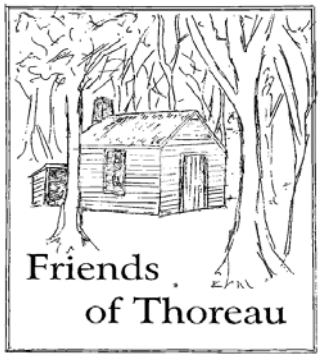

The Meaning of Salmon in the Northwest: A Historical, Scientific and Sociological Study

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INTRODUCTION

This case study explores the evolution of the land and people of the Northwest region of the United States in relation to the evolution of the Pacific salmon species from prehistoric times to the present. The reader is presented with some of the historical, evolutionary, biological, scientific, social and political information needed to understand the many-layered relationships that have been established between fish, land and people through time culminating in the current threat of extinction. An attempt is made to incorporate the role of traditional knowledge in the conservation of biodiversity and to establish the notion that landscape and fish have coevolved to the extent that the survival of the species rests on the survival of the ecosystem and vice versa.

Chapter I, "The Meaning of Salmon in the Northwest" is a broad introduction to the Northwest region and how the different inhabitants have historically shaped its natural and mental landscape.

Chapter II, "A Speculative Evolutionary History of the North American Pacific Salmon Species" visits the evolutionary history of salmon in context with the tectonic forces shaping the earth along the geological ages and explores the role of waterways in evolutionary biology and the importance of salmon to forest health within the premise that ecosystems are complex live entities that affect the outcome of evolution.

Chapter III, "Water of Life, Land of Rebirth: The Pacific Salmon's Journey from Ocean to River and Back" details the biology of the species following the life cycle from birth to death, relying on current and historic research about the homing instinct, navigational skills and anadromous survival strategies.

Finally, the **Chapter IV, "Sense of Place: The Emergence of the Restoration Era"** brings people to the fore depicting the visionary efforts of a small community of modern settlers that, in their unprecedented efforts to avert the extinction of their native salmon runs, invented Restoration as a way of life and changed our current social perception of inhabiting the natural world and our role in its conservation as a means to achieve our own conservation as species.

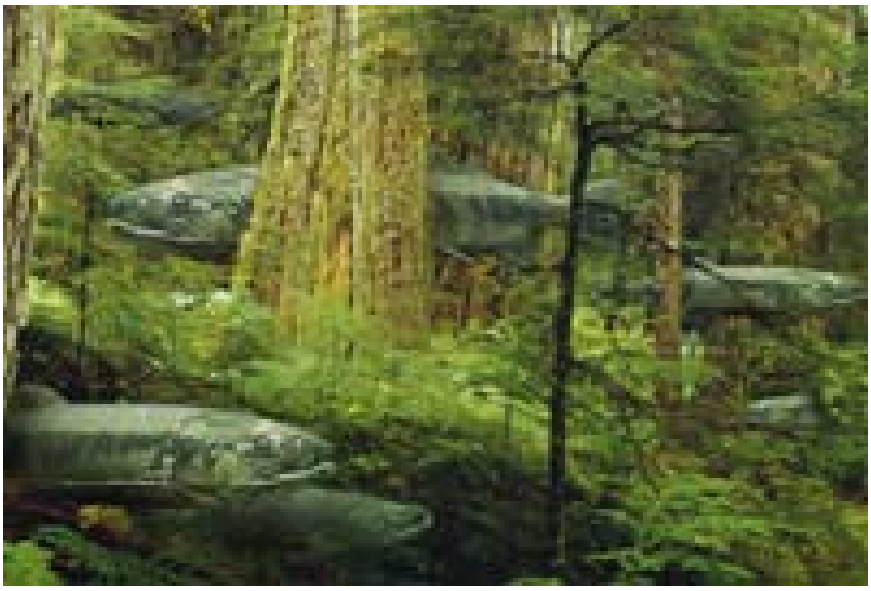
The **appendix** includes the official listing status and maps for the six species of pacific salmon national ocean.

I.

THE MEANING OF SALMON IN THE PACIFIC NORTHWEST

Salmon are among the oldest natives of the Pacific Northwest, and over millions of years they learned to inhabit and use nearly all the region's freshwater, estuarine and marine habitats. …From a mountaintop where an eagle carries a salmon carcass to feed its young, out to the distant oceanic waters of the California Current and the Alaska Gyre, the salmon have penetrated the Northwest to an extent unmatched by any other animal. They are like silver threads woven deep into the fabric of the Northwest Ecosystem. The decline of salmon to the brink of extinction is a clear sign of serious problems. The beautiful tapestry that the Northwesterners call home is unravelling; its silver threads are frayed and broken.

