exposure parameters based on the tabulated statistics. The regions we selected for the analysis were Portland, Maine; New York Harbor, including the New Jersey shore; the Delaware River up to Philadelphia; the Long Beach/Los Angeles harbor complex; and the Puget Sound region. The crude oil traffic for these regions is summarized in Table 4.3. With the exception of the Delaware River complex, foreign imports and coastwise receipts of domestic extraregional crude oil make up 90% to 100% of the crude oil traffic; and even in the Delaware River complex, the internal shipments account for 17% or less of the total traffic.

The PIRS data was accessed by computer and all "light" and "heavy" crude oil spills were identified and listed for the five regions. By carefully examining the spill incidents for each region for the 1973-1975 period, those spills related to the vessel importation of crude oil were identified. The results are summarized in Table 4.4. An attempt was made to determine whether the vessel was under way, moored, or at berth at the time of the spill incident in hopes of shedding some light on the breakout of spills incurred en route versus spills occurring at the offloading terminal. However, the data format and encoding method used in the PIRS data were poorly chosen with respect to such inquiries. A great deal of judgment and just plain guessing had to be used to resolve some of the ambiguities we encountered. Consequently we have only a modest faith

TABLE 4.3

NUMBER OF SPILLS BY REGION, 1973-1975

Region	Year	Underway	Moored	At Berth	Total
Portland	1973	0	5	8	13
	1974	1	3	8	12
	1975	0	0	6	6
New York	1973	1	3	14	18
	1974	0	0	9	9
	1975	0	1	5	6
Delaware River Complex	1973	1	1	22	24
	1974	1	1	17	19
	1975	1	0	17	18
Long Beach/ Los Angeles	1973	0	3	18	21
	1974	0	1	13	14
	1975	0	2	6	8
Puget Sound	1973	0	0	2	2
	1974	0	1	2	3
	1975	1	0	3	4

TABLE 4

REGIONAL CRUDE OIL TRAFFIC STATISTICS

Region	Year	Gross Tonnage	Net Imports & Coastwise Receipts: Tons	Net Imports & Coastwise Receipts: Barrels	Number of Calls of Crude Oil-Carrying Ships
Portland, ME	1973	22,563,374	22,563,374	161.8×10^6	460
	1974	21,291,279	21,291,279	162.5×10^6	449
	1975	N/A	22,200,000[a]	169.4×10^6	389
New York Harbor (including NJ)	1973	26,483,182	25,359,641	193×10^6 [a]	N/A
	1974	21,152,025	19,998,637	153×10^6 [a]	N/A
	1975	N/A	N/A	N/A	N/A
Delaware River Complex	1973	56,213,930	49,347,430	377×10^6 [a]	N/A
	1974	56,093,456	46,830,476	357×10^6 [a]	N/A
	1975	N/A	N/A	N/A	N/A
Long Beach	1973	19,507,502	18,389,346	140×10^6 [a]	N/A
	1974	19,049,309	18,353,636	140×10^6 [a]	N/A
	1975	N/A	N/A	N/A	N/A
Puget Sound, WA	1973	3,300,357	3,259,003	25×10^6 [a]	N/A
	1974	5,601,839	5,595,810	43×10^6 [a]	N/A
	1975	N/A	N/A	N/A	N/A

[a]Estimated on basis of 7.6 barrels crude oil per ton.

in the accuracy of the breakout between operational modes shown in the table.

We have attempted to verify the accuracy of the "Total" column in Table 4.4 through letters and personal visits with the Portland Pipe Line Corporation and the State of Maine Department of Environmental Protection. Mr. Wallace McGrew, Executive Vice President of the Portland Pipe Line Corporation, waste oil, but spilled from crude-carrying ships. Of the 18 DEP crude spills, the PIRS data listed 4 as being of crude oil, with 6 listed as waste oil or No. 6 fuel oil. Of the 17 non-crude DEP spills, 6 found their way into the PIRS file. No non-crude DEP spill was listed in the PIRS file as being a crude oil spill.

