Climate and Fisheries: Forecasting Contextual Changes, Instead of Hindcasting from Meaningless Means

By:

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Introduction

The intent of our present efforts is to bring fisheries science into a proactive mode, a sharp reversal of perspectives that now dominate information gathering and utility in conventional stock assessment procedures. The present methodologies and philosophies provide decision-makers with too little, too late and have led to the ineffective management observed in many of the world's more dynamics aquatic ecosystems. Our perspectives are linked by over a century of independent efforts to measure and monitor the major forces and an array of ecological consequences, with a focus on oceanic ecosystems, and their various commercial subcomponents.

For example, Norton and Mason (2003, 2004) analyzed the California commercial catches from 1930-2000, and found that there were essentially three response groups amongst the species included. About 1/3 had positive landing (biomass) growth, another 1/3 had negative responses, and about 1/3 showed little response over the period s of their environmental indices. Primary responses by fish are Eco-Physiological changes. Using historical understanding from these and other approaches in describing both decadal-scale regime shifts, as well as near-term ENSO and other climate perturbations, we can move from usual hindcast methods to help turn fisheries management from a crisis driven, hindcast bookkeeping exercise into a proactive, forward-facing science. Necessary understanding and technologies exist, today.

Girs (1956) described the Northern Hemisphere Atmospheric Circulation Indices (ACI) patterns used to characterize three dominant East, West, and Zonal (N-S) patterns and processes, first proposed by Vangengeim in the 1930s. Observations since the late 1800s identify two ~55 year bimodal patterns within the time series comprising classic Meridional (1894-1920) and Zonal (1920-1950) epochs - that have repeated since (1951-1975) and (1976-~2005). The most recent dipolar cycles reversed in 1998, with a shift back toward a Meridional pressure field, and we can expect the uprising of the next generations of six of the world's most productive fisheries, as the other six settle into the background - once again (Klyashtorin, 2001, Abstract this conference). From a more global perspective, Leroux (1998) describes related Mobile Polar High/Low pressure patterns, and records of their down-field interactions, providing direct physical forcing links to regional ocean fisheries.

Despite the declarations of many would-be scientists and 'believers', neither the world nor its ocean have never been anywhere near stable, nor near 'equilibrium' – as the many investigations of temporal records have proven, repeatedly. What we do not pretend to understand, given the short length of most of the important time series, is how these are linked to other, longer-term Climate System variables, very clearly etched in the various paleoclimate records. Lunar tides, solar activity, and Solar System Dynamics are very well recorded in a broad array of time-scales and sedimentary deposits, from tree rings, to sediment composition, to fish scale abundances and related shifts in both abundances and distributions of specific indicator species. We do not intend too elaborate on these, but will point out some of the more comprehensive reviews where these influences are described, starting with Pettersson (1914) in which he connects lunar tidal forces with North Sea and Baltic systems changes.

It is also clear that fisheries science was born of the first efforts to fill in the gap of ocean foodfish availabilities, via fish farming, and restocking efforts in the 1850s, in Norway (Sharp, 2000). That the Northeast Atlantic fisheries have undergone major dynamics before then should also not be disputed, as the entire recent 500 year history of European economic development, and expansion out into the world via the oceans is driven by the dynamic events involving the freezing over of the Baltic, and recurrent blooms and busts of various cod and herring fisheries.

The underlying messages in our collaboration are that climate change is continuous, often rapid, and relatively wide-scale despite having locally opposite consequences, depending upon where you are when these changes occur. Thus, it is important to understand the long-touted, poorly presented message that there are winners and losers, in almost all such dynamics, simply because the earth is a complex system of dipolar phenomena; warm/cold, hi/low pressure, wet/dry, windy/calm, sunny/occluded, clear sky Vs overcast skies, each with distinct day/night signatures. Darwinian evolution has promoted myriad biological response patterns, species and regional subspecies that track the vast array of changes recorded in earth's stratified geology.

