Catalogue no. 12-001-X
ISSN 1492-0921

Survey Methodology

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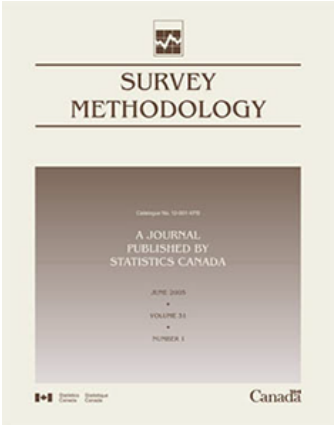

by Jae Kwang Kim

Release date: June 29, 2026

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Survey Methodology, June 2026
Vol. 52, No. 1, pp. 271-284
Statistics Canada, Catalogue No. 12-001-X

A conversation with Wayne A. Fuller

Jae Kwang Kim[1]

Abstract

Wayne A. Fuller is a leading figure in statistics whose career at Iowa State University (ISU) began in 1959; he is now Distinguished Professor Emeritus in Statistics and Economics. This article briefly recounts his early life and training in agricultural economics at ISU and highlights influential contributions spanning time series analysis, measurement error models, and survey sampling. It documents his impact through seminal textbooks, methodological advances such as the Dickey-Fuller test and regression estimation, sustained work on major operational surveys (e.g., the National Resources Inventory), and mentorship of many graduate students. The article includes an interview conducted on May 20th, 2025, at Professor Fuller's home.

Key Words: Measurement error models; National Resources Inventory; Regression estimation; Survey sampling; Time series analysis.

1. Introduction

Wayne A. Fuller joined the Iowa State University (ISU) Department of Statistics as an assistant professor in 1959 and is currently Distinguished Professor Emeritus in Statistics and Economics.

Over more than five decades, Fuller's research has advanced three distinct areas – time series analysis, measurement error models, and survey sampling. His paper with David Dickey on the unit root test (Dickey and Fuller, 1979) has over 45,000 citations as of the interview date according to Google Scholar. His textbooks on time series models (Fuller, 1996) and measurement error models (Fuller, 1987) have shaped both pedagogy and applied work.

In survey sampling, he pioneered regression estimation (Fuller, 1975; Huang and Fuller, 1978; Fuller, 2002) and supported its practical use through software such as PC CARP (Schnell, Kennedy, Sullivan, Park and Fuller, 1988); his long engagement with the National Resources Inventory exemplifies research tightly connected to real-life problems. He has also made very important research contributions on asymptotic theory for survey sampling inference (Isaki and Fuller, 1982), small area estimation (Battese, Harter and Fuller, 1988), treatment of missing data (Kim and Fuller, 2004), quantile estimation (Francisco and Fuller, 1991), two-phase sampling (Fuller, 1998) and analysis of repeated surveys (Fuller, 1990), among others. His sampling textbook (Fuller, 2009) summarizes his unique and original treatment of the research topics in survey sampling. Fuller also contributed extensively to the official statistics community, including service as chair of Statistics Canada's external advisory committee for roughly two decades, and he supervised 72 Ph.D. students over his career.

This article provides a profile of Fuller's early life, long-spanning career, and influential research contributions. While his research contribution goes beyond the area of survey sampling, the paper mainly focuses on survey sampling and its related areas. The remainder of the paper is organized as follows:

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Section 2 consists of a biography of Wayne Fuller, Section 3 reproduces an interview with me at his home. The article concludes with some historical remarks on the Survey Section at ISU in Section 4.

2. Biography

Wayne Arthur Fuller (born 1931, Brooks, Iowa) attended a one-room schoolhouse in Adams County before enrolling at Iowa State University (ISU) in 1949. He served in the U.S. Army from 1952 to 1954 and subsequently completed a B.S. in agricultural business (1955), an M.S. (1957), and a Ph.D. (1959) in Agricultural Economics, all at ISU. In 1959 he joined the ISU Department of Statistics as an Assistant Professor and was named Distinguished Professor in 1983.

