EL Ed O. Vmi
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Fifth International Conference on
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MASTER

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- University of Maryland, Baltimore, MD U.S.A.
- 5:45 Testing for Linear Trends in Univariate Time Series with Stationary m-Dependent or ARMA Residuals
S.P. Niculescu and A.H. El-Shaarawi, National Water Research Institute, Burlington, Ontario, Canada
- 6:10 Analysis of the Sampling Strategy for the Long-Term Water Quality Monitoring Network on the North Saskatchewan River in Alberta, Canada
L.Z. Florence, Hai Van Nguyen, Alberta Environmental Protection, Vegreville, Alberta, Canada, *Gary Dunn*, Prairie Provinces Water Board, Regina, Saskatchewan, Canada, and *Dave Trew*, Alberta Environmental Protection, Edmonton, Alberta, Canada
- Lib. Lounge IV ALL DAY CONSENSUS/WORKSHOP - ALUMINUM TOXICITY IN HUMANS: EVIDENCE AND IMPLICATIONS
- 4:30 Organizer and Chair: *W.F. Forbes*, Statistics Canada, Ottawa, Ontario, Canada
Sub-Session Chairs: *G. Hill*, Laboratory for Disease Control, Ottawa, Ontario, Canada, *J.F. Gentleman*, Statistics Canada, Ottawa, Ontario, Canada, *T. Flaten*, University of Trondheim, Norway, *A.S. Macpherson*, McMaster University, Hamilton, Ontario, Canada
BY INVITATION ONLY (Limited space is available for observers. Contact W.F. Forbes directly or through the registration desk if you are interested.)
- Cafeteria V RISK ASSESSMENT
- 4:30 Chair: *Eric P. Smith*, Virginia Polytechnic Institute, Blacksburg, VA U.S.A.
Assessment of Size-Dependent Mercury Distributions in King Mackerel
Eberhard O. Voit and W. Leonard Balthis, Medical University of South Carolina, Charleston, SC U.S.A.
- 4:55 Quantitative Risk Assessment for Continuous Response Data
Mehdi Razzaghi, Bloomsburg University, Bloomsburg, PA U.S.A.
- 5:20 Analysis of Spatially Varying Environmental Variables for Risk Assessment Using Interactive GIS
A. Stein, Agricultural University, Wageningen, The Netherlands
- 5:45 Development of Health-Based Cleanup Levels using Probabilistic Exposure Assessment
Natalie Wilson Harrington, ChemRisk Division of McLaren/Hart Environmental Engineering Corp., Portland, ME U.S.A.
- 6:10 Survival Analyses of Radiated Animals Incorporating Competing Risks and Covariates
Ramesh C. Gupta, University of Maine, Orono, ME U.S.A., and *Richard A. Albanese*, Armstrong Laboratory, Brooks AFB, TX U.S.A.
- L205 VI SYMPOSIUM: NEW STATISTICAL METHODS IN TURBULENT DIFFUSION
- 4:30 Organizers and Chairs: *P.J. Sullivan*, The University of Western Ontario, London, Ontario, Canada, and *P.C. Chatwin*, University of Sheffield, Sheffield, United Kingdom
A Practical Method of Estimating Toxic Loads in the Presence of Concentration Fluctuations
David J. Ride, Ministry of Defence, Salisbury, Wilts. United Kingdom
- 5:00 Uncertainty in Quantitative Risk Assessment
Stephen Ramsay, University of Waterloo, Waterloo, Ontario, Canada
- 5:30 Fractal Approach to Description of Chemicals Transport in Soils
R.A. Shcherbakov and L.P. Korsunskaya, Russian Academy of Sciences, Moscow, Russia
- 7:00 - 9:00 RECEPTION (CASH BAR) -- Holiday Inn - Halton Room

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Testing for Linear Trends in Univariate Time Series with Stationary m -Dependent or ARMA Residuals

Stefan P. Niculescu and A.H. El-Shaarawi

The asymptotic normality of the Kendall's S -score statistic is investigated when the data is a realization from a stationary m -dependent or ARMA process. The corresponding tests for the presence of a linear trend are derived and their power evaluated by simulation. The results show how misleading the use of the Kendall's S -score can be if we ignore the serial dependence. The use of the new methodology is illustrated on the yearly mean Lake Erie outflow data from 1860 to 1975.