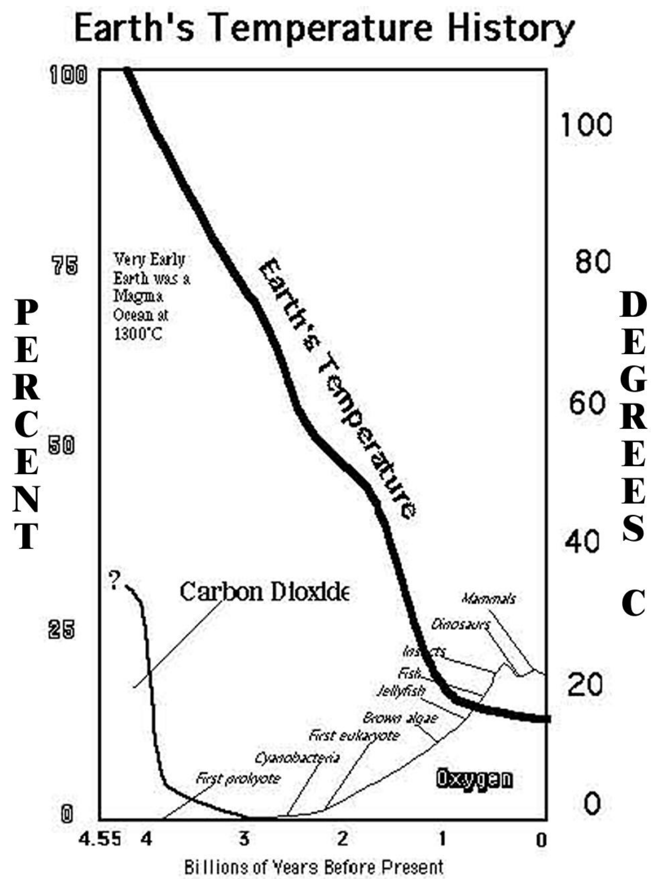

Figure 1. Provided by our colleague James Goodridge, retired California State Climatologist, provides a very important start in our arguments for looking forward, given what we already know about the past, shows Earth's Thermal History, with the various changes in species, as the earth cooled, and shifted from anaerobic bacterial domination, into plant-generated oxygen-rich regime.

Sharp (2003) provides the long-term perspectives of earth's climate changes, and eventual social responses – leading into the present century's likely climate patterns, if history can indeed be counted on as a source of credible information. Certainly, the present state of Global Climate Models (GCMs) is far too primitive, and their results too disparate and unrepresentative of observations over the globe, to provide anything but motives to go back to work, and do it right. The ongoing debate over what levels of credibility can be assumed, and what 'scenarios' that result from selective and poorly distributed data sets, has firmed our opinion that various species can and will provide more insights into earth's climate status than any existing climate models. In the recent debate regarding the differences between preconceived results and real science (c.f. Mann, ET al.1998, McKitrick & MacIntyre 2003, 2004, Baliunas and Soon 2003, etc.) rational, historically documented observational science and careful reanalysis will prevail.

Today, the greatest portion of protein consumed by humans, and their farmed meat resources, comes from ocean fisheries. Thus another, and almost more important force, given that we are gathered here to somehow 'cope' with the various dynamics, and somehow manage humanity, is the simple fact that human population growth determines the basic nutritional requirements – thus market demand.

The following table of estimated population numbers by dates should make the point clearly that no matter what one decides regarding 'methodologies', the issue of resource management will be ever more complicated by the numbers of mouths needing fed.

The pretense that somehow ocean ecosystems can be managed back to some prior 'equilibrium state' is blatant denial of both what is known and what is changing, and why. Humanity is just one, not irrelevant, but at least potentially controllable dynamic. Given knowledge of various likely force changes, adjusting public opinion to expectations relating specific and controllable forces should be of highest priority, not chasing some mythical prior 'equilibrium state.

3000BCE, at the end of the last Thermal Maximum
– about 100 million people on Earth.
At about 7 BCE, with an expanding Roman Empires
– about 250 million people on Earth.
At about 1350, at the end of the Medieval Warm period
- 300 million people on Earth.
At about 1700, within the Cold Maunder Minimum period
- 600 million people on Earth.
At about 1800, near the end of the Little Ice Age period
- 900 Million people on Earth.
At about 1900, after the beginning of the Warming Trend
- 1.6 Billion people on Earth.
At about 1927, we observed our first California sardine bloom
- 2 billion people on Earth.
At about 1950, as ICNAF 1st deliberated, and IATTC was born
- 2.4 Billion people on Earth.
At about 1960, Soviet fleet on move; England-Iceland dispute
- 3 Billion people on Earth.
At about 1975, 2 years post US Congress Endangered Species Act
- 4 Billion people on Earth.
At about 1989, recent bloom sardine catches peak Chile/Japan,
- 5 Billion people on Earth.
In Fall 1999, just in Time for Climate Regime Shift - etcetera
- 6 billion people on Earth – and counting...

Table 1

Various individuals and institutions that have not paid much attention to history carry on climate change fear mongering. When it warms, we, like many organisms, swarm. It is the cooling side of the coin that causes chaos, shrinking options, and conflicts, from war, to plagues, to extinctions. Coping is the ultimate ‘test’.

Meanwhile, there are still very active folks keeping the underlying science alive to support the basic inputs, and what to expect when climate changes occur. For example, the anoxic sediments of the Santa Barbara Basin have been a valuable source of information since first studied and reported by Soutar and Isaacs (1974). The history of the California Current shows cyclic deposition in various investigated properties. Varve thickness, total organic carbon (TOC) accumulation, and fish-scale abundance have been analyzed providing records since AD 1350 for varves, AD 1120 for TOC, and AD ~200 for fish scales. Prominent climatic periods revealed from the recent studies (Berger et al. 2004) are 169 yr, 93 yr, 51.4 yr, 17.7 yr (varve thickness), 124 yr, 56 yr, 37.4 yr (TOC flux), and 103 yr, 128 yr (fish-scale abundance). The varve and TOC cycles can be interpreted as deriving from the common tidal cycles, i.e., the 4.425 yr perigee period (describing the changing distance between Earth and Moon) and the 18.6 yr lunar nodal period (which pertains to the lineup of Earth, Moon, and Sun). The basin record is partly a result of pulsed sedimentation aligned with tides. Fish-scale cycles may reflect the influence of solar forcing

