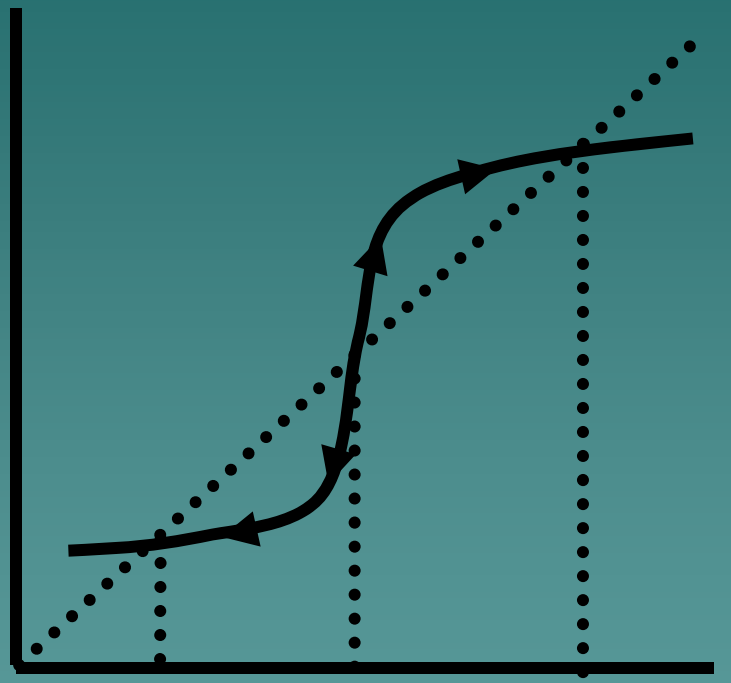
An Emergent Economics of Ecosystem Management

By E. J. S. Hearnshaw, R. Cullen, K. F. D. Hughey
Lincoln University

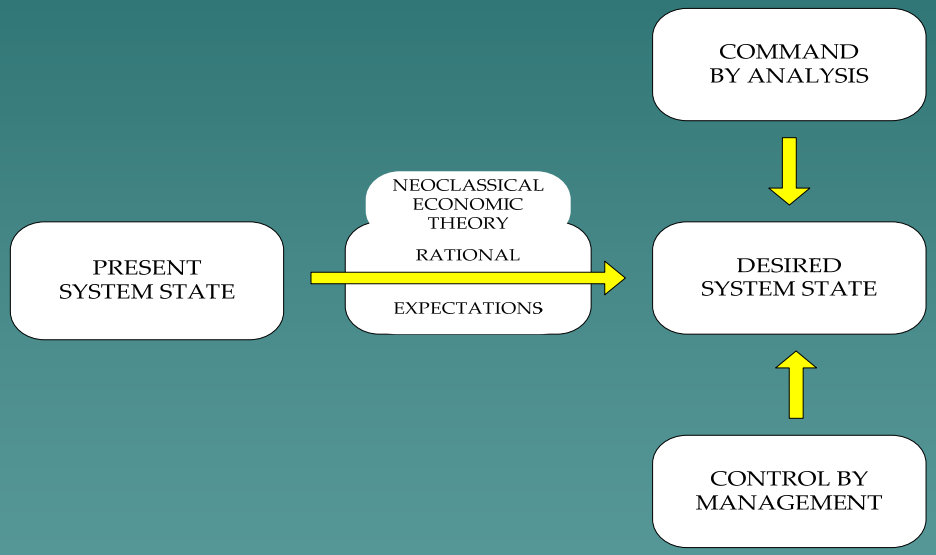
Introduction

- Non-linear ecosystem development
- Multiple system states
- No ecologically superior system state
- Select system state by utility
- Determine by economic evaluation



Anticipative Management

- Resource manager can predict *a priori* future system states
- Deductive equilibrium analysis & utility maximization
- Rational expectations & perfect information
- Evaluations by expected utility with stochastic disturbance function
- Command & control