Analysis of the Sampling Strategy for the Long-Term Water Quality Monitoring Network on the North Saskatchewan River in Alberta, Canada

L.Z. Florence, Hai Van Nguyen, Gary Dunn and Dave Trew

Three long-term water quality monitoring network stations on the North Saskatchewan River in Alberta (two stations) and at the Alberta-Saskatchewan boarder are currently under review. One objective is to determine the number of independent samples needed, and frequency of sampling over time, for evaluating monitoring protocols having sufficient power ($1-\beta=0.85$) to detect linear changes in water quality variables with the Type I error set at $\alpha=0.10$. Linear change of 10% of the series mean was set as a study guideline for comparison purposes.

Summaries from analyses of 189 time series (21 variables $\times$ 3 stations $\times$ 3 monitoring schemes [monthly and bimonthly starting in January or February]) are presented here using monthly monitoring data from the years, 1978-1989. Prior to fitting data to an AR(1) process, adjustments were made for flow (discharge), trend and seasonality. Upon fitting, for reasons discussed in the paper, each series was determined to be either AR(1) or random, i.e. "white noise" (WN). Only about one-third of the monitoring variables over the network were found capable of meeting the goal of detecting a 10% trend within a reasonable time frame e.g. predictions were 1 to 14 years for the variables total alkalinity, dissolved oxygen, bicarbonate, dissolved magnesium, pH and total dissolved solids. Grouping trend sizes (%) for the 63 variable $\times$ station combinations resulted in these frequencies and years to detection: 7-29% (26/63, 1 - 14 yr); 30-49% (9/63, 7 - 14 yr); 50-264% (28/63, 7-14 yr.). Attainable series lengths of time to detection for water quality variables falling into the two larger trend groups had to be obtained mainly by identifying where the linear change would at least equal the residual or background error: $\text{TrSize}/\sigma_r \geq 1$. Otherwise, for some variables, no practical solutions appear to exist using our protocol. For example, the variable faecal coliform count at one of the stations was predicted to require 8000 years of bimonthly monitoring (January start date) to detect a linear trend as small as 10%, or 857 years to detect at least a 30% trend, or 14 year to detect at least a 264% linear change from the mean; these sorts of outcomes must obviously affect the review of this network and will be discussed in our paper.

Saturday 4:30 - 6:35

Cafeteria V RISK ASSESSMENT

Assessment of Size-Dependent Mercury Distributions in King Mackerel

Eberhard O. Voit and W. Leonard Balthis

The assessment of health risks from fish contamination and the issuance of advisories require accurate characterizations of the actual contaminant concentrations in fish of every relevant size. Such characterizations should not only contain statistical measures of location and variation, but provide a complete parameterization of the contaminant distribution for each given size class. This paper proposes two methods for determining such distributions from scatter diagrams of contaminant concentration versus fish length and illustrates them with an analysis of mercury contaminant in king mackerel, *Scomberomorus cavalla*. The first method consists of fitting contamination data with a family of S-distributions. This family shows trends in its defining parameter values, and these trends provide a comprehensive characterization of the measured contaminant concentrations. Each S-distribution has a rather simple mathematical structure from which one readily obtains secondary characteristics like quantiles, which are necessary for advanced simulation purposes. The second method takes into account that contaminant accumulation is the outcome of a metabolic process. When this process is modeled as a system of differential equations, it can be reformulated in such a way that it describes how the contaminant distribution changes over a given period of time. The resulting distributions have a more complicated structure than those obtained with the first method, but they allow us to bridge the gap between individual metabolic accumulation processes and trends in populations.

