



## Ecosystem Functions Model A tool for restoration planning

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## Getting into EFM...

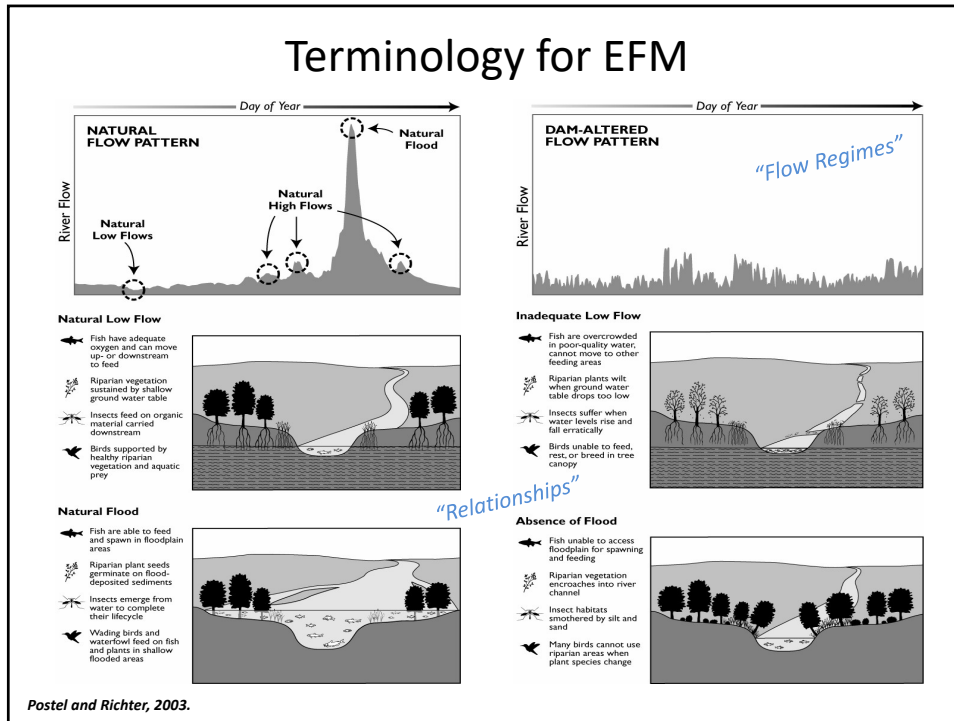
### Key eco-hydrology points

- Ecosystems evolve in concert with hydrologic patterns
- Humans alter natural hydrologic patterns
- Connections between ecology and hydrology can be used to:
  - ✓ Set flow targets
  - ✓ Map habitat
  - ✓ Create ecological models