Sandweiss et al. (2004) in their ongoing studies describe geoarchaeological evidence for multidecadal natural climatic variability and ancient Peruvian fisheries. They point out that defining the influence of natural climatic variability on modern fisheries is complicated by over a century of industrial fishing. Thus, archaeological data provide unique opportunities for assessing precolonial and preindustrial fisheries. Their studies show that anchoveta Vs sardine-dominated fisheries correlate with 20th-century climate change in the Pacific Basin and are linked to multidecadal climatic variability. Cooler conditions and lower frequency El Niño/Southern Oscillation (ENSO) events characterize the “anchovy regime”, while the "sardine regime" is associated with warmer conditions and higher frequency ENSO. Fish remains excavated at Lo Demás, an Inca-period (ca. AD 1480-1540) fishing site at 13°25'S on the Peruvian coast, document a shift from an anchoveta-to a sardine-dominated fishery at about AD 1500. This shift correlates with records for increasing ENSO frequency (c.f. Sharp, 2003) at the same time. Middle and late Holocene sites have archaeofish assemblages that also suggest regime changes. They also show that changes in fish regimes can result from natural variability and support the potential role of archaeological assemblages in tracking multidecadal climate change in the Pacific Basin throughout the Holocene (0-11,500 cal yr BP). Similar conclusions have been steadily generated since the early work of Soutar and Isaacs (1974); it’s update (Baumgartner et al. 1989) and more recent studies reported at this year’s Pacific Climate Conference (PACLIM 2004).

Meanwhile, the recent efforts to ‘define’ more physical ‘indicators’ on the order of the Southern Oscillation Index (SOI) for the North Pacific (PDO, PDI), North Atlantic (NAO) and the Arctic Ocean (AO) that can be used to classify ‘expectations’ within regional ocean ecosystems has progressed, but to date – is still only representative of specific ‘states’ not their causality within these systems, or their direct consequences, thus responses to changes over time. The recent AGU meeting in Portland, Oregon provided a forum for discussing this dilemma – given the bobbling about of the PDO since the later 1980s, and its present instability. Sharp et al. (2001) reviewed these issues for the California coastline, and pointed out that these ‘local’ perspectives are quite important, but must be placed into the larger context of at least basin-scale climate/ocean dynamics, if not even greater scales. Klyashtorin (2001) provides excellent comparisons of the various climate indices. The more local the index, the more noisy patterns. They are primarily simply local artifacts, not causal; thus too often likely to be misleading if used as the sole sources of ecosystem forcing.

The recent resurgence of Pacific salmon runs south of Vancouver BC has exceeded all previous records, since the 1938 completion of Bonneville Dam. Despite their ‘on time’ 1998 reappearance in the region, the various locally generated climate regime indicators were still unable to explain much as the key climate and ecosystem conditions do not match previous phases. There are particularly powerful patterns that have recently ‘earned’ labels, such as the El Niño/La Niña phases. Somewhat opposite SST and Atmospheric pressure distributions are often used to characterize these - but it would be very difficult to define the varieties observed as being easily classified, or sequenced in the annual cycle as being in any way ‘fixed’ or evenly distributed. Recent observations suggest the Pacific might evolve through more than only two modes of long-term behavior.

The Northeast Pacific – A Single System, or Several?

Ebbesmeyer et al (1991) describe forty environmental changes between 1968-1975 and 1977-1984, including the 1976 step in the Pacific Ocean climate. Linking some of these changes to local salmon population response. Pearcy (1992) examined the role of the ocean ecology in the changing potential amongst the myriad North Pacific salmon populations. Ware and Thompson, (1991) described links between long-term variability in upwelling and fish production in the northeast Pacific Ocean. Francis (1993) linked climate change and salmon production in the North Pacific Ocean and Ware (1995) outlined a century and a half of change in the climate of the Northeast Pacific. However, after watching several reruns of the Pacific Basin monthly SST anomaly time series movies overlain by Surface Winds for the period from 1960 until 2000 (available along with several examples from around the world's ocean basins from FSU/COAPS), it would seem that any of the popular, simplistic 'two-phase' mental model are simply inadequate as an explanation of anything in the oceans. ("Never the same twice" is a motto that this principal author has promoted since beginning his earliest sea-voyages in the summers of 1957 and 1958).

Chavez et al. (2003) outline what has been learned since the early 1970s, as the eastern Pacific and Japanese systems have experienced transitions - multidecadal change in food-fish dominance, e.g., anchovies to sardines and back around the North Pacific Ocean. The analogies within other upwelling dominated systems have been tracked since the early 1980s, and updated as the various systems exhibited their transitions (Kondo, 1980; Kawasaki 1984, Lluch-Belda et al. 1989; Kawasaki et al., 1991; Bakun and Parrish 1991; Lluch-Belda et al. 1995).

The 21st Annual Pacific Climate Conference (PACLIM 2004) was held at Asilomar, Pacific Grove, California, from 28-31 March 2004. At this convergence, previous high-resolution studies of sedimentary deposition of fish scales has been updated and extended for several regions. The most recent updates include Cannariato et al. (Abstract PACLIM 2004) from USC, that extended the time series from the Santa Barbara Basin. The focus was on California coastal climate, and California's neighbors, as well. Catch variations express related climate-driven dipoles. Cannariato et al. study has extended the record, using more typical paleochemistry, back to ~11.5kaBP. The cores were sampled at 2cm intervals, or ~20 year increments (~575 sampled sets in the sequence). The sequence showed a clear rise in SST occurred from 6.5-4KaBP, while the previous epoch was consistent with continuous glacial melting. Those records that were within 2C variability were more stratified, while those with 4C variability were indicative of greater upwelling, and somewhat less stratified. The records were compared to GISP ice core results, and found to be notably similar. Periodicities were found at 100, 185, 1200, and 2600 years, in accordance with many paleoclimate data sets, and in general it appeared to have been warmer and wetter after the 3-4ka transition. Periods of known lower solar activity were also observed to have lower temperatures, e.g. Maunder Minimum, 500-600 years BP. The California bristlecone pine record was also in accordance with the Santa Barbara Basin – Warm SST = Wet; Cool SST = Dry proxies.