Quantitative Risk Assessment for Continuous Response Data

Mehdi Razzaghi

Environmental risks have become an important concern to scientists, policy makers, government regulators and the general public. Numerous attempts have been made in recent years to characterize and control environmental hazards. It is generally believed, however, that any rational approach to management of environmental risks should be based on valid information obtained from rigorously conducted studies of the human health risks associated with specific environmental agents. Increasingly, statistical methods are used to identify specific environmental and occupational hazards and to estimate the levels of risk likely to be associated with them. Recently, there has been growing recognition of the need for an inter-disciplinary approach to health risk assessment and, specifically, for integrating the methods and results of statistical, epidemiological, toxicological, and other research in order to derive valid estimates of human risk. The process of risk assessment generally consists of four stages: hazard identification, dose-response description, human exposure assessment, and quantitative risk characterization. Hazard identification is the process of establishing the potential for toxic effects in humans as a result of exposure to a substance. Dose-response relationships are generated from experimental data in order to estimate the relationship between the risk and dose of a toxic substance. Exposure assessment is the process of determining the nature and extent of human exposure from toxic substances present in the environment. The final step of the risk assessment process involves the integration of the available data to estimate risk for various exposure conditions.

Here, our discussion is focused on quantitative risk estimation. The emphasis is therefore, on the development of dose-response relationships to provide numerical estimates of risk as a function of dose. While there have been many studies to consider the process of risk assessment for quantal response data, comparatively less attention has been given to the situation where bioassay data are from continuous variables. This is partly because it is relatively more difficult to define an adverse effect for continuous toxic responses. Likewise, the proper definition of risk in the case of binary toxic responses can easily be characterized, whereas the corresponding definition of risk for continuous responses is not as intuitive. In this paper, we discuss different methods and models that have been proposed and used for quantitative risk assessment when responses are continuous measurements. A new model will also be introduced which accounts for the concept of heterogeneity of populations in the form of a mixture of distribution. Since in many bioassay experiments it has been observed that some subjects in the treatment group are more susceptible when exposed to a treatment, the model provides an adequate relationship between the probability of response and the dose of a chemical. The problem of quantitative risk assessment using the proposed dose-response model will be discussed and some examples will be used to illustrate application of the model.

**Assessment of Size-Dependent Mercury
Distributions in King Mackerel,
*Scomberomorus cavalla***

Eberhard O. Voit[†] and W. Leonard Balthis^{†‡}

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Mercury is bad for you

- Occurs naturally and from anthropogenic sources.
- Methylation to more toxic methylmercury by bacteria
- Accumulation in food chains:
 Water → edible fish tissue may exceed 10 million
- Human population exposed through consumption of fish and seafood
- Global levels of atmospheric mercury vapor and mercury in precipitation
- Outbreaks of methylmercury poisoning in Japan and Iraq
- Tolerable intake exceeded in fishing countries
- Fetus 10 times more sensitive than adults

Data

National Marine Fisheries Service
Microconstituents Program

800 fish

Length distribution

Contaminant distribution

Contaminant concentration vs. Length

(Contaminant accumulation
Consumption)

Parameter values of S-distributions modeling mercury concentrations in king mackerel of different lengths

Length Class	$\alpha = 1/s$	g	h	Median
$L \leq 0.65m$	5.6080	1.3610	1.5980	0.29
$0.65m < L \leq 0.75m$	5.5562	1.5310	1.7833	0.33
$0.75m < L \leq 0.85m$	3.9550	1.2960	1.4650	0.55
$0.85m < L \leq 0.95m$	2.8549	1.2409	1.4222	0.76
$0.95m < L \leq 1.05m$	2.1975	1.0843	1.2242	1.02
$1.05m < L \leq 1.15m$	1.7004	1.1769	1.3530	1.23
$1.15m < L$	1.7757	1.2560	1.4246	1.58

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