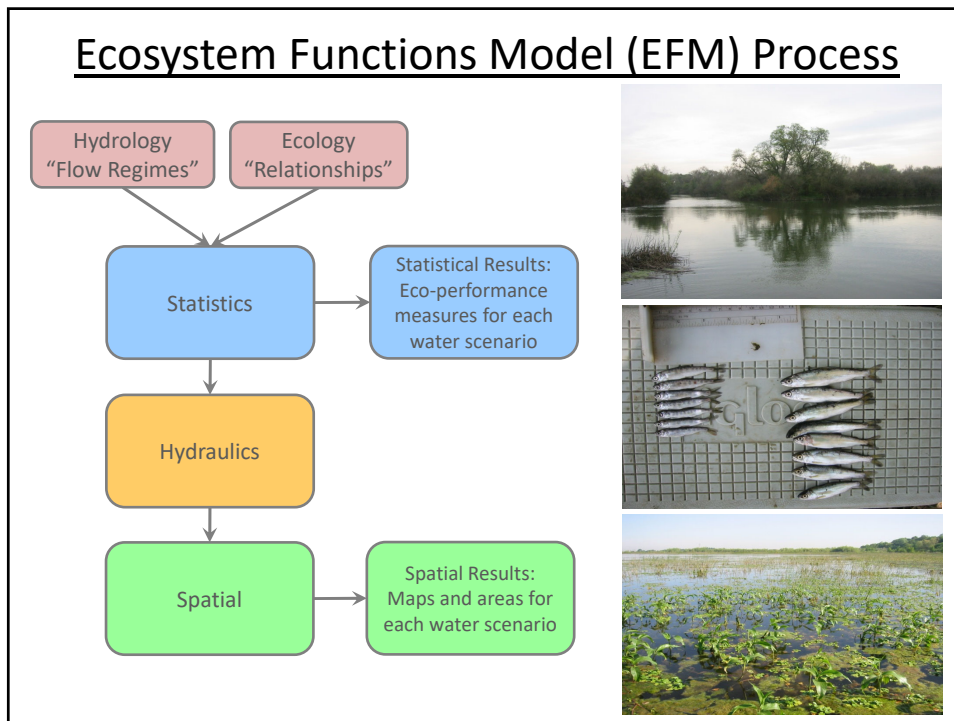
### Intro for Ecosystem Functions Model

- *How does EFM allow users to investigate ecosystems?*

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## Terminology Quiz

Study team needs to figure out which scenario - existing, restored, or restored with 2050 climate - is best for chinook rearing.

Juvenile chinook rear between March and June. Rearing requires sustained high flows for approximately 20 to 24 days to achieve optimal growth. Rearing occurs in shallow vegetated floodplain areas.

*Which paragraph is about the "flow regimes"? How many are there?*

*Which is about a "relationship"? In the EFM process introduced in previous slide, which criteria would be applied statistically and which would be applied spatially?*

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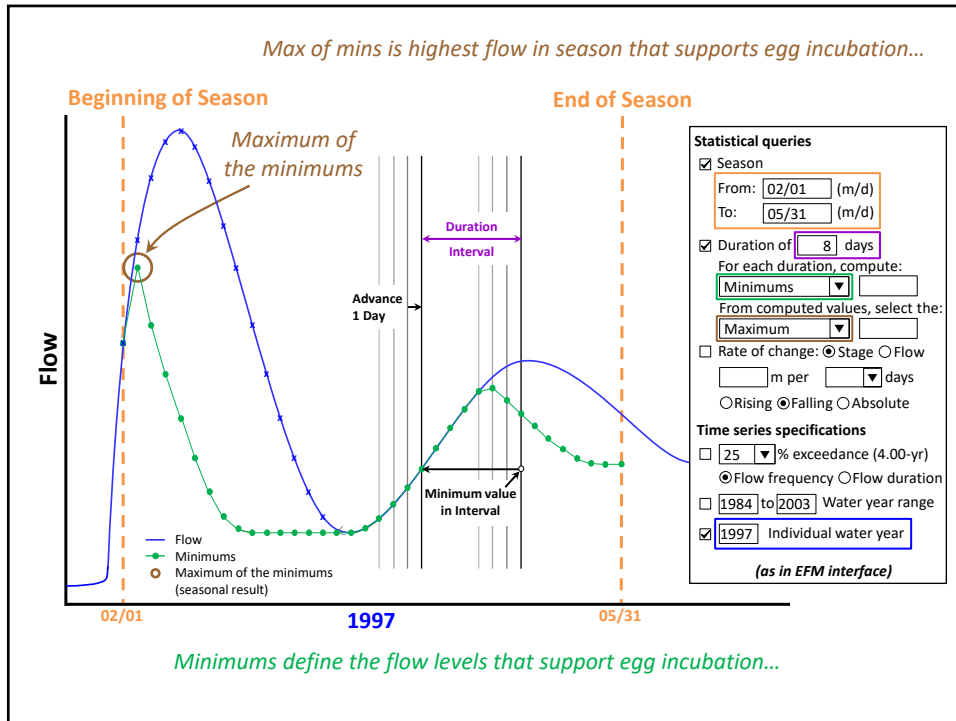
The screenshot shows the HEC-EFM software interface. The main window displays model information for 'San Joaquin River near Yreka, CA'. A secondary window shows the configuration for a relationship named 'Spittal Spawning', including a description and various options. A third window displays a 'Summary' table of statistical results for various relationships, and a 'Reverse Look-ups - Flow Duration' table.

