

RESEARCH IN THE FISH ECOLOGY DIVISION

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Who?

A group of ~125 FTE's & contractors

Where?

Washington (Seattle, Pasco, Mukilteo)

Oregon (Pt Adams, Newport)

Our division comprises 4 programs

1. Ecosystem Analysis

Salmon studies

Life cycle models

Legal consultations



2. Estuarine and Ocean Ecology

Biophysical coupling

Food web studies

Ecological forecasting



Photo: NWFSC

3. Migrational Behavior

Dam passage

Survival studies

Salmon, shad, sturgeon
& lamprey



Photo: NWFSC

4. Watershed

Salmon studies

Fish habitat

Restoration &
monitoring



Photo: G Pess

I was trained as a field ecologist



Now I develop *hierarchical models*



Credit: Paramount Studios

Hi·er·ar·chi·cal

adjective

1. Arranged in an order

A hierarchical model is simply
a model within a model

Hierarchical models also masquerade as

Nested data models

Mixed models

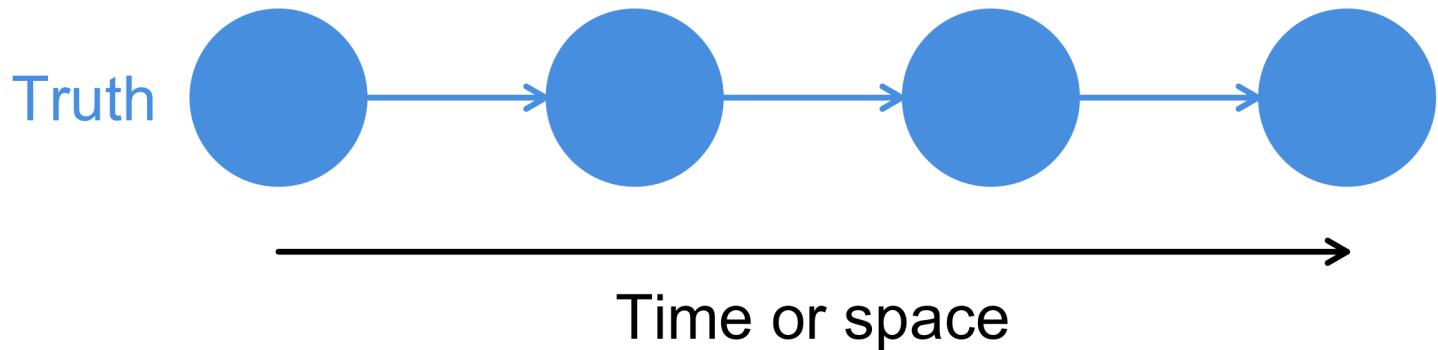
Random-effects models

State-space models

A state-space model has 2 parts

Part 1: State model

Describes the **true state of nature** over time or space



States of nature might be

Animal location

Species density

Age structure

Reproductive status

Revealing the state of nature
requires some observations

Observing nature can be easy

A photograph showing a large school of salmon swimming in a river. The water is clear, revealing a rocky riverbed. The salmon are a vibrant red color, contrasting with the blue and green tones of the water and rocks. They are swimming in various directions, creating a sense of movement.

How many salmon are there?

Observing nature can also be hard

A close-up photograph of a shallow stream bed. The water is clear, revealing a rocky bottom covered in small, yellowish-green pebbles. Numerous red mayflies are visible, flying low over the water's surface in a dense, swirling pattern.

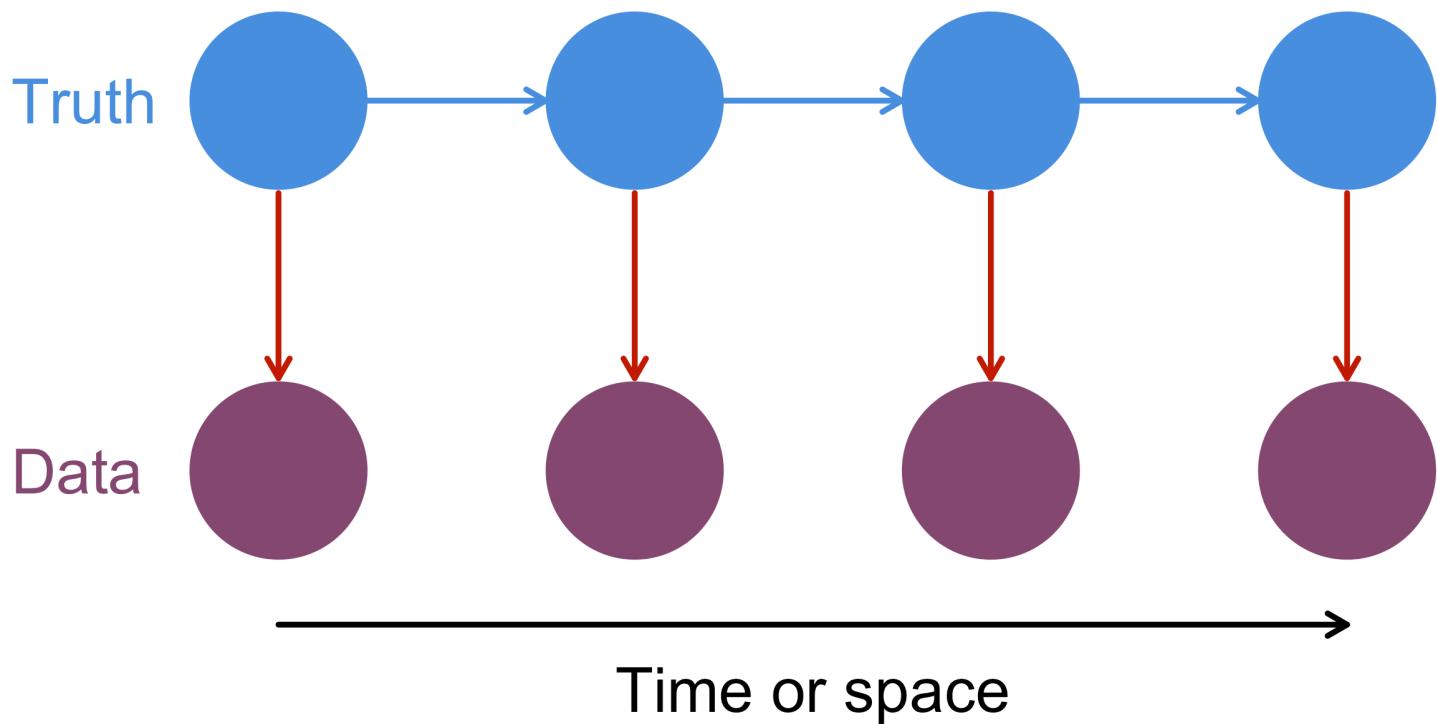
How many mayflies are there?