Throughout his decades-long career in statistics, Fuller has been considered a leading researcher with seminal textbooks and articles in three distinct fields – time series analysis, measurement error models and sample surveys – a feat rarely achieved. He has mentored nearly 100 master's and doctoral students at ISU. He has worked closely with many government agencies seeking to improve the information they provide to the public.

A long-time affiliate of the Statistical Laboratory's Survey Section, now the Center for Survey Statistics and Methodology, Fuller helped establish a robust technical research program. He played a central role in shaping the National Resources Inventory (NRI), a major land survey that provides data on land cover and use, soil erosion, conservation practices, and related agro-environmental indicators for U.S. non-federal lands. His leadership underpinned ISU's durable collaboration with the U.S. Department of Agriculture (USDA) and the development of statistically sound, policy-relevant estimates of natural-resource conditions and trends.

Fuller also served as an adviser and technical consultant to multiple agencies on survey redesign and estimation. Working with the National Agricultural Statistics Service, he developed model-based approaches to improve small-area estimates, laying foundations for reliable statistics for small geographic areas and population subgroups (e.g., local poverty rates). With the U.S. Census Bureau, he contributed to advances in sampling, estimation, and evaluation for the decennial census and other surveys. For roughly two decades he chaired Statistics Canada's technical advisory board, fostering a culture of rigorous methodological review and continuous improvement. He led a line of research with USDA in response to a call by the National Research Council to improve how American dietary intake data are collected and evaluated to provide estimates of nutritional status and food intake patterns (Nusser, Carriquiry, Dodd and Fuller, 1996).

He has received numerous prestigious awards from professional societies, as well as from ISU. He is a fellow of the American Statistical Association, the Econometric Society, the Institute of Mathematical Statistics, and an elected member of the International Statistical Institute. His editorial service includes roles with the American Journal of Agricultural Economics, Journal of the American Statistical Association, The American Statistician, Journal of Business & Economic Statistics, and Survey Methodology. He has served

on numerous National Academy of Sciences panels and was a member of the Committee on National Statistics. Major recognitions include the Marvin Zelen Leadership Award in Statistical Science (2003), the Waksberg Award from Survey Methodology (2002), the American Statistical Association's Founders Award (2011), and honorary doctorates from North Carolina State University (2009) and the University of Neuchâtel, Switzerland (2011).

3. Interview at Fuller's home

On May 20th, 2025, I interviewed Wayne Fuller at his house.

3.1 Childhood

Jae: Maybe we can start with your childhood.

Wayne: I was born in a farmhouse in Iowa. So I grew up on a farm. A farm then was different than a farm now. It was a typical farm for that time. We had dairy cows, hogs, sheep, and chickens. We did not have running water or electricity. That was standard for people on farms at that time. Probably my family was a little better off than the average. I like to say that my dad was a "good farmer", meaning he was good at agriculture and had a reasonable standing in the community. The postal address then was Brooks, Iowa. It's not an incorporated place but had a post office, bank, grocery store, and church. Maybe 200 people.

Jae: Are you the eldest one in your family?

Wayne: I'm the oldest, yes. I had a sister two years younger, a brother two years younger than her, and then a final brother 18 years younger than me. The last one arrived essentially the same time as I left for college. He still farms the farm where I grew up. The other two siblings are deceased. As a farm boy, I did the usual farm chores. My daily tasks included going to the well to bring in water and to a building to bring in wood and cobs for the stove. As I grew up, I got bigger tasks, graduating into milking cows, cleaning out the pig house, and those sorts of things. This was standard for people growing up on farms at that time.

Jae: But I heard you also enjoyed reading books when you were young.