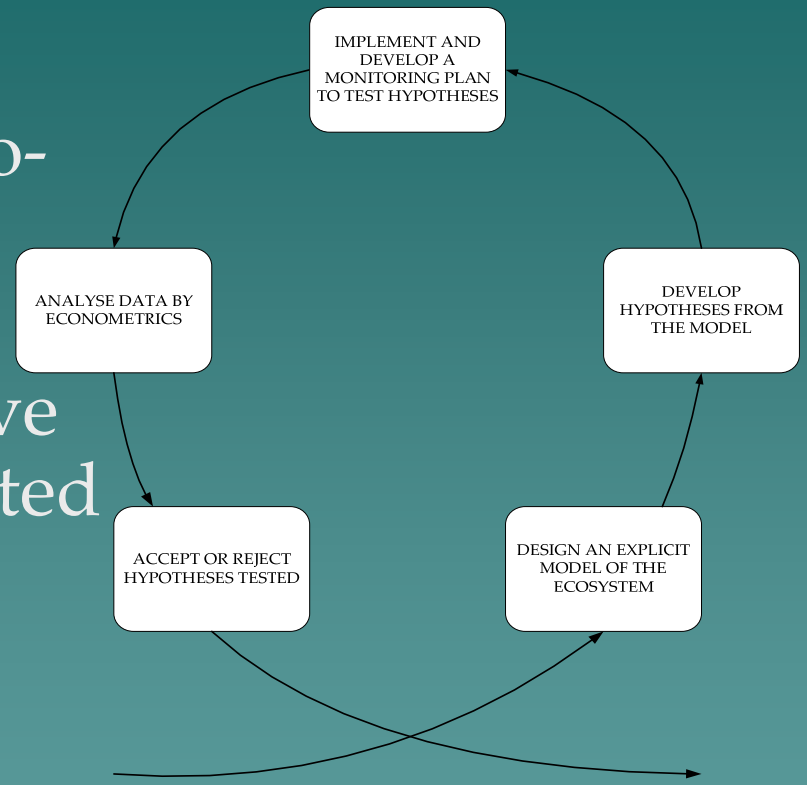


Information & Learning

- Empirical violations of expected utility
- For command & control remove diversity to increase prediction
- *ANEM* leads to ecological catastrophes
- Bounded rationality of resource manager
- Learning knowledge & information
- Descriptive heuristics by induction & their biases
- As-if optimization & prescriptive approach