Excerpted from "Salmon without Rivers: a History of the Pacific Salmon Crisis"
by Jim Lichatowich, 1999. Island Press.



"-What is the Northwest?
-Anywhere the salmon can get to"
Timothy Egan, "A Year Without Rain"

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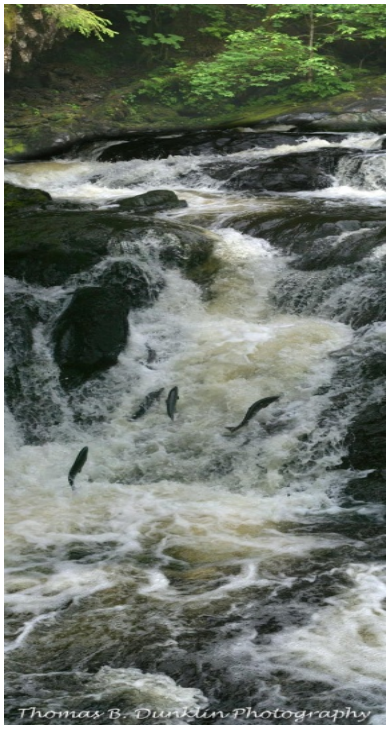
I doubt there is an area in the world that identifies itself with a species to the extent that the people and the landscape of the Pacific Northwest identify with the salmon. The long-lasting marriage between the salmon and the Northwest is made of the stuff of legends. Long before the first people appeared in the American Continent, the salmon and the lands of the Pacific had developed one of the most interesting cases of coevolution we know of.

The salmon depend on the pristine environment of the streams of the Northwest forests, kept alive by the complex web of relationship between earth, weather, vegetation and water, to spawn and grow its young in cool, clear, moving mountain creeks so they can continue the cycle and return to the deep ocean feeding grounds to mature.

Redwood stand in Del Norte Humboldt State Park. (photo taken for the Park's website)

The land relies on the salmon to bring marine nutrients inland, the key element to keep the food cycle going at all the trophic levels. Without salmon, not only the lives of bears, ospreys, bald eagles, martens, wolverines, frogs, salamanders, and even deer and other herbivores would be vastly different if not impossible, but also the livelihood of trees, the productivity of the forest floor, and the insects that are at the base of the food chain would be imperiled without the energetic input of salmon. The annual massive die out of salmon has created the most biologically diverse forest on earth. For millions of years the salmon have danced this life-giving dance with the Northwest, their coming in the autumn heralding that *all* would survive the winter.

The salmon have shaped the physiognomy and ecological and social processes of the Northwest as much as the landscape and weather patterns of the Northwest have shaped the biology of salmon. The annual massive die out of the salmon has contributed to create one of the most biologically diverse forests on earth.



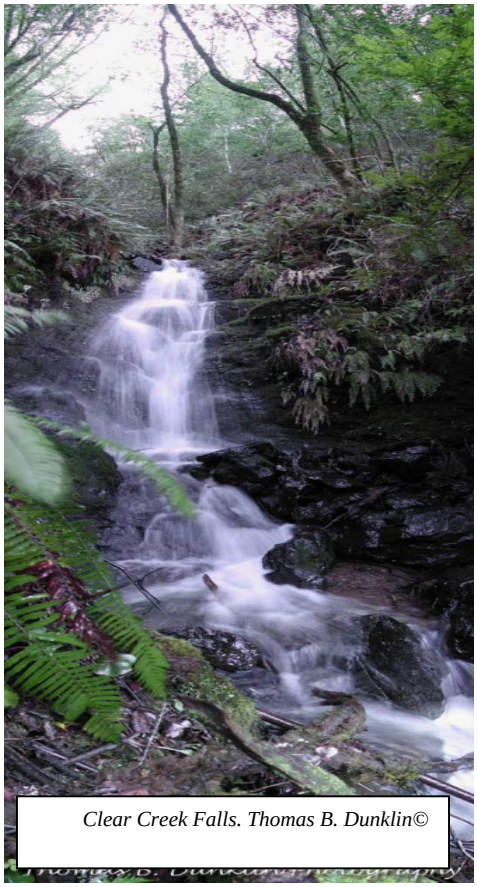
Even now that the Northwest is eminently a people's place and "pristine" is a word that can only be applied gingerly, the landscape still retains a vastness and a grandeur that bespeaks of a primal lack of domestication, more acute the further north one goes. The ever returning salmon are to this day the welcome - if waning- seasonal food for, again, all the inhabitants of the Northwest forests, including people. People fish

salmon for sport and industry, for food staple and fancy. The perception of salmon as the link that joins the people of the Northwest together is becoming so widespread precisely now that its numbers are rapidly declining, that for the inhabitants of local watersheds, attending the annual return of the salmon to their native streams has become an almost religious ritual, if "religious" is to be understood as synonymous with spirituality and cycle understood as rebirth, the continuance of life, and not the mechanical step of a process. For the many Pacific native tribes whose mythologies and racial memories are permeated by the presence and abundance of salmon this ritual has always been a sacred tradition. Redwood State Park del Norte County.