### EFM Interfaces

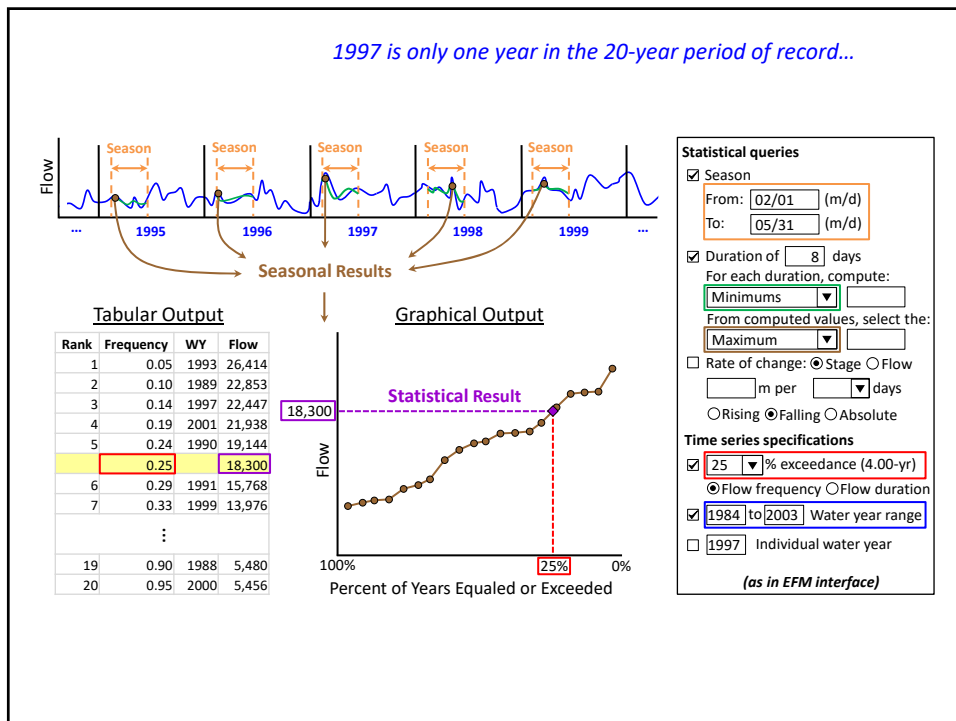
- Analyze up to ~37,000 flow regimes at once
- User-defined stats link hydro and ecology
- Statistical results: How well flows met eco-criteria

*Helps determine eco-responses to changes in river and wetland flow regimes...*

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San Joaquin Demo.efm - HEC-EFM

Evaluated at: 03/21/2014 17:23

Relationship	Conf.	SJQ Gaged			SJQ Natural	
		Stage, ft	Flow, cfs	Chg.	Stage, ft	Flow, cfs
Splittail Spawning	**	17.6	18,300	Pos	25.5	36,138
Striped bass winter habitat	**	3.0	1,713	Neg	5.1	3,186
Benthic macroinvertebrate biodiversity	**	14.2	12,500	Pos	28.5	44,274
Wetland health	**	4.5	2,780	Pos	18.2	19,427
Riparian tree recruitment	**	4.1	2,480	Neg	3.9	2,350
Riparian tree inundation	**	2.4	1,350	Neg	3.2	1,897

**Index Values**

Index	SJQ Natural
A - All	147.8
B - Fish	39.8

No reverse lookup flow frequency data sets were analyzed.

Relationship	Conf.	SJQ Gaged		SJQ Natural	
		% X, of time	Chg.	% X, of time	Chg.
Wetland health reverse lookup	**	17.9	Pos	56.4	Neg

## HEC-EFM

- Uses daily time series of flow and stage
- Computes statistics that are eco-relevant (as defined by users)
- Compare management scenarios for multiple eco-relationships

*Statistical results investigated spatially with hydraulic models and GIS...*

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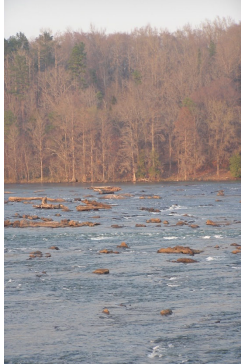
## HEC-EFM - from Statistical to Spatial...

- Statistical results are input to hydraulic models to get:
  - *Water surface profiles*
  - *Depth and velocity grids*
  - *Inundation boundary maps*
  - *Shear stress...*

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## Applications and Relationships...