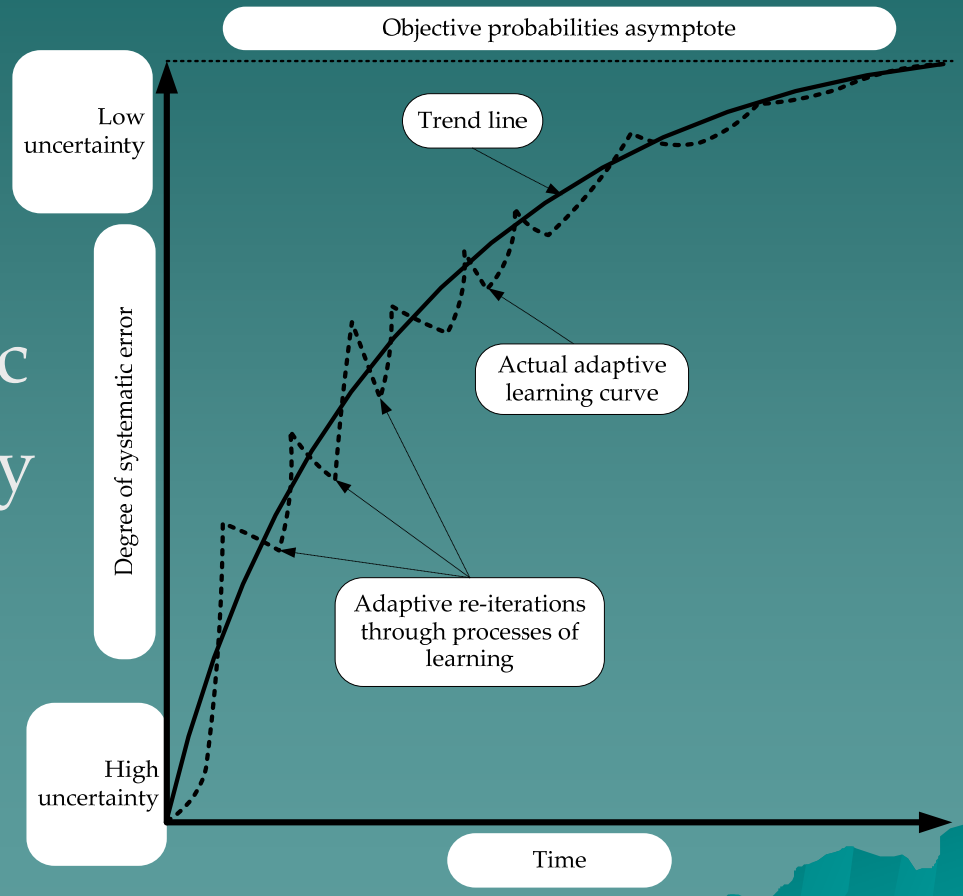
Adaptive Management

- Build models & experiment
- Active *ADEM* by hypothetico-deduction & vNM expected utility
- Passive *ADEM* by quantitative induction & subjective expected utility
- Precautionary principle & subjective probabilities
- Utilize SMS where no prior probabilities
- Ignorance & liquidity preference



Expectations & Ergodicity

- Adaptive expectations
- Convergence onto rational expectations
- Environment is ergodic
- Exogenous change only
- Future statistical reflection of past
- Ergodicity allows for generalizable laws & economics as a science



Complexity & Chaos

- Non-linear dynamics develop Hamiltonian chaos
- Far-from-equilibrium & dissipation brings multiple system states
- Ecosystems are species & connections
- Endogenous bifurcations as density of connections increase leads to chaos
- Window of vitality & self-organization
- Chaotic uncertainty is a quasi-ontological uncertainty which prevents quantitative prediction
- Probability & equilibrium useless…
- *ANEM* & *ADEM* unsuitable for complex systems

Capacitive Management

- Post-classical economic evaluations
- Recognition of complex systems through connections & far-from-equilibrium behaviour
- Adaptive capacity
- Focus on future efficiencies by maximizing flexibility by the analytical multiplicity construct
- Exploration by multi-agent simulations to determine exhaustive set of systems states

Analytical Complexity

- Sunk costs by maximizing flexibility
- Need to explore & exploit…
- Dynamic balance between flexibility & utility
- Naturalistic economic evaluators
- Localized phases of order in chaos
- 'Predict' within analytical complexity by qualitative induction

ANALYTICAL EQUILIBRIUM	ANALYTICAL COMPLEXITY	ANALYTICAL MULTIPLICITY
Utility maximisation	Utility and flexibility optimisation...	Flexibility maximisation

Open Systems

- Ecosystems evolve, hence are 'complex adaptive systems'
- Genetic algorithms peter out…
- Complex adaptive systems are creative non-ergodic systems
- Future not reflected in past
- Genuine uncertainty & analytical nihilism
- Intuition & abduction

Form of Uncertainty	Knowledge of System states	Objective probability function
Risk	All states in set Known	Probabilities known
Ambiguity	All states in set Known	Probabilities unknown, but knowable
Ignorance	All states unknown, but knowable	Probabilities unknown, but Knowable
Chaotic Uncertainty	All states unknown; but knowable	Probabilities unknowable
Genuine Uncertainty	All states in set Unknowable	Probabilities unknowable

Creative Management

- Given nature's creativity we can transform ecosystems
- Naturalistic fallacy
- What kind of garden do we want?
- Economic evaluation:

1. Open system methods
2. Possibility theory
3. Abductive reasoning

Approach	*Ontology*	*Uncertainty*	*Causality*	*Analysis*
ANEM	Closed System	Risk	Predictive	Equilibrium
ADEM	Closed System	Ambiguity & ignorance	Towards predictive	Dis-Equilibrium
CAEM	Closed System	Chaotic Uncertainty	Regularity	Far-from Equilibrium
CREM	Open System	Genuine Uncertainty	Universal	Non-Equilibrium

Conclusions

- Towards an ecological rationality…
- Unification of ecology & economics

QUESTIONS?