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DISTRIBUTION OF RADON LEVELS IN NEW YORK STATE HOMES

R. L. Perritt, T. D. Hartwell, L. S. Sheldon, B. G. Cox, and M. L. Smith
Research Triangle Institute
Research Triangle Park, N. C.

J. E. Rizzuto
New York State Energy Research and Development Authority
Albany, N. Y.

ABSTRACT

The results of a statewide survey conducted in over 2,000 homes to determine the distribution of radon concentrations in the main living area and basement of single-family, owner-occupied, homes in New York State are presented. The participants were selected by a random-digit-dialing procedure developed by Mitofsky-Waksberg. After completing a questionnaire and obtaining agreement to monitor their homes, alpha track detectors were mailed to the eligible participants. One main-living-area detector was returned by mail after two months while a second main-living-area detector and a basement detector (if applicable) were returned after a year. The statewide mean for the two-month living-area readings was 1.4 picocuries per liter (pCi/l), with a mean of 1.1 pCi/l for the twelve-month living-area readings and 2.7 for the twelve-month basement readings.

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INTRODUCTION

While radon levels and their possible health effects have been studied widely, these studies were usually limited to small geographic areas and/or few homes. The lack of large-scale surveys to determine the frequency distribution of radon exposure for the general population has been of concern to scientists (1). The study reported here is rare in that a probability sample of sufficient magnitude was drawn to make inferences to a whole state and to seven geographic regions within the state.

Under contract to the New York State Energy Research and Development Authority, the Research Triangle Institute (RTI) conducted a statewide survey to determine the distribution of indoor radon concentrations in New York State. The survey, based on a statewide probability sample, was limited to year-round, owner-occupied, single-family homes where the owner did not move during the twelve month monitoring period. The state was divided into seven regions, based on geological and geographic factors. The number of samples per region was based on several factors, including anticipated radon concentration, population of the area, and cost of interviewing. Homeowners were initially contacted by telephone to determine if they met eligibility requirements and then to determine their willingness to participate in the study. Eligible participants were mailed two alpha track radon detectors to be placed in the main living areas of their homes, one to be returned by mail after two months, the other to be returned by mail after twelve months. For houses with basements, a third detector was sent to be placed in the basement for a year. This paper summarizes the radon levels for the three area/time phases of the study for each of the seven regions and for New York State as a whole. A detailed description of the study design and analysis results is given in (2).

SAMPLE DESIGN AND SELECTION

The radon survey had as its target population housing units in New York State that were (a) year-round residences, (b) single-unit, and (c) owner-occupied. The target population for the survey was further limited to those housing units in which the owner resided for the next twelve months. The sample for the telephone survey was selected using the Mitofsky-Waksberg random-digit-dialing procedure (2) within the seven regions. The seven regions were:

(1) eastern southern tier (Broome, Chemung, and Tioga counties),
(2) the central and western counties (characterized geologically by undeformed sediments),
(3) northeastern counties (characterized by metamorphic rocks),
(4) eastern counties (characterized by deformed sediments and rocks),
(5) Staten Island,
(6) Long Island, and
(7) New York City.

These seven regions are shown in Figure 1.

Use of the Mitofsky-Waksberg random-digit-dialing procedure resulted in calls to a total of 21,813 telephone numbers. These numbers comprised the bank of telephone numbers from which calls were made by RTI's CATI (computer assisted telephone interviewing) personnel. Of the telephone numbers selected, 7,678 or 35 percent were working residential numbers. Fifty-four percent of these or 4,147 working residential numbers were determined to be eligible households while 92 percent or 3,813 yielded a completed interview. Of these, 131 households were ineligible due to the respondents' plans of moving within the next twelve months. This meant that 97 percent or 3,682 respondents satisfied the movement status criteria. Of those who satisfied the movement criteria, 89 percent or 3,264 households agreed to monitoring. From those who agreed to monitoring, a probability sample of 3,115 households were mailed detectors.

In addition to survey objectives, certain quality control (QC) measures were considered necessary to assure data quality. QC activities included blank and duplicate monitoring of a subsample of homes for each of the detector-place-time period combinations. QC homes were selected at random according to waves of radon detector monitor mailouting periods which coincided with periods of data collection. Prior to a detector mailout, a five percent sample of eligible households was selected to form each QC subsample. This procedure resulted in selecting a total of 906 cooperating nonmoving households for the QC sample. A detailed description of the QC procedures and results is given in (2).

