Characterizing Ocean Conditions for Juvenile Salmonids at the Time of Ocean Entry for Spring Outmigrants (April-May)

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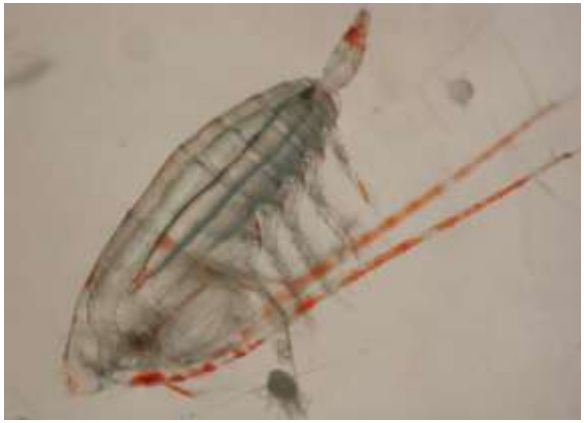
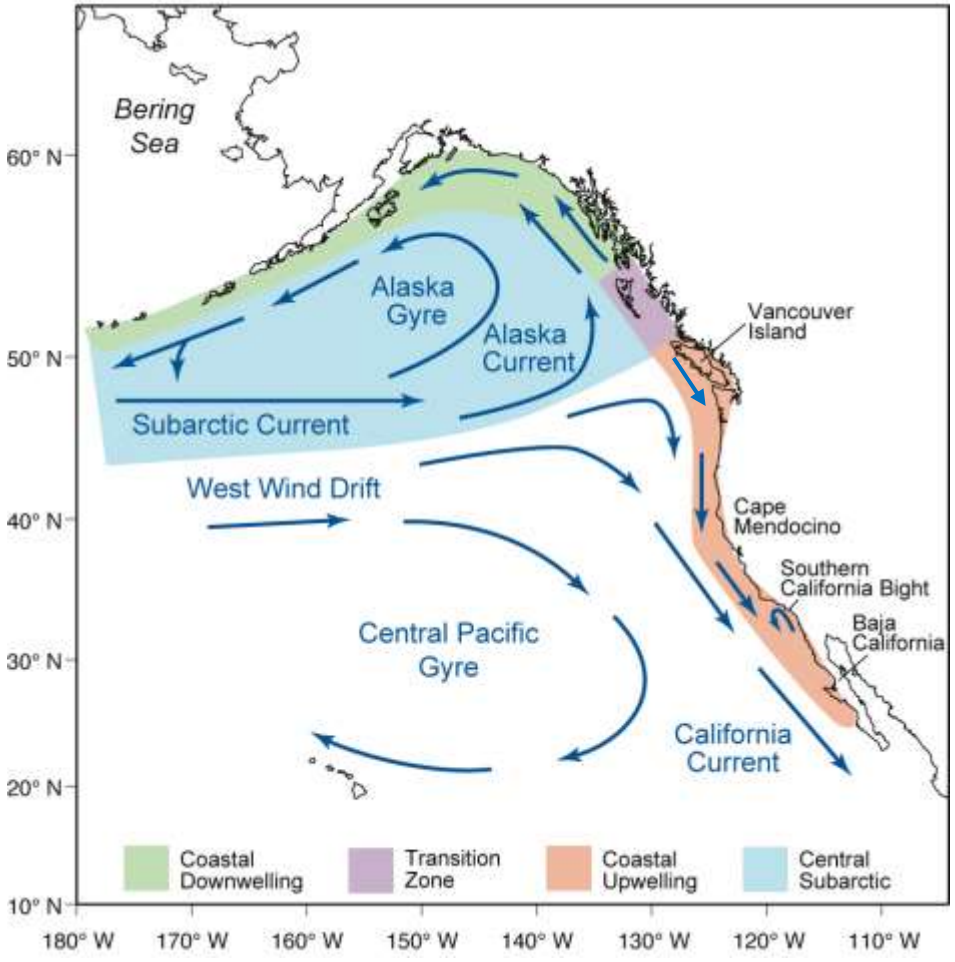