- Farmington River, CT.....*Floodplain forest, shrubs, buttonbush*
- Sandy River Delta, OR.....*Chinook salmon*
- Bill Williams River, AZ.....*Cottonwood, willow, saltcedar*
- Mississippi River, MO.....*Waterfowl, bluegill, plants*
- Truckee River, NV.....*Mayflies and cottonwood*
- Ashuelot Rivers, NH.....*Mussels, host fish*
- Savannah River, GA/SC.....*Shad, bass, shoals lily*
- Sacramento/San Joaquin, CA...*Spittail, geomorph, LWD*



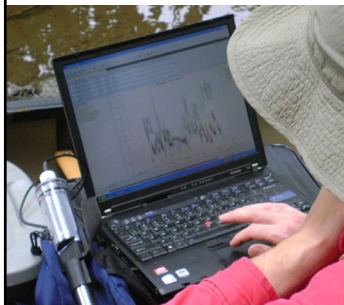
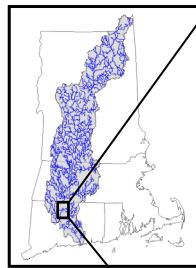
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## Floodplain Vegetation Farmington River, CT

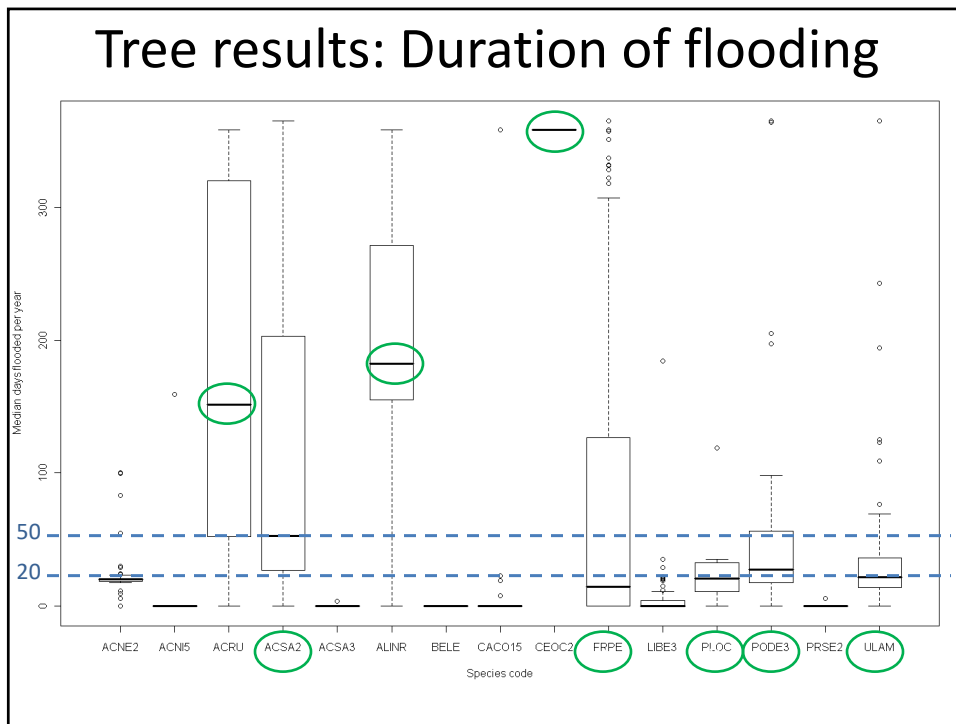
Field Work: Vegetation Survey

- Survey vegetation and elevation data along floodplain transects
- Monitor channel water levels with pressure transducer
- *How much flooding is needed for healthy floodplain ecosystem?*