RESULTS

Weighted summary statistics for the short-term (two to three winter months) living-area radon levels are given in Table 1. These statistics represent population estimates since probability sampling techniques were used to obtain the data. Short-term monitors were returned by 2,401 participants representing an estimated population of 2,600,830 homes. The average radon concentration in the living area for the state was 1.4 picocuries per liter (pCi/l), with a maximum of 39.8 pCi/l. The geographic regions did show some variability in concentrations. Of the seven regions, the eastern southern tier showed the highest concentrations followed by the eastern area (deformed sediment and rock), the central and western region (undeformed sediment), and the northeastern area (metamorphic sediments). New York City, Staten Island, and Long Island showed the lowest average levels with 0.8, 0.8, and 0.9 pCi/l, respectively.

Overall, the long-term (approximately twelve months) living-area radon concentrations were lower than the short-term results as shown in Table 2. This was expected since the short-term study was conducted during the winter months when most houses are kept closed. The state average for the long-term living-area results was 1.1 pCi/l with a maximum of 38.3 pCi/l. As with the short-term results the eastern southern tier showed the highest overall levels while Staten Island, Long Island, and New York City showed the lowest.

The long-term basement levels were generally higher (see Table 3) than either of the living-area results. For the state the average was 2.7 pCi/l with a maximum of 115 pCi/l. The pattern for the seven regions was the same as in the living-area results.

In comparing the three area readings, the short-term living-area concentrations were, on average, about 1.5 times higher than the long-term living-area concentrations for homes where both readings were available. The basement concentrations were, on average, about three times higher than those for the long-term living-area for homes where both readings were received. These ratios were fairly consistent for each of the seven geographic regions.

The concentrations for the three area/time phases of the study are summarized in Figure 2. The figure shows the percentage of concentrations below 4 pCi/l, between 4 and 20 pCi/l, and above 20 pCi/l for short-term living area, long-term living area, and long-term basement readings in the state, the eastern southern tier, and Staten Island. These levels were chosen because EPA guidelines recommend that no action be taken to reduce radon levels in homes with readings of less than 4 pCi/l, while for homes with readings between 4 and 20 pCi/l EPA recommends action should be taken within a few years. For homes with readings above 20 pCi/l, action should be taken within several months. The figure demonstrates the major trends in the results -- (1) for the state approximately 95 percent of the living area readings and 86 percent of the basement reading were below 4 pCi/l, (2) the short-term levels tended to be higher than the long-term living-area concentrations, (3) the basement readings tended to be the highest of the three, (4) there was variability among the seven regions with the eastern southern tier having the highest concentrations (e.g. only 55 percent of the basement readings were below 4 pCi/l) and Staten Island tending to be the lowest (e.g. 100 percent of the basement readings were below 4 pCi/l), and (5) there were very few readings greater than 20 pCi/l (e.g. for the state only 0.3 percent in the living area and 1.4 percent in the basement).

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Figure 1.