Of the spills omitted from one file or the other, it was possible to discern some pattern in the PIRS omissions, although no pattern could be seen in the DEP omissions. The two PIRS crude spills that were not in the DEP file were of 15 and 30 gallons and they occurred in the harbor area. Further, the PIRS data contained a number of product spills of several hundred gallons that were not in the DEP file. However, of the 8 DEP crude spills that failed to show up in the PIRS data (as either a crude oil or as one of the other oil-related selections) one spill was of 15 gallons, 4 were of 1 gallon, and the remainder were either sheens or the volume was not recorded. Further, of the 9 spills of waste or fuel oils from crude carriers that were found in the DEP files but not in the PIRS files, two were of 10 and 25 gallons, while the rest were of 1 gallon or less. Thus, it seems likely that the Coast Guard is no longer bothering to record all of the small spills reported to it. Why the DEP doesn't have records of the larger PIRS incidents is, however, a mystery. Perhaps they were simply caused by the inevitable confusion that accompanies the shakedown period of any new enterprise.

With respect to our inquiry, we needn't be too concerned about the omission in the PIRS data of the small spills (1 gallon down to sheens on the water). However, if the DEP is correct in its identification of the PPLC-related oil spills, then we find that our estimate of the number of spills is somewhat low. If we discard all spills in both lists smaller than 10 gallons, we find that the PIRS data would lead us to conclude that there were 5 spills in 1975, while the DEP data suggests there were 12 spills. Of the DEP list, about half the spills would be of crude oil, while the other half would consist of waste or fuel oils. Since the PIRS data was screened by oil type, all five entries would be crude oil spills. Due to the discrepancy in the identification of the oil types, it is difficult to believe the DEP finding that the split is actually 50/50 between crude oil and other oils. However, in the absence of any other data, it is a reasonable first assumption. In this case we might consider the crude oil screening method used here leads to estimates of the number of spills that are systematically low by about a factor of two.

With these qualifications on the accuracy and validity of the data in Table 4.4, it is appropriate to proceed with the discussion of the "Total" column. Note especially the strong decreasing trend in the number of spills annually. Every region exhibits such a trend, with the exception of Puget Sound. Puget Sound is a special case because this region is in the process of increasing its crude imports as the supply of pipelined Canadian crude oil is being cut back by the Canadians.

Thinking this trend might be caused by a tendency to overlook smaller spills as time goes on (i.e., assuming the 1973 PIRS data contained the 1 gallon spills and the sheens, whereas the 1975 data does not), we tabulated only those spills over 100 gallons. Table 4.5 shows the result. Again, the strong timewise trend is evident. Rather remarkably, we also find that the Los Angeles/Long Beach region slips from its position as the second worse spiller (see Table 4.4) to one hardly distinguishable from the New York or Portland regions.

TABLE 4.5

CRUDE OIL SPILLS OVER 100 GALLONS

Region	1973	1974	1975
Portland	4	3	1
New York	7	5	2
Delaware River	13	8	9
Long Beach/ Los Angeles	7	2	1
Puget Sound	1	1	1

Figure 4.1 shows a scatter diagram of the total number of spills by region versus regional throughput in millions f barrels for the two years 1973 and 1974. 1975 was not included, with the exception of the Portland region, because the 1975 waterborne commerce statistics have not yet