Wayne: Switching over to education, I went to a one room school. This was very common at that time. It covered eight grades, and I don't think we ever had more than 12 students. It was where rural kids went to school, basically covering a distance kids could walk. My school was Jasper number three. I was fortunate; I had an excellent teacher, Darlene Harlow, for about six of those eight years, and I consider it the most influential part of my education. I learned how to enjoy learning. The county would bring books from town to our school, and if you got your assignments done, there were books to read.

Jae: I see. How was your high school?

Wayne: After the one-room school, I went to a town named Corning for high school. Corning had about 2,100 people then, and less than 2,000 people today. The high school was a fairly small school by modern standards. There were about 50 people in my class. I took vocational agriculture and the school also offered a pre-college track. The basic difference was those doing pre-college took Latin. I was thinking agriculture and farming at that time. I took pretty similar sorts of stuff to those in the pre-college track, like physics and English courses. I took speech and participated in extemporaneous speaking.

Jae: Not much mathematics in your courses?

Wayne: I took some, enough to be admitted to college unrestricted. In my last year, it was noticed I didn't have the last math course required for college, so the principal said if I could find enough people, they'd offer it. I asked some friends, who were very good friends, and they said yes.

Jae: So you wanted to take a math course and asked your friends to register so it could be taught.

Wayne: Yes. I did reasonably well in high school.

Jae: I think you must have been the top student in your class.

Wayne: I was.

3.2 College, Army, and Graduate School

Jae: So then going to college must have been a natural choice.

Wayne: Yeah. And I was still thinking of agriculture. And so I enrolled at Iowa State. And even though I was still thinking agriculture, I didn't really want to do animal science or agronomy. So I looked around and agricultural economics seemed a reasonable choice. So I signed up for agriculture economics as my major. I went to college for three years and then I was drafted into the army during the Korean War.

Jae: Korean War, from 1950 to 1953!

Wayne: When I began college, all males entering Iowa State had to take two years of reserve officer training. But I failed the physical because of my eyesight. So I didn't take the Reserve Officer Training Course (ROTC). But when I was drafted, I was healthy enough to serve. They needed people. And in fact, after a little while, I was offered a chance to go to officer's training. But I chose to stay an enlisted man for the two years.

Jae: That was 1952?

Wayne: Yes. I graduated high school in 1949 and three years would be 1952. After the Korean war, I came back to do the last year of my college. I met Evelyn Steenford in that last year, my wife-to-be.

Jae: so that was 1954-1955, right?

Wayne: That's right. An Econ [economics] professor, Raymond Beneke, told me that I should go to graduate school. In fact, the department hired me for a year and I took some courses as well as being an employee. After that first year I switched to a full-time graduate student. Evelyn and I got married in 1956.

Jae: I see. Married as a graduate student.

Wayne: As a graduate student, Yeah. She graduated when I did, which was in 1955. She spent a year with the Public Health Service in Staten Island. When she came back from that, we got married.

Jae: How was your graduate study in economics?

Wayne: Ray Beneke was advising me, but he developed some very severe health problems and went on leave. Geoffrey Shepard became my advisor. And I also worked a lot with George Ladd to complete my PhD in Agricultural Economics. At that time you had to have a minor outside of your major. I chose to minor in statistics.

Jae: That's nice.

Wayne: I don't know exactly how, but T.A. Bancroft, the head of the Statistics Department, became a member of my committee.

Jae: That's interesting.

Wayne: As I was getting along towards the end and started looking around for a job, Bancroft offered me a job in statistics. I thought, well, if I go into the department and study up on statistics, I'll be in pretty good shape to be an econometrician. So, I took that job.

Jae: Wonderful!

Figure 1 A picture of Wayne taken at the age of 21

3.3 Early career in statistics

Jae: Okay, so you had finished your PhD study in agricultural economics and minored in statistics. How did your early career in statistics begin?