In Figure 2, below, provided by George Taylor, you can see that the sea surface temperature versus the rainfall pattern is opposite that of the southern California region.

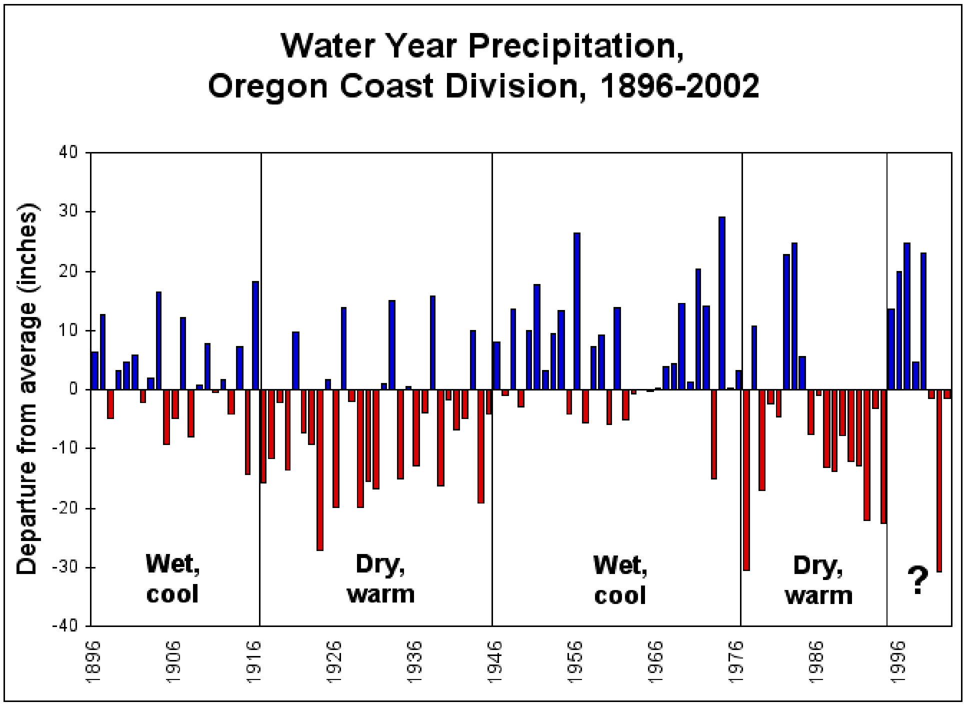

Figure 2. Water Year (Oct.-Sept.) Precipitation, Oregon Coast, from 1896 through 2003 (Oregon Climate Service, http://www.ocs.orst.edu)

The bottom line in these new data sets and their comparisons is that there was a 'Little Ice Age signal, along with various numerous synchronous changes that track those observed in the GISP ice cores, but the signs of the temperature/wetness variations depended upon location, as one should expect given the trimodal overview of Hadley Cell atmospheric circulation, and the regions intermediary position between the Tropical and Polar dynamic regions that drive these changes. Much of the confusion in today's climate change debate is due to the fact that GCMs do not reflect well the Tropical Deep Convection, nor the Polar Subsidence Events that are the powerful forcings driving the Hadley Cells, and affecting all intermediate locales, often in opposite ways. The All Bad, Vs All Good perspective has been rejected - repeatedly (Glantz et al.1987, 1991) - yet fails to register.

Douglas et al. (Abstract PACLIM 2004), also from the USC climate research group, provided an overview description of the Gulf of California's ocean-climate records. On the longer time scale, there was a decline in wetness from 9000BP until 1500BP. Lower freshwater input seems to be the culprit in low primary production. North America's Mega-drought of 1500CE was clearly observed as the sediment layering was quite diminished. Douglas also pointed out that the normal, 'intuitively' expected circulation and productivity patterns within the Gulf were completely contrary to what actually occurs. When the Gulf records timing of changes were compared with the Cariaco Basin record, they were found to be in general accordance. However, the western side of the Gulf appears to have developed an opposing pattern to the east side. While they were similar during the early 4000BP, at 1500BP, there was a decrease in productivity in the west, and a slight increase in the east, suggesting a different nutrient resource for each. This is likely due to both changes in the Colorado River output, and related low salinity layering and varied wind mixing. During the Younger Dryas, the Guaymas Basin (eastern mid-latitude site) primary production increased. Over the recent 100 years there has been a decline in primary production. Both salinity and temperature increased. The manipulation of the Colorado River flow obviously played an important part in the region's productivity starting about 90 years ago.