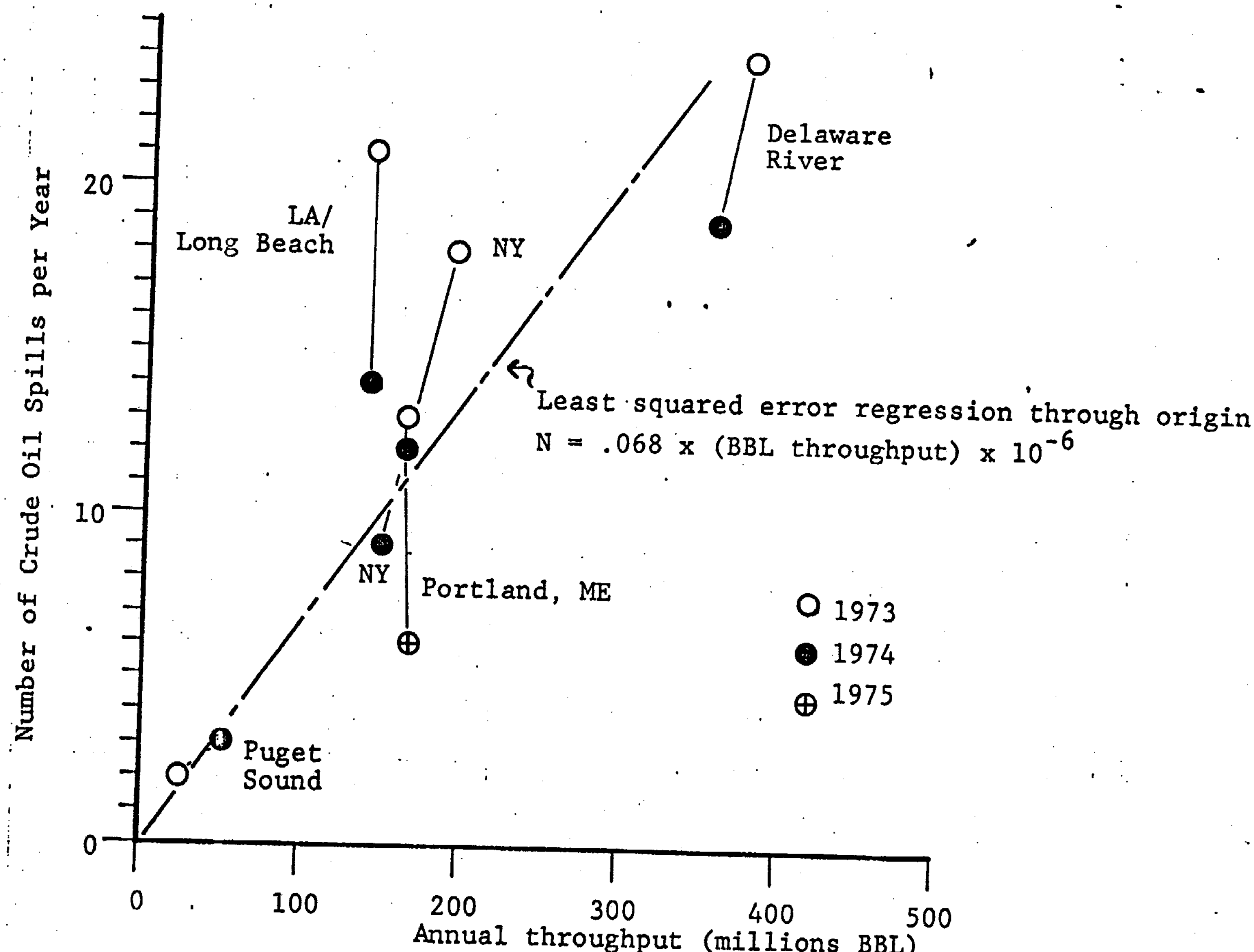

Figure 4.1--Scatter diagram of number of vessel-related crude oil spills versus throughput by region and year.

been published by the Corps of Engineers. If we ignore the obvious trend in the data, and lump all eleven points into one big data set, we find that the ray having a least squared error with respect to the data has a slope of 6.8 spills per hundred million barrels throughput. Notice that Portland, New York, and Los Angeles all have very similar throughput figures, but that the number of spills for Los Angeles is considerably higher than those for the other two regions. The similarity in the number of large spills shown in Table 4.5 suggests that this is due to the inclusion of a large number of small spills in the Los Angeles data. Presumably, differences in internal reporting procedures for the various Coast Guard Districts accounts for some of this difference.