Circulation in the northeast Pacific



Food chain structure is affected by the source waters which feed the California Current

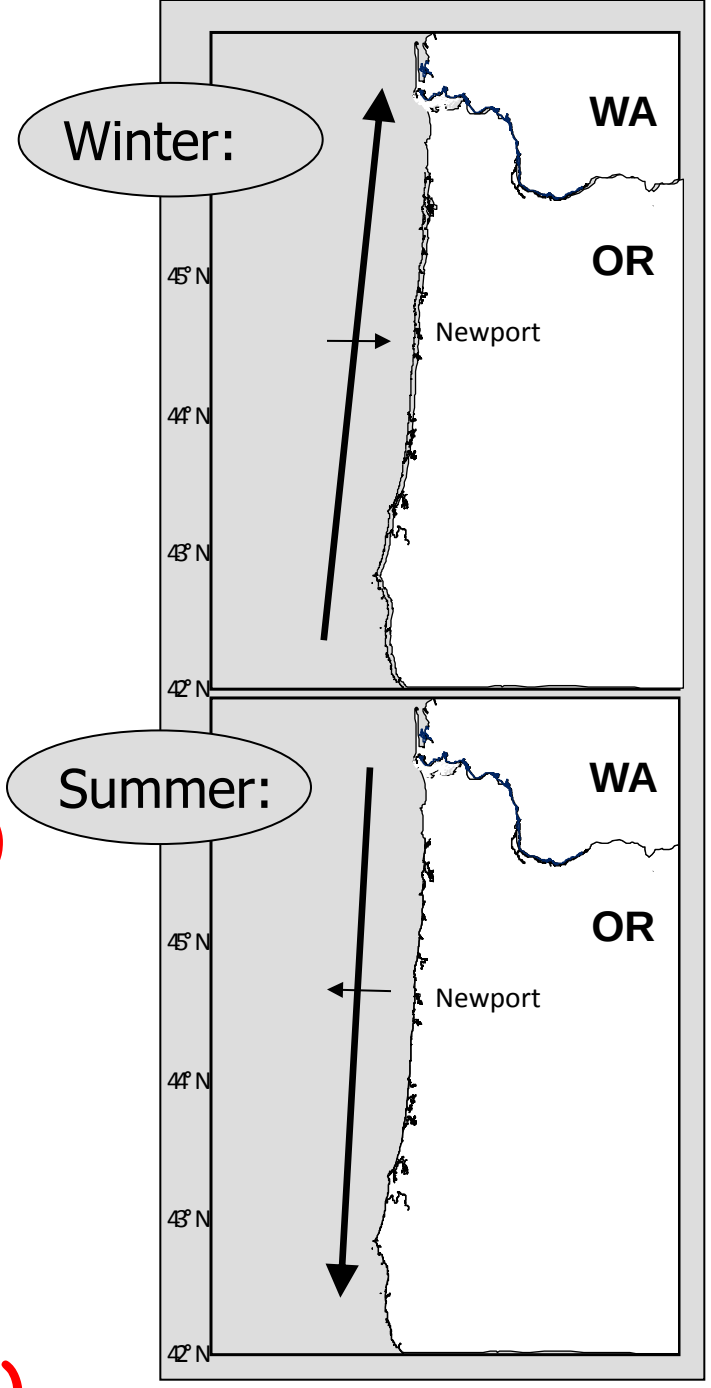
Subarctic coastal currents bring cold water and **lipid-rich "northern" copepod** species to the northern California Current NCC);

The West Wind Drift brings subtropical water and lipid-poor **Subtropical "southern" copepod** species to the NCC

Keister et al. (2011) *GCB*

Local seasonal changes in winds and current structure also affect local food chain structure in the Oregon upwelling zone:

- Winter:
  - Winds from the South cause downwelling
  - Poleward-flowing Davidson Current
  - Subtropical and **southern species** transported northward & onshore
- **Spring Transition in April (usually)**
- Summer:
  - Strong winds from the north cause coastal upwelling
  - Equatorward alongshore transport
  - **Northern species** transported southward
- **Fall Transition in October (usually)**