Seven Geographic Regions

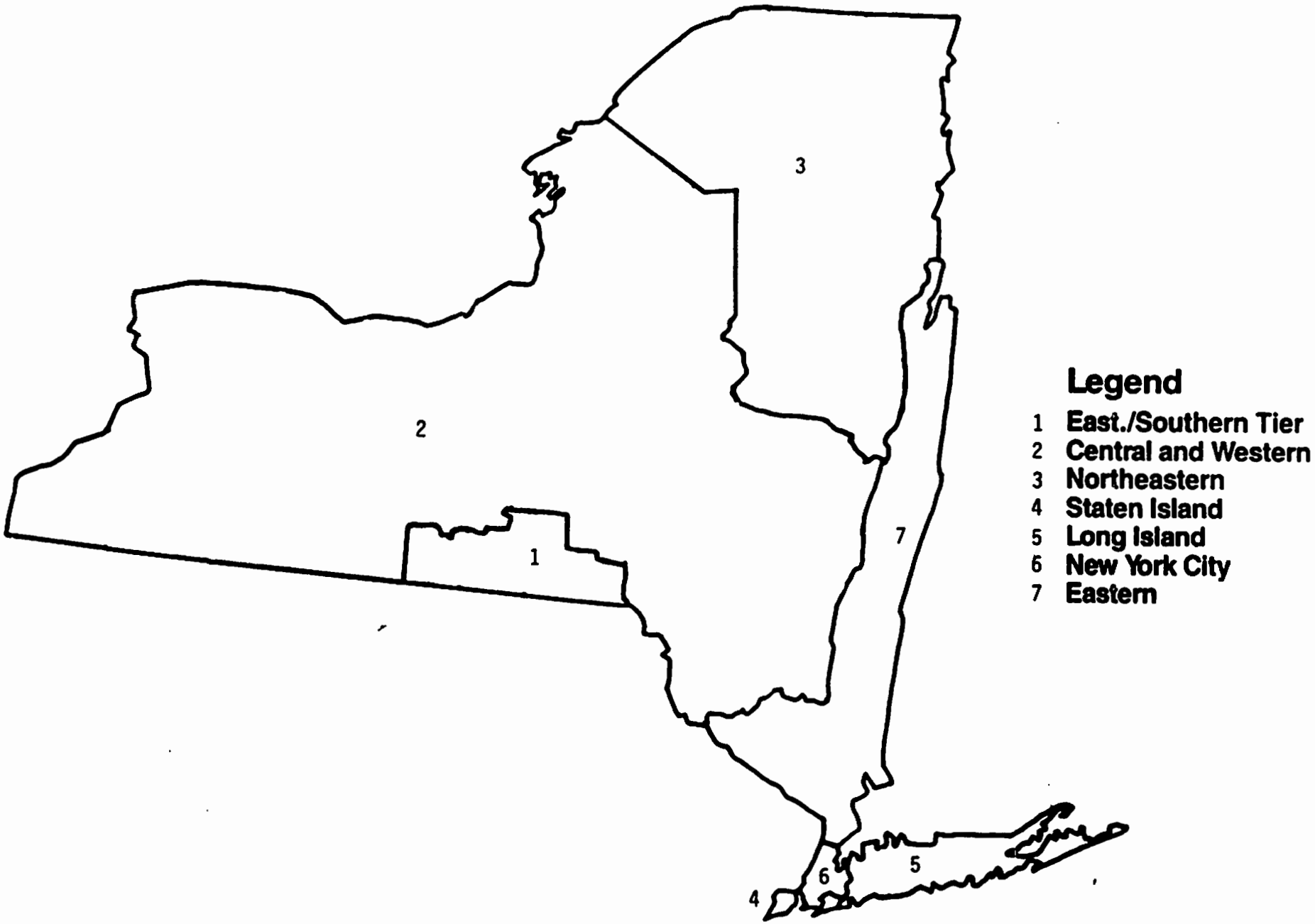

Figure 2. Percentages Below 4 pCi/L, Between 4 and 20 pCi/L, and Above 20 pCi/L for New York State and Two Geographic Regions