The rather substantial trend evidenced by the data points in Figure 4.1 deserves some comment. First of all, we ought to expect such a trend due solely to the increased regulatory activities of state and federal authorities. Quite obviously, the perception that the ocean or a harbor is a convenient and cheap dumping ground has changed a great deal in the past few years. Quite aside from this factor is the enormous scrapping of old and obsolescent tankers caused by the slump in world tanker charter rates. Some of the older segments of the fleet are disappearing at a rate of 4% of the segment tonnage per quarter. The vessels transporting oil have thus undergone a vast change in average vessel age from 1973 to 1975.

Another way of looking at the ship spillage data is to regress the number of tanker port calls against the number of large (> 100 gallons) tanker spills. In this case we aggregate crude and product carriers. We shall neglect smaller spills due to the apparent variability in reporting policy. Table 4.6 shows this data for 1973 and 1974 as obtained from the Corps' Waterborne Commerce of the United States, the Portland Pipe Line Corporation, and the USCG PIRS data. Again, there is a strong trend evident in the data. Figure 4.2 is a scatter diagram of the data, less the Portland crude spill points. As before, we have fitted a line through the origin according to a minimized squared error criterion. If we were to plot the Portland crude oil spills on this graph, we would see that they would fall to the left and slightly above the Puget Sound points. They would not be so far away from the regressed line as to suggest the crude oil spills occurred at a substantially different rate than the aggregated population of tankers. However, if we double the number to account for the non-crude spills accompanying these tankers, we would find that tankers bringing in crude oil have substantially greater numbers of spills per port call. This is not an unusual finding, and it bears further investigation.

The question remains as to how we might best put this information to work. The answer is not as easy as we would like, both because of the strong trends in the data and because of the disparate reporting of small spills. If we

TABLE 4.6

TANKER PORT CALLS AND LARGE TANKER SPILLS

		Port Calls	Spills (> 100 Gallons)
Portland, all	1973	1789	6
	1974	1619	5
Portland, crude carriers only	1973	460[a]	4
	1974	449[a]	3
New York	1973	5560	29
	1974	4995	19
Delaware	1973	2718	18
	1974	2571	12
Los Angeles/Long Beach	1973	1270	12
	1974	1226	5
Puget Sound	1973	598	2
	1974	517	1

[a]These figures are courtesy of the Portland Pipe Line Corporation.