Wayne: When I got there, I knew I would have a teaching assignment. Bancroft put me in a building with the survey group. It was a wood barracks building, not a very nice place, with no air conditioning and only two phones. I shared a cubicle with another faculty member, Leroy Wolins. Across the hall was H.O. Hartley. They gave me an assignment to work with some sociologists who had conducted a survey. That was my first job on a survey. I had taken one survey statistics course before. I ended up being a joint author on their publication. I didn't realize it at the time, but the survey group was actually paying part of my salary. I didn't know it was a formal arrangement. I also had to work very, very hard that first year teaching "Statistical Methods for Research Workers" to economists, using Snedecor's book (Snedecor, 1956).

Jae: So, you were initially involved with teaching and the survey group right away.

Wayne: That's right. My involvement with the survey group increased in 1962. We had made arrangements for me to do a trade with Harold Huddleston from the Department of Agriculture, where I would go to USDA and Huddleston would come to Ames. We had it all set up to start in the fall of 1962. But in July, the professor in charge of the survey group, Norman Strand, had a very severe heart attack. I was forced to cancel the exchange and take over being the professor in charge of the survey group.

Jae: That sounds like an unexpected turn, especially since you initially thought about becoming an econometrician.

Wayne: Yes, you're quite right. I just stumbled along. Norm Strand did eventually come back after a while. Later, I received an NSF (National Science Foundation) postdoc to go to Stanford in 1964-65. I essentially used that time to complete the formal training for a PhD in statistics.

Jae: What was it like starting your academic career in statistics during that period?

Wayne: It was an excellent time to start. Sputnik had gone up not too long ago, in 1957. There was a lot of growth in universities and science. There was a real demand, and promotions came much more rapidly than they do now. So, it was a good time to start. In those early years, the biggest fraction of my time was spent consulting with people in agriculture – in economics, animal science, agronomy, and education. This was part of an agreement that the statistics department would provide consulting to people in agriculture. My duties were teaching, consulting, and the survey group. I published back then too, in agricultural economics journals, and often as a joint author with people I consulted with in animal science and agronomy.

Jae: Did you meet J.N.K. Rao at that time?

Wayne: Oh yes. After I moved into Snedecor Hall, I shared an office with Jon (J.N.K.) Rao. And we became real friends, and we remain real friends to this day.

Jae: Jon Rao is certainly a very well-regarded figure in statistics. What was it like working alongside him during those years?

Wayne: Well, he is a very bright person, and young. As I mentioned, there was a big demand for professors back then, and the minute I joined the statistics faculty, I started serving on committees for students in economics. Jon Rao, when he became a faculty member right after getting his PhD at Iowa State, immediately started serving on graduate student committees in statistics.

Figure 2 1967. T.A. Bancroft (center) with Wayne Fuller (left) and Mohammed Yusuf (right)

Jae: I imagine working with graduate students can be quite demanding?

Wayne: Yes, it can. Jon Rao could be demanding. I tell the story that he would come upstairs after a graduate student committee meeting and say, “Oh, that was a terrible student. Couldn’t even integrate the gamma”. And I would say, “Jon, what’s a gamma?”.

Jae: You must have worked hard during your visit to Stanford to catch up with the statistical theory.

Wayne: Yes, I did.

Jae: Did your research interests develop quickly in the early years?

Wayne: When Gerhard Tintner left Iowa State, I started teaching an econometrics course and a time series course. Bea Shube, statistics editor for Wiley, suggested writing a time series book, based on my course notes, which became my time series book. That’s how I became a member of the time series “crowd”.

Jae: Your book on time series was very influential.

Wayne: Yeah. I did a second edition in 1996.

Jae: You also made a big contribution on measurement error models, but the topic was not well appreciated. Maybe your measurement error book was too difficult to read.

Wayne: It could be. I got interested in measurement error from doing an evaluation on a project in the survey section that used re-interviewing.

3.4 Contribution to survey sampling

Jae: And survey sampling seems to have been your constant interest throughout your career?