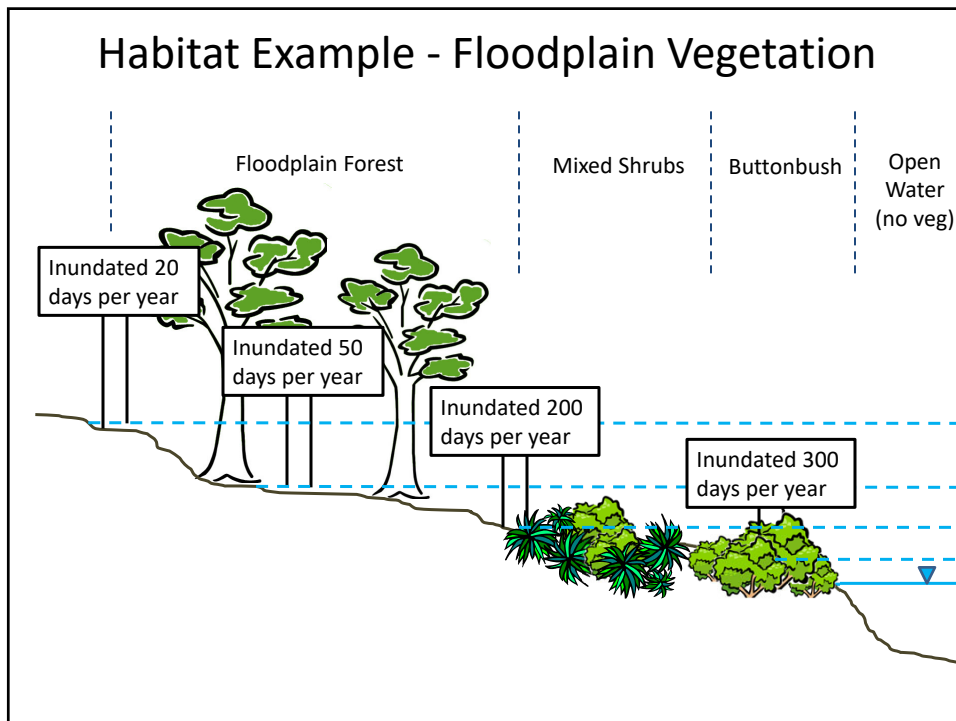
(Marks et al. 2014)



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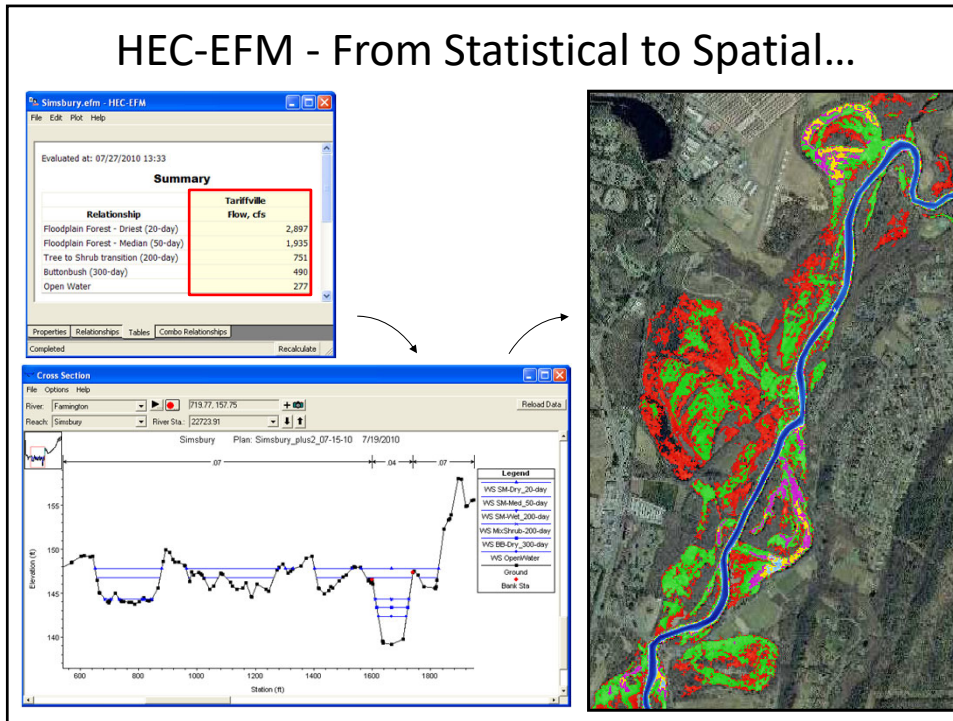