Barron, et al (Abstract PACLIM 2004) described the coastal climate of northern California from their extended records, expanding the coastal region's latitudinal coverage. Their studies involved observations of sub-Arctic and subtropical diatoms in sediment cores in the coastal ocean, along with alkenone records. These were compared with samples from a coastal bog; based on pollens from douglas fir Vs oak (indicators of wet Vs dry) and Sequoia (warm) and alder (cool). The ocean core diatom records suggested an onshore-offshore SST gradient in the region's season prior to 600AD. This gradient abruptly collapsed ~650AD, and again ~1050AD, followed by warmer conditions between 1050 and 1300AD. A generally cool period exists since. As well, douglas fir dominated the pollen records until 600AD, at which time oak dominated. Around 900AD, both declined, suggesting severe drought. The recent 150-year records appear to be complicated by generally higher nutrient levels, and increased productivity. Typically warmer SSTs correspond with increased Sequoia pollen, and lower SSTs with declines in percentages of sequoia pollen, and suggest alternating warm and cool PDO-like periods 300-400 years in length.

These new studies provide interesting similarities and regional/temporal contrasts in climate from the upper Gulf of California, along the Pacific coast northward to Oregon. Again, the simplistic ‘One uniform response’ over the west coast is clearly inappropriate. Transition zones are complicated, and that is why their species diversity is high, and subject to major dynamics changes.

On comparison of the Santa Barbara Basin sardine (warm positive) record with these northern records from the Little Ice Age (1300-1850AD) records indicate that California coastal waters were unusually cool, while the periods of warmth appeared to be antithetical between north (in the interval 1050-1300AD) and the south (850-1050AD). However, a general agreement was that SSTs decreased from 500-600AD, as well in the upper Gulf of California. Also, during 900-1400AD the conditions were generally drier, supporting the basic concept of a wider influence of the Medieval Warm Period than only northern Europe. All this suggests that the recent debate over the appropriateness of the Mann, Bradley and Hughs (1998) denial of an extensive Medieval Warm Period, and Little Ice Age (Soon and Baliunas, 2003a, 2003b; MacIntyre and McKitrick 2003) is not unjust. The above descriptions of various western Americas’ sediment and archeological records certainly reflect strong responses, both physical and ecological, that support these climate regimes - within which much more was ongoing. No simple answers, but denial of observational data sets is despicable. The “Hockey Stick” is a clear example of despicable science, avoiding well-known and documented history, as neither the present trends nor those likely in the future are credibly represented (Essex and MacIntyre 2002).

So, Where Away?

The relatively recent re-emergence of the Russian Arctic Institute’s northern hemisphere Atmospheric Indices, related to the world’s major fisheries resource Bloom/Bust cycles (Klyashtorin 1998, Klyashtorin 2001, Sharp 2003) and ongoing collaborations within various regions, e.g. the Benguela Ecosystem Program; the North Sea ICES efforts, and the North Atlantic Fisheries Organization (NAFO; and emergent efforts between Peru and Chile; as well as the CalCOFI program) have yet to be dealt with by aquatic resource managers in any but a nod-of-the-head fashion.

What we suggest as the most important ‘next step’ in fisheries science is that given the real capability to forecast the all-important ‘transition’ points along the more or less universal dipolar time sequences, no matter the many external and internal forces involved, will provide lead time for implementing proactive monitoring of individual species status. These observations will provide for more up to date information about the relative health and reproductive potential of these individual species than the usual hindcast methods from VPA or other extrapolations, and thus improve and encourage proactive management strategies. The key concepts are found in the following Figure 3.

