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PROCEEDINGS:

# NORTH AMERICAN FOREST INSECT WORK CONFERENCE

## Forest Entomology: Vision 20:21

NORTH AMERICAN FOREST INSECT WORK CONFERENCE
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VISION 20:21
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A second point of discussion focused on the use of the term "noise" when referring to the influence of external factors lumped into the "random variable" category. It was suggested that "noise" should be restricted to the idea of "error" around population estimates (a strictly additive term), and that "perturbations" should be used when referring to factors that have an impact on the TRAJECTORIES adopted by the population processes rather than just adding fuzziness to that trajectory. In most population processes where density dependence must exist, the influence of external factors is filtered through the population system and becomes an intrinsic part of the population trajectory.

In summary, this was a very interesting workshop, at the end of which peace was made between proponents of diverging modelling approaches to population studies. Luckily, nobody suggested that models were not useful. Also, the issue of "simple" *vs* "big ugly" models (Logan 1994) was avoided altogether.

## ROLE OF MODELS IN POPULATION STUDIES

T. Royama[a]

Population studies depend heavily on the use of models. There are different types of models: descriptive, explanatory, deterministic, stochastic, linear, nonlinear, etc. These serve different purposes at different levels or stages of progress in research. A model is, by definition, not a real thing; it is a paradigm or idealization of essential features that we wish to abstract from observations. It is important to use a model within the scope it is designed for. An uncritical application and over-interpretation of a model results in distorted perceptions of population processes. [This presentation discussed the bases and caveats of time series analysis applied to population census data, by describing and applying increasingly "complex" linear stochastic processes to mimic observed time series with a view of inferring the underlying regulation structure.] [ ]Added by J. Régnière.

## DETECTION OF DELAYED DENSITY DEPENDENCE IN ECOLOGICAL TIME SERIES: EFFECTS OF AUTOCORRELATION IN EXOGENOUS FACTORS

A. M. Liebhold[b] and D. W. Williams[c]

Delayed density-dependence is important in regulating animal populations, and recent work has suggested analytical methods for its detection in population censuses. However, theory suggests that autocorrelation in an exogenous factor, such as weather, which acts in density-independent fashion, may give the appearance of delayed density dependence. We examined this question through stochastic simulations of a linear difference equation model and a discrete version of the logistic model, neither of which contained lags. The random term for the simulations was modeled as a first order autoregressive process. We varied the parameters that determine direct density dependence in the population models and autocorrelation and random variation in the exogenous factor, and subjected the resulting series to time series analysis and regression analysis. Using these methods, many simulated series were diagnosed with significant delayed density dependence, and the frequencies of significant cases also increased as the parameter for direct density dependence increased in the linear model, and decreased as $r$ increased in the logistic model. We concluded by discussing generalist predators and weather as possible autocorrelated exogenous factors and urged caution in the use of single-species models and analyses in predicting populations and diagnosing their regulation.

## TEMPORAL EVOLUTION OF SPATIAL PATTERNS IN MOUNTAIN PINE BEETLE OUTBREAKS

James Powell[d]

We discussed how aggregative population movement can generate spatial heterogeneity, using a model for the chemotactic movement of the mountain pine beetle (MPB) (*Dendroctonus ponderosae* Hopkins) and its 'predator-prey' interaction with host species, in particular lodgepole pine (*Pinus contorta* Douglas). Since the prey species is immobile, the predator disperses only once a year, and the details of the

interaction are well-understood qualitatively, we have a singular opportunity to examine deterministic creation of spatial-complexity in an important ecological system.

We have examined the ecological impact of the model's spatial pattern formation. Preliminary indications are that endemic MPB dispersal is dominated by environmental considerations. In epidemic infestations, dispersal is initially seeded by environmental factors, but correlation is rapidly lost. The influence of detailed ecological circumstances on model output, including distribution of sources, timing and density of emergence, indicates that population models without spatially-extended dynamics will never be descriptive.

## A SIMPLE MODEL OF INTERACTIONS BETWEEN VARIOUS GROUPS OF NATURAL ENEMIES AND THE SPRUCE BUDWORM

Jacques Régnière[d]

A simple descriptive model is being developed to investigate the outcome of the interactions between spruce budworm and its major natural enemies as a function of environmental conditions. In this model, natural enemies have been divided into three groups: generalist predators, the microsporidian *Nosema fumiferanae* (Régnière 1984), and multivoltine parasitoids that require alternative hosts for completion of their life cycle. A logistic function is used as a description of interactions with host plants. Preliminary investigation of the behavior of this model was presented. Interesting parallels can be established between model outputs and actual budworm populations in terms of the changes in relative importance of the three groups of natural enemies over the course of an outbreak. Also, there are striking resemblances between model output and observations in terms of outbreak severity, duration, and frequency, in response to changes in parameter values reflecting changes in environmental conditions (habitat harshness and species diversity).

REFERENCES

Powell, J.A., J.A. Logan, and B.J. Bentz. 1996. Local projections for a global model of mountain pine beetle mass attacks. J. Theor. Biol. 179: 243-260.

Logan, J.A. 1994. In defense of big ugly models. Amer. Entomol. 40: 202-207.

Régnière, J. 1984. Vertical transmission of diseases and population dynamics of insects with discrete generations: a model. J. Theor. Biol. 107: 287-301.

Royama, T. 1992. Analytical population dynamics. Population and Community Biology Series 10. Chapman & Hall, NY.

Royama, T. 1996. A fundamental problem with key factor analysis. Ecology 77: 87-93.

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