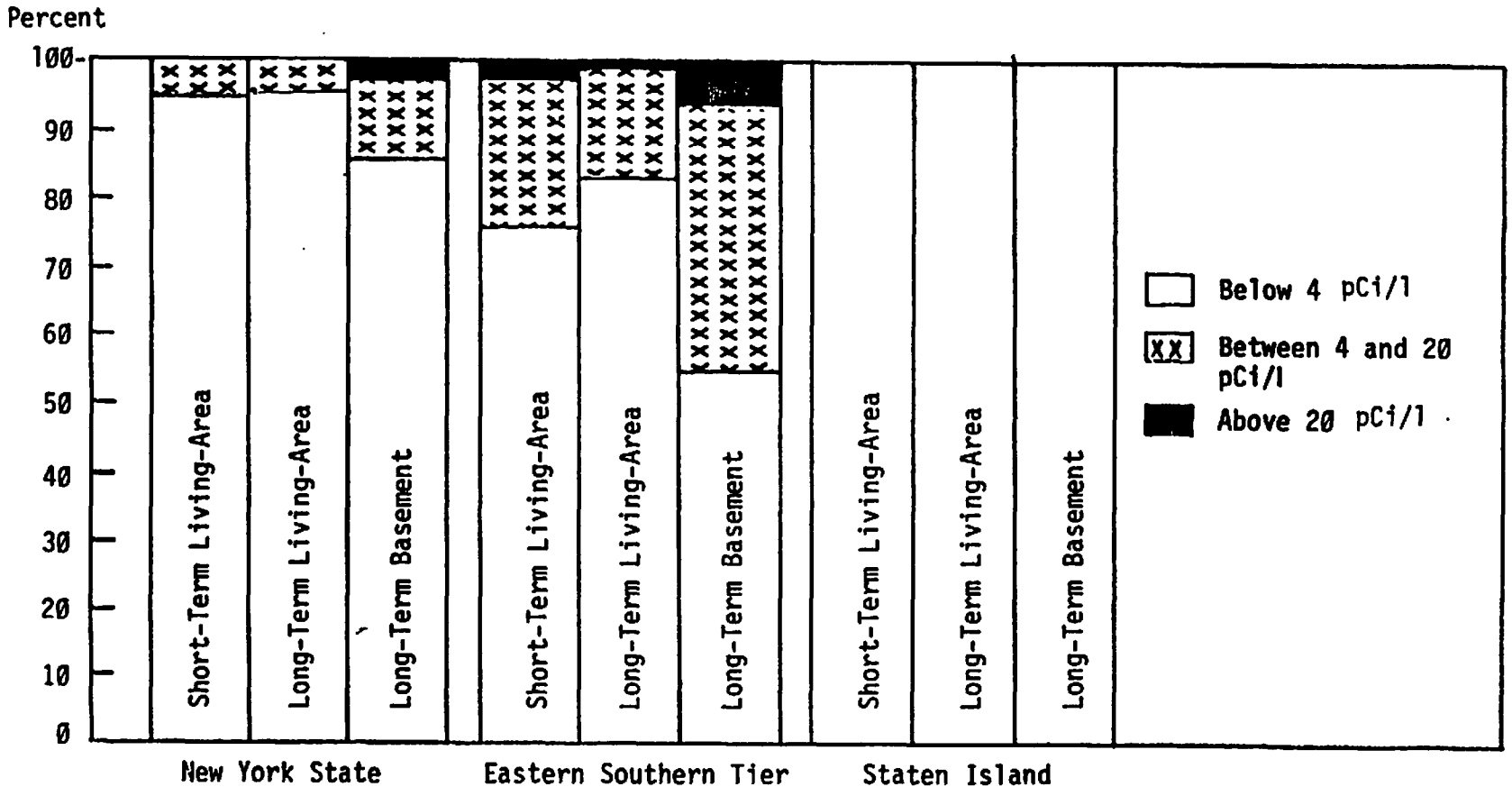

TABLE 1. WEIGHTED SUMMARY STATISTICS (pCi/L) FOR THE NEW YORK STATE SHORT-TERM, LIVING-AREA RADON STUDY, OVERALL AND BY GEOGRAPHIC REGION

Region	Sample Size	Population Estimate	Mean	Std. Error	Median	90th Percentile	Maximum
State	2401	2,600,830	1.39	0.05	0.86	2.51	39.8
Eastern Southern Tier	346	82,929	3.34	0.30	1.31	8.81	39.8
Central & Western	767	1,078,804	1.58	0.10	0.95	3.21	28.4
North-eastern	545	137,452	1.09	0.08	0.81	1.86	21.6
Eastern	276	374,910	1.82	0.18	1.06	3.42	20.9
Staten Island	51	58,676	0.75	0.06	0.63	1.22	2.4
Long Island	335	563,816	0.87	0.04	0.73	1.75	3.4
New York City	81	304,243	0.81	0.08	0.78	1.46	2.4

TABLE 2. WEIGHTED SUMMARY STATISTICS (pCi/L) FOR THE NEW YORK STATE LONG-TERM, LIVING-AREA RADON STUDY, OVERALL AND BY GEOGRAPHIC REGION

Region	Sample Size	Population Estimate	Mean	Std. Error	Median	90th Percentile	Maximum
State	2043	2,598,722	1.13	0.05	0.6	2.2	38.3
Eastern Southern Tier	307	81,810	2.65	0.26	1.2	6.0	38.3
Central & Eastern	655	1,075,537	1.33	0.08	0.8	2.7	21.7
North-eastern	465	137,475	0.88	0.06	0.6	1.7	9.5
Eastern	238	377,165	1.51	0.15	0.9	3.2	16.2
Staten Island	41	58,408	0.55	0.06	0.4	1.1	2.3
Long Island	273	563,816	0.68	0.04	0.5	1.2	7.4
New York City	64	304,512	0.64	0.10	0.5	1.4	5.1

TABLE 3. WEIGHTED SUMMARY STATISTICS (pCi/L) FOR THE NEW YORK STATE LONG-TERM, BASEMENT RADON STUDY, OVERALL AND BY GEOGRAPHIC REGION

Region	Sample Size	Population Estimate	Mean	Std. Error	Median	90th Percentile	Maximum
State	1,716	2,187,865	2.68	0.13	1.4	5.3	115.
Eastern Southern Tier	262	70,186	6.58	0.69	3.6	14.7	115.
Central & Eastern	561	912,234	3.05	0.25	1.5	6.7	52.9
North-eastern	371	112,241	2.56	0.35	1.3	4.4	65.7
Eastern	199	300,925	4.02	0.36	2.2	9.0	31.5
Staten Island	35	46,836	1.35	0.17	1.2	3.2	3.6
Long Island	231	461,512	1.49	0.08	1.2	2.9	6.5
New York City	57	283,929	1.30	0.13	1.1	2.4	3.5