Spring Transition

- **Widely held that this a key variable whose characteristics influence early marine survival of juvenile salmonids. If better known and understood, a "spring transition index" will almost certainly contribute new and useful information for salmon forecasting models (Stay tuned for Brian Burke's talk this afternoon).**

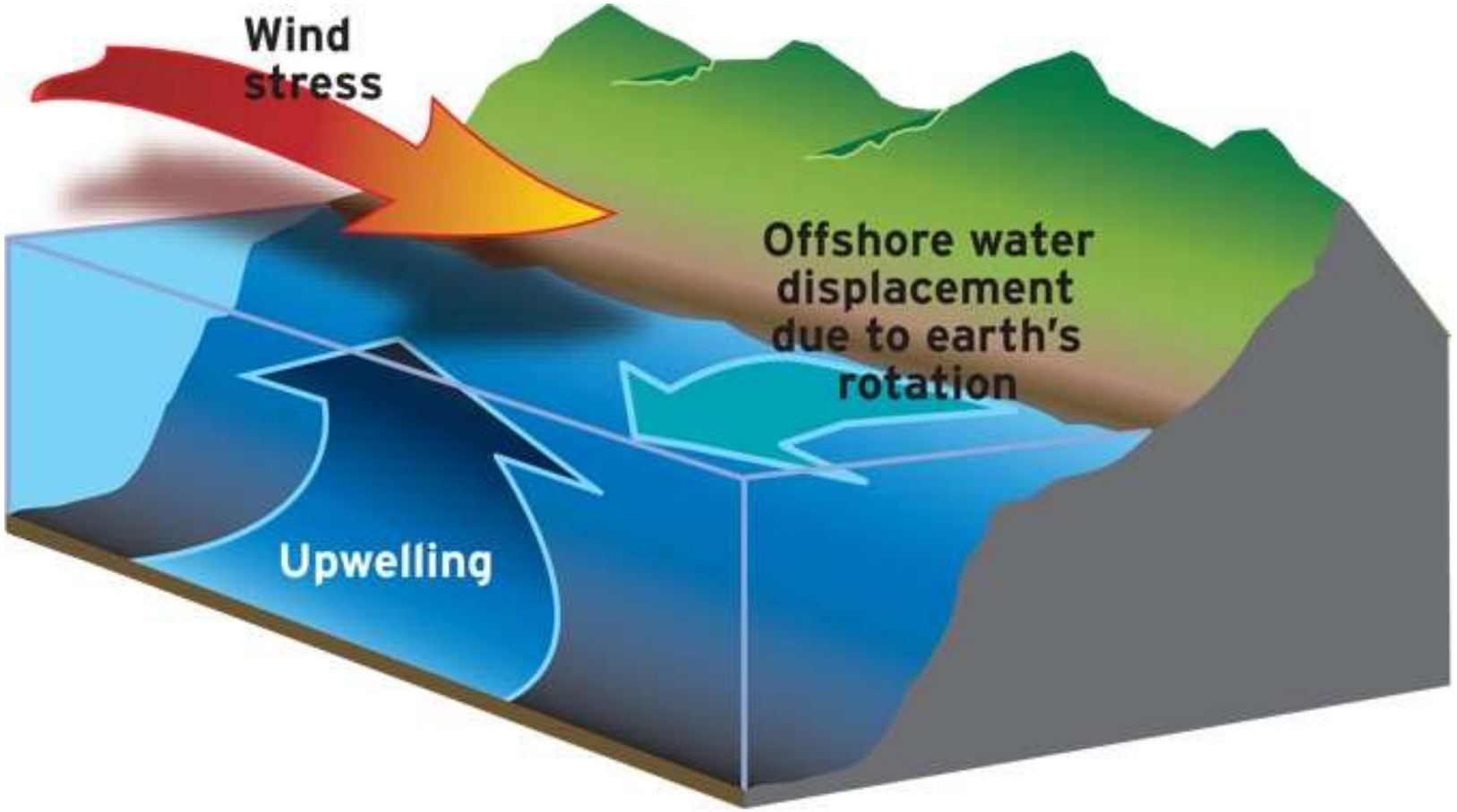
- **Giving us fits**
  1. because it is hard to define when "spring" actually begins in the ocean,
  2. because there are at least 8 measures that can be used to characterize when "spring" begins in the ocean, but how to best define them?