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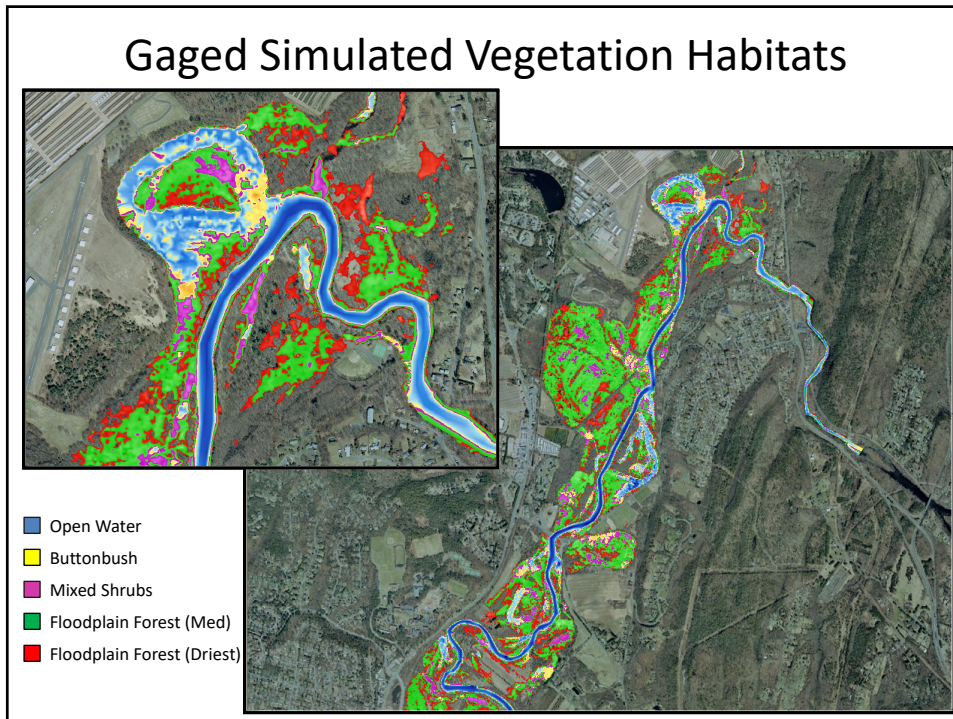
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## HEC-EFM - From Statistical to Spatial...



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## Gaged Simulated Vegetation Habitats

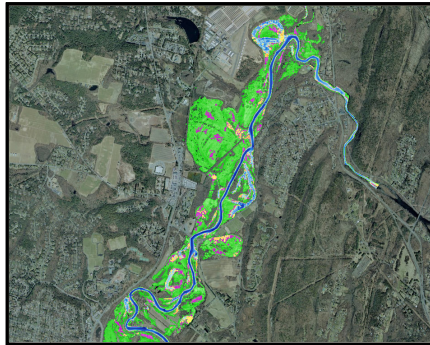


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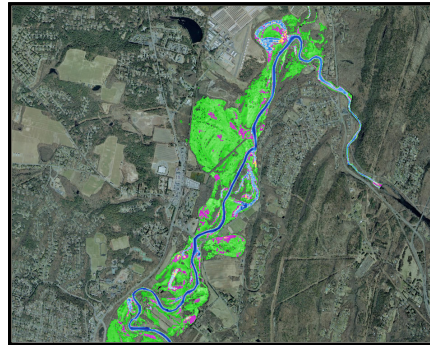