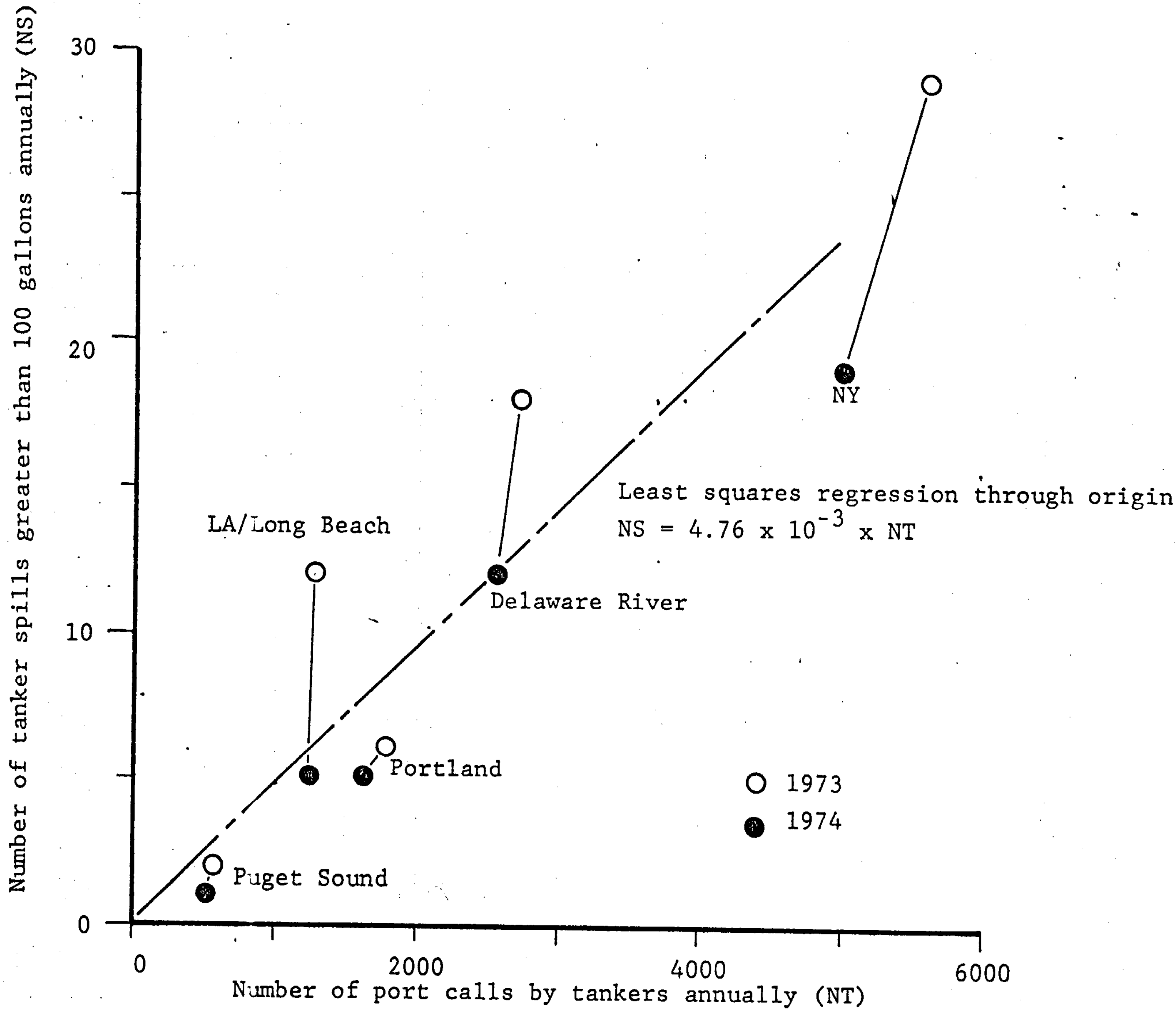

Figure 4.2--Scatter diagram of large tanker spills (> 100 gallons) versus number of tanker port calls.

use the negative binomial distribution with the data plotted in Figure 4.1, we would simply sum the throughputs and sum the number of spills and proceed with the evaluation of the PMF. However, the data obviously fails to group nicely about the line in the figure, due primarily to the Los Angeles/Long Beach data points. This means that the assumptions behind the derivation of the negative binomial are not very good and predictions made using this badly scattered data may be somewhat in error. If we attempt to plot the data of Table 4.5 (the large crude oil spills) against throughput, thereby bringing the Los Angeles/Long Beach data back into the fold, we would find that the small number of large spills in any given region in 1975 leads to some very uneven results.

Thus, the best approach seems to be to use either the slope of the ship call regression of Figure 4.2, or a negative binomial using the number of ship calls as the exposure parameter. The question then arises as to the handling of the obvious trend, and here it would seem best to be conservative and use the aggregated 1973 and 1974 data. If the results are marginal in some sense, a slightly improved ship spillage figure swinging a conclusion one way or another, then we might think seriously about using just the 1974 data. However, the number of points is so small that classical confidence interval techniques could not be expected to distinguish one choice from the other.

If the analysis cannot accommodate the number of port calls exposure parameter, it would seem best to use the negative binomial coupled with the greater than 100 gallon tanker spill data of Table 4.2. Since this data relates to crude spills only, the number of spills should be multiplied by a factor of two to accommodate the related non-crude oil spills.