What do we mean when we say "the spring transition"

- REGIONAL SCALE: When the northerly winds begin to blow, sea level drops, the currents reverse, and the upwelling season begins

- LOCAL SCALE: When the upwelled waters reach the mid-shelf regions (necessary to cause phytoplankton blooms) and when the lipid-rich "cold water copepods" show up (which ensure an energetically rich food chain)

Local winds drive currents and cause upwelling along the coasts of Washington, Oregon and California

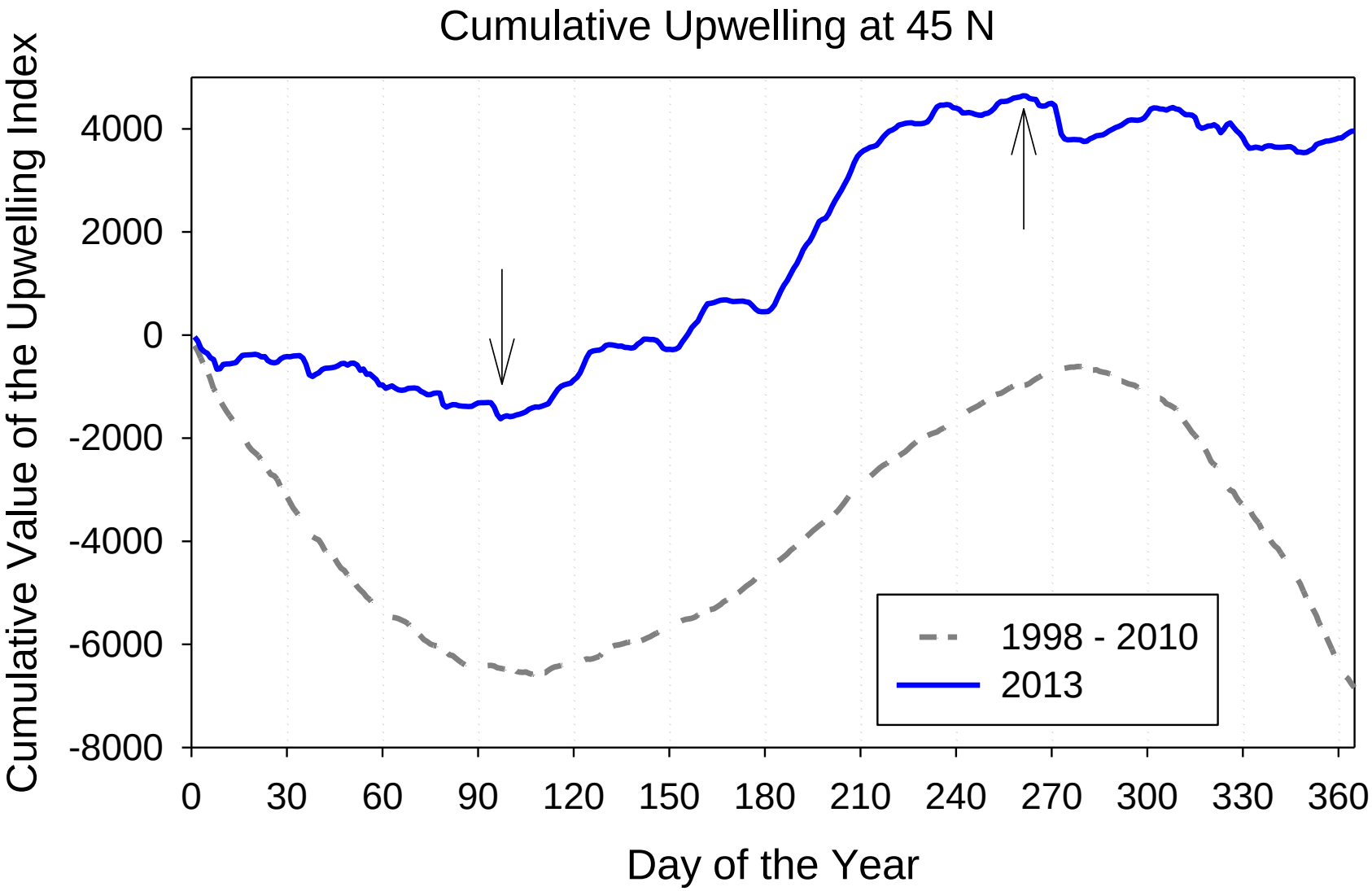


How is the spring transition indexed?

- PHYSICS
  - When northerly winds begin to blow consistently
  - When sea level drops at the coast (because surface waters are pushed offshore by the northerly winds)
    - But, since there can be a fair bit of variability in these records, the sea level data, wind data and CUI data are often smoothed.
  - When the currents on the shelf change direction
- BIOLOGY
  - When the copepod community begins to transition from a winter to summer community
  - When the copepod community has transitioned.

- CUI is the Cumulative Upwelling Index is calculated from 6-hourly atmospheric pressure and winds from a large-scale weather forecast model; the date of spring transition is the day of the minimum value of the CUI. Use 45°N
- LOGERWELL method is based on the first day when the value of the 10-day running average for upwelling (CUI) is positive and the 10-day running average for sea level is negative
- CBR (Columbia Basin Report –Univ. Washington). The daily upwelling deviation indices averaged for 39, 42 and 45°N are smoothed using a 15 day running mean. The smoothed data are then plotted and examined for spring minima.

CUI (Cumulative Upwelling Index)