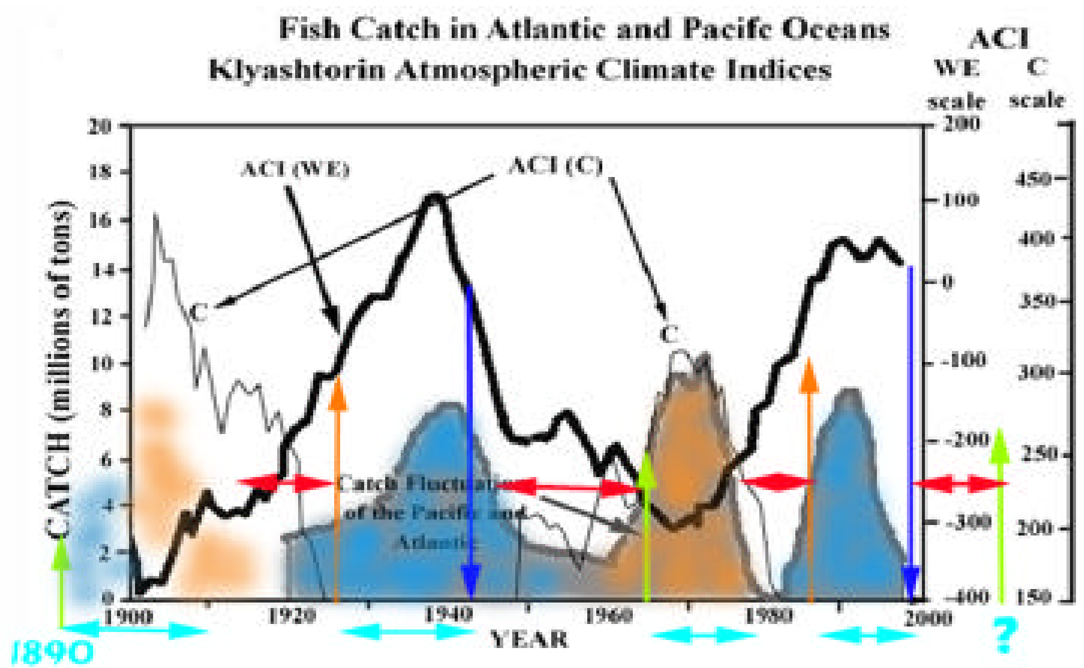

Figure 3. The world’s 12 most productive fisheries have been divided into two groups of six ‘Warm’ associated and six ‘Cool’ associated Bloom/Bust periods. The Warm group’s total production is represented under the gold-colored curves, and the Cool group‘s total catch is represented under the blue-colored curve. Early data sets are poor quality, but it was certain that the Cool-species were also abundant during the previous cool (ACI-C index high) cycle. Such dipoles are well represented in various regional sediment record sets studied to date (see text).

The Major Point needing made clear to all involved in resource management efforts is that no matter what the cause of the ‘transitions, upward, or downward, for each group, there are extended periods when neither group should be heavily fished – represented by the red horizontal arrows – as neither is near its optimal reproductive potential. The blue-green arrows at the bottom of the figure show the most likely ‘safe’ periods over which either the Cold or Warm species set can be fished without great concern. The second point we are suggesting as a ‘solution’ to hindcast stock assessment method weaknesses is that once the apex of each ACI phases (C or EW) is attained, that all the species involved be routinely sampled for indicators of their physiological status, e.g. Growth/Age, Fat Content, Reproductive Potential/Capabilities. Etc. The collapse phase should be obvious from specific indicators, but there are important reasons to track not only the declining species, but also those expected to bloom, using similar criteria, while resisting the urge to ‘turn-on’ their fisheries prior to their having opportunities to recolonize and initiate more reproduction options. Thus red arrows in Figure 2 cover the periods when neither population type should be subjected to extensive fishing effort, although we heartily agree that during these periods it is imperative to sample, and maintain careful monitoring of the physiological status of each of the species. This sampling should involve local commercial fishing operations, not just the usual annual ‘great white ship’ surveys that seem to be inadequate, alone, as indicators of much useful information.

Meanwhile, it is imperative that each fisheries region’s catch records be continuously assessed and analyzed in a manner that will provide the most information about the sign of the response of the individual species to the range of local/regional patterns, as per Norton and Mason (2003, 2004). Their careful filtering of California species catch records by whether or not the ‘nominal’ landings were indeed representative of a single species, was an important first step. Then they showed the entire record’s information content from Principal Component Analyses, using carefully defined climate indicators, e.g., upwelling indices from sea level pressure records, as well as temperate versus tropical influences within the long and representative Scripps Pier SST record, to show the individual response distributions across the entire species array.

The response patterns (loadings) ranged as a continuum, from very positive to very negative – on both axes. Their effort to identify the two most powerful, yet relatively independent system variables provided enough information to allow them to array the time series of what patterns promoted which species in such a manner that their relative lags and progression from state to state could be diagrammed. Figure 4, from Norton and Mason (2004, in press) provides their most powerful and ultimately useful insights:

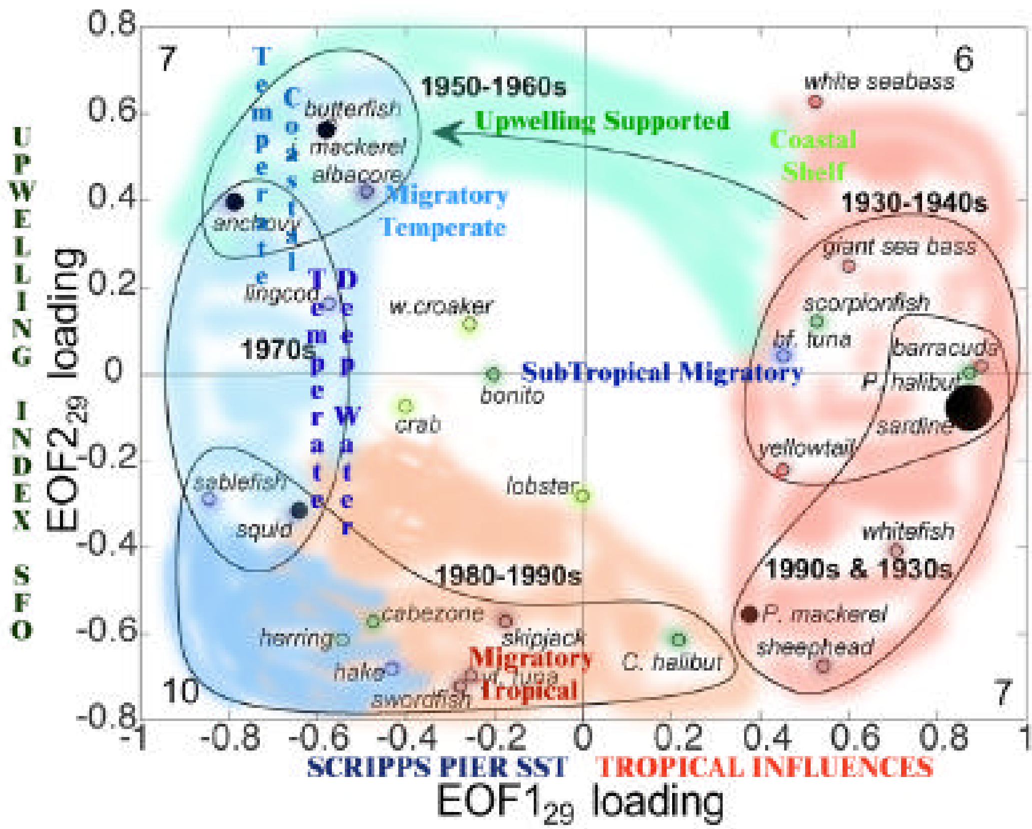

Figure 4. After carefully evaluating California's historical catch records (Mason 2003), for clearly identifiable individual species, Norton and Mason preformed rigorous Principal Component Analyses – comparing individual species response to major climate records, eventually arriving at the two most important axes within the California Coastal Ocean Ecosystem, 1) the Scripps Pier SST time series; and 2) the PFEL Upwelling Index for the San Francisco nearshore quadrant (Norton & Mason, 2004). In this Figure from their 2004 follow-up study, they plotted the response patterns of the major fish species against the two Principal axes, and added in dates of the dominance of the individual species.

The resulting “Do-Loop” in Figure 4 hints at the future changes in species dominance as the Climate Cycles, and various location’s physical environments change, and individual species respond. The figure was enhanced with colors relating relative temperature and labels for species types, by GD Sharp.

While it was also clear that there were obvious physiological and behavioral affinities, i.e., tropical type Vs coastal upwelling types, predator and related prey abundances, etc. The powerful positive response to a ‘warmer-lower upwelling’ system by such species as Pacific halibut requires further insights, likely related to life history patterns, migration/distribution patterns, and preferred food resources – true ecosystem dynamics, not just simplistic “Trophic Level assignment” by species names, adult size, and a few stomach content analyses.

New Syntheses - Empirical Thinking: Beginning a New Awareness

1) Good decision making needs well-documented prognoses about the whole system.
2) Future states of individual living resources may remain truly unpredictable, or in many cases only marginally forecastable.
3) Equilibrium conceptual approach to modeling fisheries cannot provide the necessary insights for proactive management.

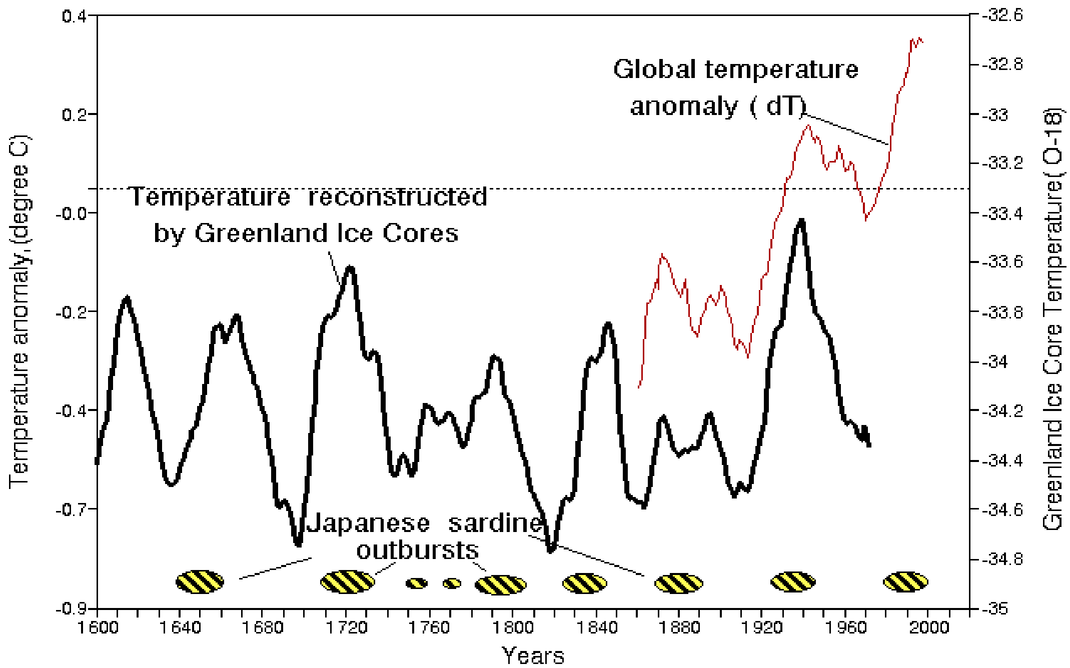

Figure 5. Klyashtorin and colleagues have provided many useful insights, resulting from extensive integration of climate and other records, amongst the most powerful is the relationships between temperature records and various fisheries. Above you can see that Japanese sardine epochs follow immediately warming trends. Collapses are relatively rapid responses to declining warming trends.

What about Growth Dynamic Changes?