Wayne: Yes, I did survey sampling throughout that whole period. It was an important part of my career. I think I became recognized as a member of the survey sampling community through attending ISI (International Statistical Institute) meetings. In those early years, I also worked on a project with Tom Jabine at the Census Bureau, which exposed me further to survey sampling. I used to go in regularly to the Census Bureau and met with people like Hurwitz. He was a good listener, even to young people. I was a big fan of regression estimation and would try to convince them that they ought to be doing it with the new powerful machines available. They listened, but it didn't happen immediately.

Jae: Yes, you are the pioneer in regression estimation but it has not been fully recognized in the survey community.

Wayne: I believe the first use of regression weights in survey sampling was on a consulting job I did with the Doane Agricultural Services in the early 60s. Later, one of my students, Mike Hidiroglou, wrote a program for regression estimation and measurement error models. The program has been borrowed and improved upon by others. I believe it was the first functional machine program for regression weighting. The PC version of the program was named PC CARP.

Jae: You mentioned your connections with the broader statistical community. Could you talk about your involvement with Statistics Canada, specifically the Advisory Board?

Wayne: Yes, I believe I joined the advisory committee for Statistics Canada partially through Jon Rao. He was a consultant for Statistics Canada in addition to being a professor at Carleton University.

Jae: What was the nature of this committee, and what was your role?

Wayne: That committee has regular meetings. When I started, Morris Hansen was the chair. When he retired as chair, I became the chair. I guess I was chair for around 20 years.

Jae: That's a significant commitment. What did you find most important or rewarding about serving on that committee?

Wayne: I enjoyed it. The most important thing about that advisory committee is that you had regular meetings with presentations from the staff. This motivates the staff to prepare the presentation, to think about what they're doing. I believe that was our primary duty – to act as a motivator. It was a very interesting and enjoyable committee to serve on.

Jae: It sounds like the committee played a crucial role in encouraging ongoing research and development within Statistics Canada. How did you find working with the Statistics Canada staff?

Wayne: Oh yes. Stat Canada has very good staff. Excellent staff. Ivan Fellegi was the Chief Statistician at that time point.

Figure 3 1983. Survey Section faculty discuss projects with visiting lecturer V.P. Godambe. L to R Mark Reiser, Jeff Goebel, Wayne Fuller, Roy Hickman, Godambe, and Ronaldo Iachan

Jae: Much of your research, and by extension, your students' research, seems rooted in real-world problems. Is that a fair assessment?

Wayne: Yes, the vast majority of my research has been motivated by real-life problems. A prime example is the National Resources Inventory (NRI). I worked on that project on land cover and land use for a very long time. Periodic reports have been produced since 1982.

Jae: I think the NRI is an important part of your professional life.

Wayne: Yes, I spent a lot of time on that project, continuing after retirement. The survey is designed to produce a continuous set of data. There have been tremendous technological changes in data collection and data processing during that time.

3.5 Student advising and research

Jae: You had an incredibly productive career, supervising a large number of graduate students. What was that experience like for you, and was working with students a rewarding part of your academic life?

Wayne: Yes, I had 72 PhD students over my career. Working with graduate students can be very rewarding, watching students grow, mature, and make valuable contributions.

Jae: Beyond the direct supervision, how did your research projects, like the NRI, involve students?

Wayne: The National Resources Inventory, or NRI, is a production operation in that we produce data sets regularly. But it's also a chance for students to participate in developing procedures that will be implemented.

Jae: Yes, I know personally that the NRI has deep roots in survey sampling research. My own PhD topic on two-phase sampling had an NRI root in it.

Wayne: That's right. The NRI is a prime example for research motivated by real-life problems. Most material in survey sampling has been tied to real problems, and the NRI is tied to a product. It's a little bit like experimental design in that sense.

Jae: It sounds like the interaction with students and providing them with real problems was a key aspect.

Wayne: Yes, it was. In fact, I'd say students were a very important reason that I stayed at Iowa State. We were able to recruit very good students into the survey group back then. In the "middle days", I had a lot of students at one time and I was pretty busy. One morning when I came to work there was a little "take a number" thing beside my door, and I put up a competing sign that said "The answer is in chapter five"! Nobody ever confessed to placing the sign, but I was certainly busy in those days!