Salmon have kept coming back since time immemorial to this unpredictable land of earthquakes, torrential rains, and beautiful forested valleys open to the majestic cold surf of the Pacific Ocean, an area configured to be prime salmon territory. This is a place where water rules with abandon, shaping shores, highlands, and valleys, and the primal presence and memories of the old growth forest still warps the space-time perception. To stand in an old growth conifer grove carpeted with dripping moss and giant ferns transports us instantly to the times of the dinosaurs, when man was still a distant dream and manipulation of the environment not a concept, not only because man was not there, but because the environment could not keep quiet long enough to be manipulated.

The Estuary of the Mattole River, 7 miles north of Cape Mendocino,on the King Range right on the Triple Junction. Observe the sand berm closing the mouth of the river.Photo courtesy by Thomas B. Dunklin©

The Northwest is characterized by its geological youth. The Coastal Range is still rising from the ocean floor inch by inch, as we go about our daily lives, and when you spread an inch over thousands of vertical acres, the result is a lot of unstable soil moving rapidly upwards and displacing other things, such as huge trees and massive boulders. This activity coupled with the very high levels of precipitation that characterize the region and superimposed on the constant grind of the subduction zone against the continental plate happening in an area famous for its very active earthquake faults that have a life of their own, makes for a very "interesting" landscape scientifically-wise that tends to become a not so pressingly interesting "sliding down hill very fast" landscape, physically-wise, especially when the unfathomable mass of the Pacific looms there manufacturing extreme weather patterns, unless it is otherwise occupied rearing up in massive water walls that crash on the shore colliding with the fresh water. This sustained interaction between sea and shore – on top of the daily tide fluctuations- adds to the scene by blocking the estuaries impeding the passage for fish, or destroying the berms at the mouths of rivers messing up estuarine conditions, depending on the Pacific's mood and the amount of debris and sediment floating around, and makes intertidal spaces rich and chaotic because they are in a permanent state of flux. This means that, for good or bad, the land is in constant motion and all the water floating in the atmosphere -as fog, or as torrential, or monsoon-like rain, being breathed in and out by the forest mass in a night-day cycle, upwelling from the headwaters of all the tributaries, running at high speed down the slopes, cascading from logjams and generally oozing everywhere- has to be on the move to keep a channel to its name.



Clear Creek Falls. Thomas B. Dunklin©

Another way to look at it is that because of all this shifting, opportunities to *always* have an efficiently operating channel are continuously being created. It is easy to see, then, how any impediment to the free flow of water would have far-reaching consequences on

the shaping (the unshaping, rather) of the habitat, and such impediments are precisely what the water policy agencies have been advocating since the 1800s, policies that—unknowingly at the beginning and in blatant disregard of available knowledge now—have been paving the way for the current wave of salmon extinction we are witnessing, comparable only to the mass extinctions of the Pleistocene, but there was an Ice Age raging then. As Roy Hemingway so vividly describes in "Salmon and the Northwest" (Open Spaces Magazine, 2005):

> *"Before the effects of man, creeks and streams and rivers moved across their floodplains, changing positions as high water cut new channels and dammed up old ones. Floods spread out into multiple channels, where the over-wintering juvenile salmon could find refuge from the fast water. In summer, these streams, slowed and directed by logs and boulders near the banks, dug deep channels, keeping the water cool throughout the hot days. It was in these conditions that the salmon evolved. They are a product of this particular landscape. Although the salmon were home throughout the Columbia River and Pacific Coast states, from the coastal rain forest to the high deserts, the streams in which they began and ended their lives shared these attributes. Vegetation along stream banks provided shade and engineered the variety that salmon need during the freshwater phases of their life cycle. The rivers interacted with their flood plains by changing channels as flows increased and decreased. Small spawning streams were narrow, deep and cool, with lots of riffles, pools and gravel bars. In the arid areas east of the Cascades, where fewer firs and pines grow, willows, aspens, locusts and cottonwoods provided stream complexity."*