The recent decade's regime Shifts, and the prior declines in major fisheries biomasses, e.g., Atlantic cod, have also resulted in several syndromes, notably the slower growth, low fat content, and earlier first spawning, often resulting in debilitation and early death. This all seems quite dramatic and 'critical' to those with little background in population biology, evolutionary biology, and physiological ecology. Stress syndromes vary amongst species, but the common pattern that can be found from bacteria to single cell organisms, onward into the vertebrates. There is a general tendency for stressed organisms to place more of their available resources into stabilization of their reproductive potential, resulting in their shuttling energy resources away from body mass development, and more into maturation and 'one last shot at reproduction' – a fundamentally selected species survival effort. The fact that eludes most fisheries scientists is that many fish species have Dome – or U-shaped stress responses (Sharp 1996).

Lionel Johnson (1981), a Canadian limnologist with years of experience in mono-specific arctic lake ecology wrote a very definitive work about the often single fish species found in arctic lakes, the arctic char, and lake-by-lake responses to long-term climatic dynamics. A fundamental message was that upon examination, the oldest fish in these systems (arctic char can live to 125 years) were most often found in the middle of the size spectrum. This does not fit common knowledge, or expectation, but the explanation is simple enough. Those larger, faster growing individuals are poorly adapted to stress situations, so that as each lake undergoes its normal patterns of high/dry, warm/cold, productive/non-productive dynamics, the larger more energy dependent individuals die, and leave behind the smaller, slower developing, but better adapted individuals. Over a century or longer period, these smaller, more adapted, longer-living individuals crowd the middle of the overall size distribution. Similar situations are apparent in high latitude demersal species, such as Atlantic cod- but too often misunderstood.

The underlying message in these patterns is that physiological status is important – and a good indicator of the relative stress levels, hence survival potential of any species. It is wise to leave stressed systems alone, and await their return to more ‘fit’ and productive states. The message underlying the Norton and Mason studies, as well as those of other Dipolar systems is that there is more to these dynamics than just tow response groups. Given the literal dominance of the two independent groups that thrive under near opposite conditions, they must also be left alone to cope with the long period between Blooms, usually about 30-40 years, if they are to maintain their presence in these dynamics ecosystems. Meanwhile, there appear to be other species that fill in the gaps by thriving during the transition periods. This is a far cry from the ‘return to prior equilibrium conditions’ promoted by those who have not learned from the recent century or so of intensified research into cause and effect for aquatic species, populations and ecosystems. Equilibrium is a Myth. Dynamics are the Rules. Species diversity is the product. Monitoring of single species distributions and abundances is not enough information to manage anything, certainly not the dynamic ocean ecosystems. Studying Landing Statistics, alone, has proven to be nearly ineffective in management efforts.

The absence of truly Systems perspectives led to the continuation of 1950s ‘equilibrium’ – single species modeling. The most important change needing made in fisheries science is to get back to work observing the oceans, to study the myriad interactions and responses, biological and physical, working with those with the most real-world knowledge, if not the sophistication of university–trained theorists. In terms of potential for optimizing fisheries, the recent surge in efforts to collate Trophic Interactions lists based on species names and landings statistics is not going to produce many more useful insights into management until they are free from the limiting pretense that fishing is the only force that matters in ecosystem variabilities. All the fishes and their food resources live the ocean, and participate in the ocean’s dynamic responses to local, regional, and distant physical forces. Until these are integrated into fisheries management procedures, there is little hope for success. The details are clear enough, as this was the same logical error set that led from the 1950s equilibrium-population modeling approach to the unexplained monotypic declines (or recoveries) in many major fisheries, despite management efforts. Sharp, Csirke and Garcia (1983) described these failings, and solutions, and soon thereafter Caddy and Sharp (1986) provided more guidelines for integration of the necessary dynamics within ecosystems. That we were ignored is another example of denial and the most wasteful characteristic of bureaucracy and academic modeling games that led us to the present state of chaos that exists in world fisheries management contexts. Herein, we suggest a more focused but wider perspective.

The first step is to decide what the important questions are that need answers – now!

Modeling - What was the Question?

1st - Define the Objectives - ALL of Them…

2nd - List the important Forcings and Interactions - State Variables within Each Spatial Hierarchy - Recognize Asymmetries;

3rd - Avoid Errors, i.e., Exclusion; Interpolation and Extrapolation; Time Steps - dT; Presumptions - Steady State; Boundaries and Spatial Resolution(s); Input/Export Transfer Dynamics; Truncation of Model Dynamics; Wrong Inputs; Order All Interactions - Fit Their Temporal Dynamics Relative to 2;

4th - Work Your Way Up from the Shortest, Nearest Interactions to the Larger Scales and their Related Dynamics;

5th - Test, Correct; Fill in the Blanks, Until Objectives Are Met.

Finally, and above all, *Do Not Trust the results until they successfully reproduce known historical patterns*, and then carefully promote resulting futurecasts – based only on the successes of their past behaviors.

Necessary Actions to Take - NOW!

1 -What's Coming up? Monitor Climate Indices and -LOD

2 - Which Species will do what - Given historical response information?

3 - Define Indicators of Transitions - both Physical and Ecological

4 - Continuous catch Monitoring - via Collaborations with Fishermen

5 - Rapid Control/Management of Fishing Effort Location and Intensity

6 - Continuous Environmental Monitoring for Long-Term Signals

7 - Rapid Response to Event-Scale 'Noise' - i.e., ENSO Warm/Cold, Dry/Wet

8 - Market-Floor Flow-Through Measures to Inhibit Gold Rushes

9 - Re-education of Fisheries Managers, and Industry about "Transitions".

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