Part 2: Observation model

Data = Truth \pm Errors

Part 2: Observation model

Data = Truth \pm Errors



OK, but why bother?

Advantages of hierarchical models

1. Can combine many different data types

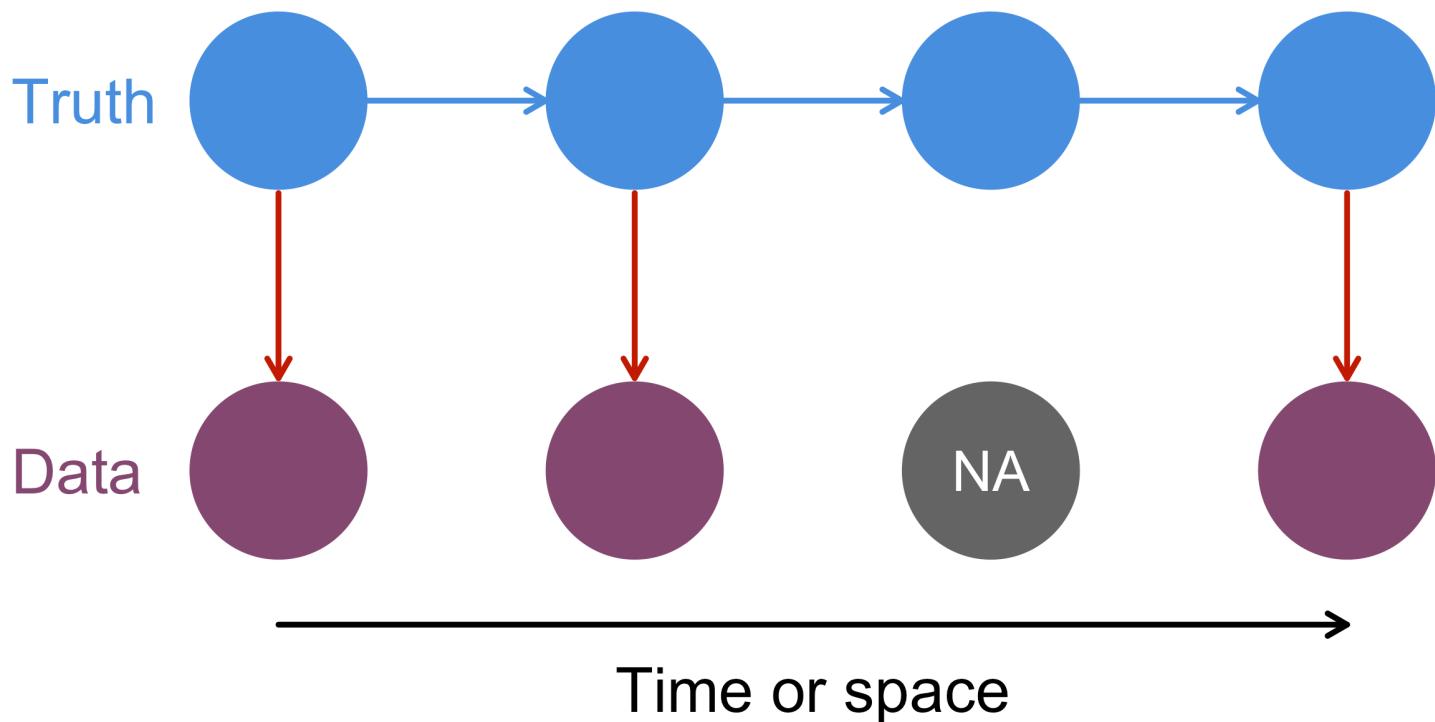
Changes in observers or sensors

Varying survey locations & effort

Direct & remote sampling

Advantages of hierarchical models

2. Missing data are easily accommodated



Advantages of hierarchical models

3. Improved accuracy & precision

Article | [OPEN](#)

Joint estimation over multiple individuals improves behavioural state inference from animal movement data

Ian Jonsen 

Scientific Reports **6**, Article number: 20625

(2016)

doi:10.1038/srep20625

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Advantages of hierarchical models

4. Rather flexible

This simple model can be used for 5+ unique applications!

$$\mathbf{x}_t = \mathbf{B}\mathbf{x}_{t-1} + \mathbf{w}_t$$

$$\mathbf{y}_t = \mathbf{Z}\mathbf{x}_t + \mathbf{v}_t$$

More info

<https://github.com/mdscheuerell>

<https://github.com/nwfsc-timeseries>

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