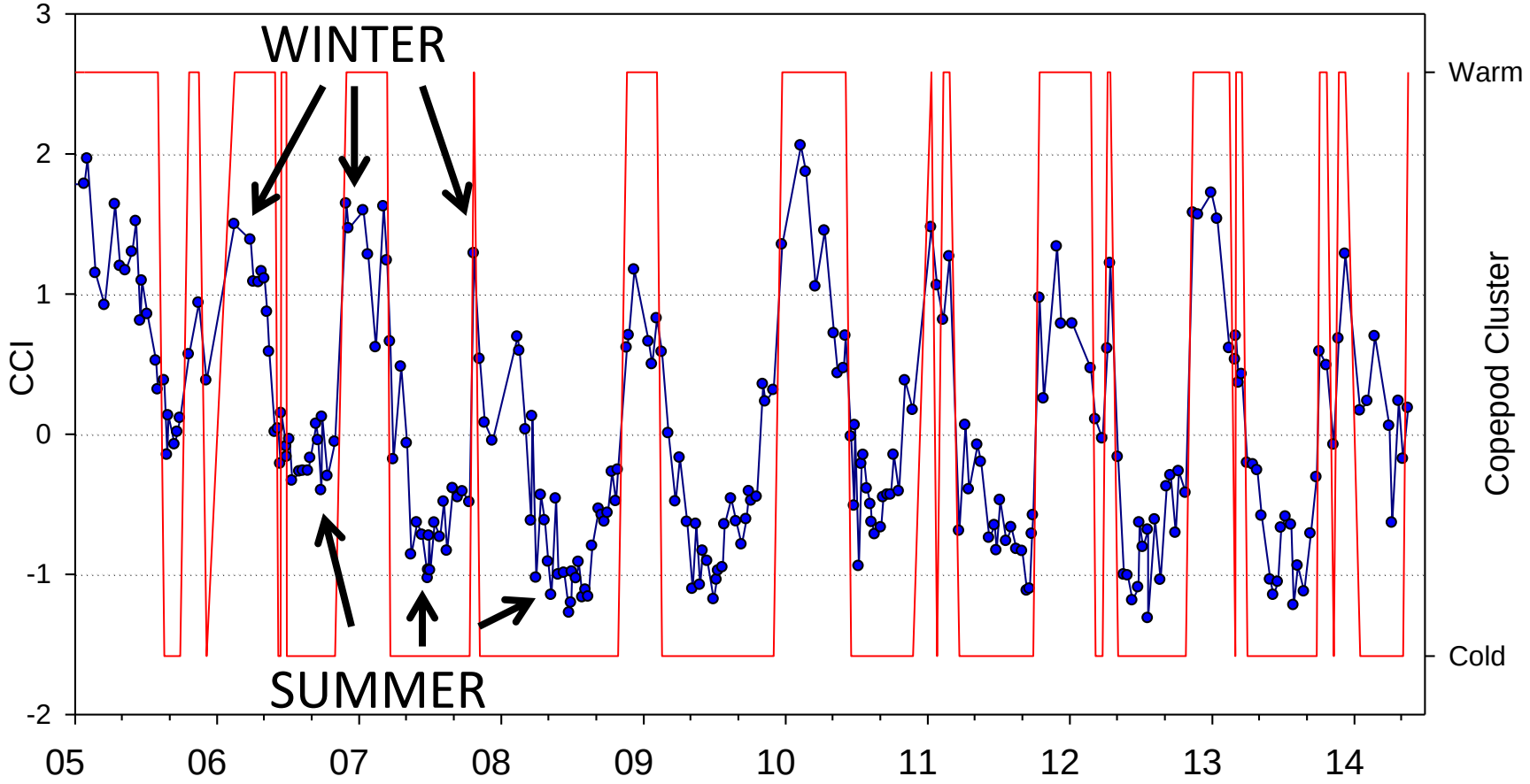


Seven measures of the date of Spring Transition

- Local copepods
  - Copepod Community (Date when transition**ing**)
  - Cluster Analysis (Date when transition**ed**)
- Local hydrography (Temperature at 50 m at NH 05

- Logerwell (Smoothed CUI + smoothed sea level)
- CBR (Smoothed CUI from three latitudes
- CUI (Cumulative Upwelling Index) at a single latitude
- Local winds (Northerly component of the wind) at Newport
- An 8th measure, local sea level, is not part of this talk

Copepod Community Index



- "Transitioning " when the descending line passes a value of CCI = 1; date is the first data point that is < + 1 (and after 1 Jan)

Comparison of seven measures of the date spring transition

	Copepod Cluster	Copepod Comm'ty	Newport Deep T	Logerwell	CBR	CUI	Local Winds
Copepod Cluster							
Copepod Community	.0001						
Newport Deep T	.01	.005					
Logerwell	.01 *	.015	.005				
CBR	.01 **	.005 *	0.25	.02 ***			
CUI	0.21	.014 *	.08	.04 ****	.07		
Local Winds	0.98	.96	.25	.98	.81	.06	