Jae: That's a great anecdote! You indeed have a lot of very good students.

Wayne: Yes, I had a lot of very good students. How well students do on a topic is subject to chance, it depends if you put them on something that's really good, something they can develop.

Jae: Do you have any advice to young researchers in statistics?

Wayne: In terms of advice, especially looking back, I believe the most important attribute for someone in research is to be an optimist. You have to think you can solve the problem or at least make a contribution towards a solution. The people I've known who have been successful, that's really their primary attribute. You need to say, "Yeah, that sounds interesting. Let's see what we could get out of it". You also need to have confidence in your ability. What you end up with might not be exactly what you initially aimed for, but there will likely be something interesting discovered along the way.

Jae: I fully agree with you on the importance of confidence in research.

Figure 4 2001. Evelyn Fuller and Wayne Fuller

3.6 Conclusion

Jae: You must have a lot of honors and awards throughout your career. What is the honor or award that you are most proud of (or happy about)?

Wayne: On a personal basis, I prize the Margaret Ellen White Award. It is a university award for "guidance and encouragement of graduate students". The award is led by and maintained by graduate students. I met Margaret Ellen White very early in my career. She was the principal person in the Graduate College who had direct contact with graduate students and their advisors.

Jae: Also, you have been invited to give seminars or presentations from all over the world. Do you have any interesting story of your trips? I know Evelyn enjoyed going on trips with you.

Wayne: I will tell one story about the hazards of speaking. A large number of years ago, I was speaking at a university when I started feeling faint. I believe I have never fainted, but I was feeling as though I was about to collapse. I started to turn from the audience when someone in the front row stood up and helped me move away. It turned out I was directly under a heat vent. After shutting off the vent, and a moment to recover, I was able to continue.

The meetings of the International Statistical Institute are held every two years and in a different country for every meeting. Those meetings and other international conferences led to considerable international travel. Evelyn liked to travel and would often arrange an after-the-meetings tourist venture. For example, in 1987, she arranged a two-week trip around China.

Jae: Do you have any hobbies other than research?

Wayne: I enjoyed fishing and have made fishing trips to Minnesota and Alaska. Also, I have done a little duck hunting.

Jae: I think we have a full coverage of your story. Can you tell us about your family?

Wayne: Evelyn and I had two sons. The oldest, Doug, was born while I was in graduate school. He did not marry and died about eight years ago. The second son, Bret, married and they had two daughters. Each daughter married and has two daughters. Bret and one granddaughter live in the Denver area. The other granddaughter lives in the Silicon Valley area of California.

Jae: Thank you for your time.

4. Discussion

As reviewed by Kim (2023), Iowa State University (ISU) has played an important role in research and education in survey sampling. The Survey Section of the Statistical Laboratory, which later became the Center for Survey Statistics and Methodology (CSSM), was established in 1938 as a result of a cooperative agreement between the Statistical Laboratory and the U.S. Department of Agriculture (USDA). After joining in 1959, Wayne Fuller has been the key person at the Statistical Laboratory Survey Section (now known as the Center for Survey Statistics and Methodology). In 1956, the Survey Section began cooperating with the U.S. Soil Conservation Service (now the USDA Natural Resources Conservation Service) to develop survey methods and provide operational support for the National Resources Inventory (NRI), a longitudinal survey of agricultural and other natural resources on nonfederal lands. Wayne Fuller officially retired in 2001, but he continued working as a part-time consultant at the CSSM. CSSM continues to work on the NRI project today, and the survey has been the inspiration for many methodologies related to sampling and estimation (Nusser and Goebel, 1997).

Figure 5 2025. Wayne Fuller on the interview date

Acknowledgements

The author wishes to thank the Editor, Jean-François Beaumont, for his invitation and also thank two anonymous reviewers for constructive comments and suggestions.

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