## Comparing Scenarios - Gaged and Nat

Gaged

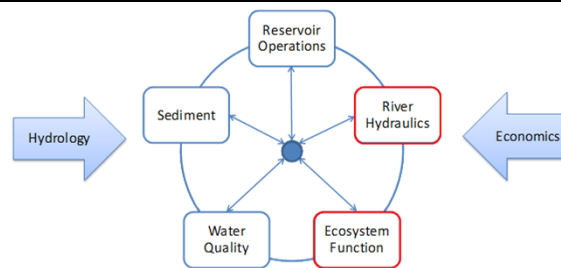


Nat



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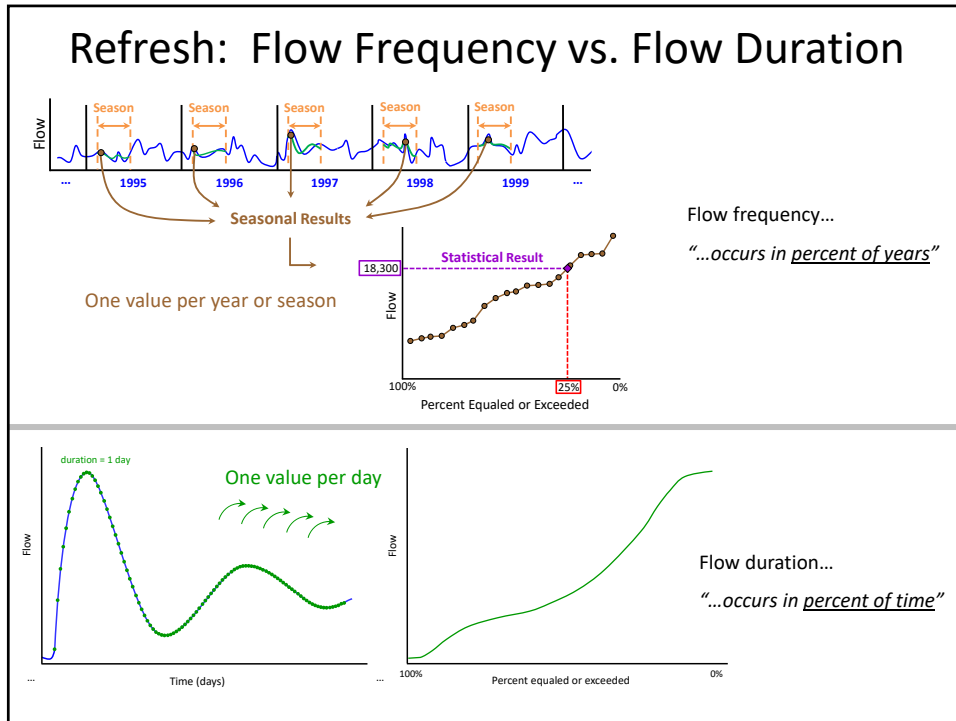
## HEC-EFM Summary



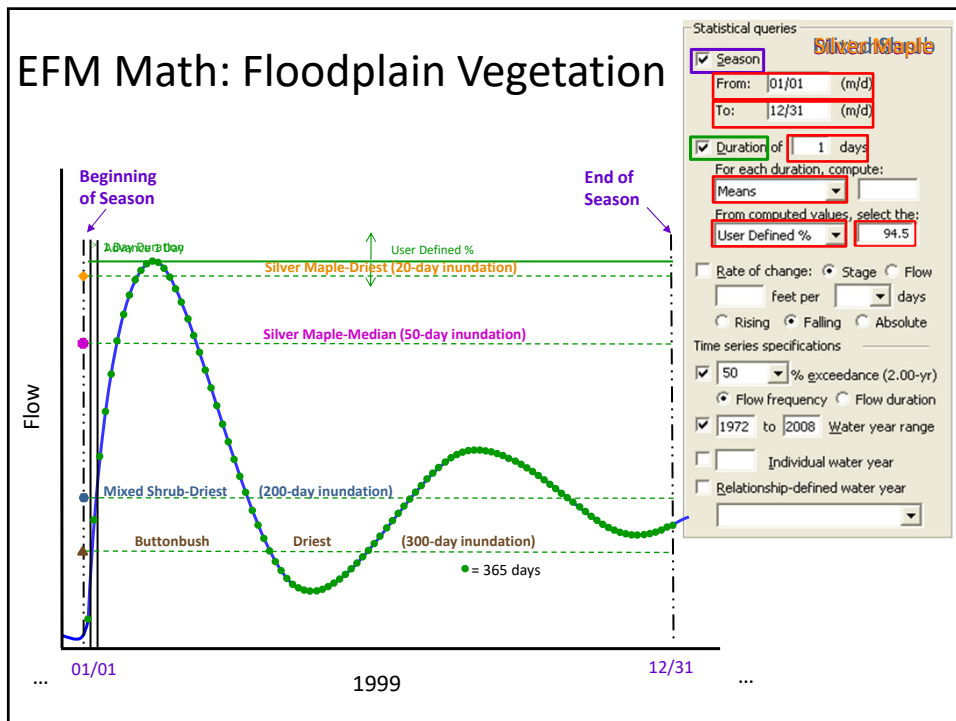
- Use connections between hydrology and ecology as performance measures
- “Flow Regimes” = water management and/or ecosystem restoration scenarios
- “Relationships” = connections between hydrology and ecology
- EFM is generic...can test many Relationships
- EFM is powerful...can test many Flow Regimes
- Statistical output (direction of eco-change and magnitude of eco-change)
- Spatial output via hydraulic models (habitat areas and habitat connectivity)

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