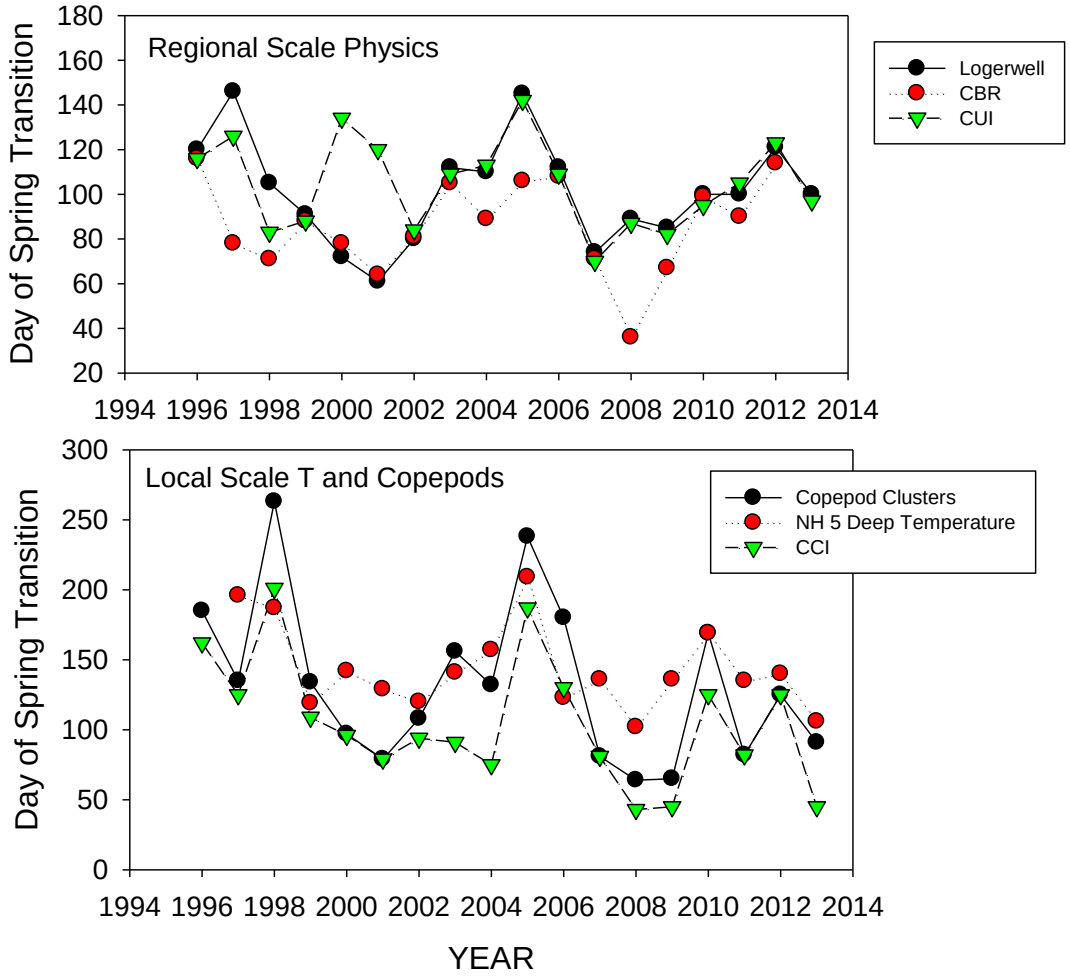
* w/o 1998 ** w/o 1998, 2005, 2008 *** w/o 1997, 2008 **** w/o 2000, 2001

Dates of spring transition compared

	CBR Smoothed CUI – 39, 42, 45°N	Logerwell Smoothed CUI + Sea level	CUI 45°N only	Copepod Community Index Transitioning	Local Winds	Summer copepod cluster Transitioned	Deep Temperature Newport inner shelf
Day of the year	86	101	105	106	119	132	143
Date	27 March	11 April	15 April	16 Apr	29 April	12 May	23 May

- Large-scale atmospheric processes indicate that the atmosphere is set-up for upwelling by late March; slightly more local upwelling starts 2 weeks later (but with local winds not favorable until a month after the atmosphere is set up).
- Copepods at Newport begin to transition at the same time as the CUI at Newport and sea level.
- The transition is not really complete until mid-May; upwelling is not really in “full force” until 23 May on average

Regional Physics vs. Local Biology

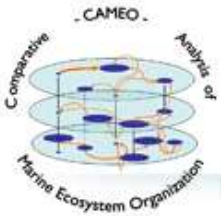


- No trend in the physics ($p = 0.42$)
- Trend towards earlier transition in the local biology ($p = 0.047$)

Conclusions

- If you want to use someone's "date of spring transition" from the web, make certain you know what it is indexing http://www.cbr.washington.edu/status/trans
- An hypothesis for why the spring transition might be linked to salmon growth or survival for example should have mechanistic underpinnings as this should help you chose the appropriate index
- May be a trend towards an earlier transition in local indicators but not in regional physics
- As we explore some of these indices further, we will publish them and also put them up on our website along with appropriate metadata for others to use

My Friends



CAMEO
COMPARATIVE ANALYSIS OF MARINE ECOSYSTEM ORGANIZATION