The Native American tribes that thrived for thousands of years in this environment before the advent of the white man did not bother to alter significantly their environment, since it was doing pretty well by itself. They were thought to be the richest tribes of the continent because of the wealth displayed in their salmon smokehouses and the sophistication and variation of the recipes they used to dress and preserve the rich red meat that would keep them alive until spring (like the delicious dried salmon cakes mixed with berries and nuts, a trail food of more energetic value than our modern power bars and equally packable). The autumn return of the salmon, the miracle of abundance that repeated year after year, was evidence enough to reinforce their belief in the cyclic nature of life and prevented them from suffering the winter famines that plagued other North American tribes. All of the Northwestern tribes without exception, from Monterey to the northernmost tip of Alaska (as well as their Asian counterparts in the salmon rich Pacific Northeast), share, in their diversity and

different mythologies and traditions, a reverence for salmon, the giver of life, the keeper of the unity of their land souls with the far ocean. The sighting of the First She Salmon triumphantly breaching the invisible barrier between ocean and land was the harbinger of riches from the ocean delivered at one's door step and was honored celebrating the Salmon Ceremony, a ritual of appreciation for life renewed, for cycles maintained, and for rich food for all. This ceremony, an example of "convergent anthropology," is shared by tribes that had virtually no contact, and sometimes no knowledge of each other.

The salmon was the staple food of hunter-gatherers, and by coming in such numbers it allowed the tribes, even after the coming of the pioneers, to keep their wild spirit and their perspective of their place in the land in relation to the rest of creation. Having salmon, they did not need to tame the land and domesticate animals. In turn, preserving the land intact kept it pristine for the salmon. Salmon kept the people, as well as the landscape, not only alive but wild, and this was an important element of their continued link with the fish they called, reverently, the Salmon People.

The effects of ritual and tradition on the understanding and conservation of species should not be discarded as irrelevant, as Daniel L. Bottom writes in "How Stories and Ritual Sustain Us":

> "*In elaborate art, traditions, and ceremonies these people expressed reverence to salmon and set detailed ground rules to regulate their use*."

Elizabeth Woody a Native American poet who writes for *Salmon Nation*, completes the thought while recounting how things were before the damming of the Columbia River in "Recalling Celilo",

> "*…and stories and rituals worked, as Northwest cultures and salmon coexisted for thousands of years*."

The wisdom of those stories contained not only a working approach to sustainability, what we today call in a less refined way a "management tool," but also an intimate knowledge of the biology and ecology of salmon that has taken the scientific community many years to decipher -fragmentarily- with the help of mechanistic and invasive technology. It could be argued that a mythopoetic approach to nature is a

prerequisite to begin to understand some of its processes. Some of the best research to date has been illuminated in this way.

This appeal to our older, wilder selves makes the Northwest still a place of pilgrimage for urbanites seeking to regain their feel for the natural world. Ever since the Lewis & Clark expedition opened up the trail to westward migration in the early 1800s - first as a commercial venue for the business of fur-trade explorers (the Astorians) and later for mass migration since Jedediah Strong Smith rediscovered the "the South Pass" across the Rockies Divide, opening up the passage later known as the Oregon Trail - bringing a wave of death and devastation in the form of the great westward migrations to follow, the carefully kept equilibrium of the wild lands began to erode, and the fate of the northwest was altered forever. The people who made up these waves of quintessentially American migration—from civilization to nature, rather than the more European from nature to civilization—were impacted by the sheer wealth of the tribes and the abundance of the land. After experiencing scarcity themselves, what they saw in the Great Plains first and the northwest later, went beyond their expectations: thundering buffalos massed in endless herds, forests of ancient trees full of game, rivers boiling with fish, and clean water everywhere to keep it that way, but, unprepared to understand the real significance of such sights, they failed to take in the immemorial interlocking of land, people, and animals that had lasted so successfully for so long. The great herds of buffalo and the great runs of salmon were at the root of this web of complex relationships. And, although the newcomers failed, to our immense loss, to understand they also had a side of the bargain to keep, the sheer *joi de vivre* salmon exude had its effect on them.

> "*Only a few wild animals symbolize the heart and soul of a region, tigers in India, lions and elephants in Africa, kangaroos in Australia. In North America, the buffalo of the Great Plains and the salmon of the Pacific Northwest supported economies, cultures and human self-identities. And though white settlers destroyed the buffalo in greed and in genocide against the natives, they embraced the salmon. Immigrants, like native peoples, saw in salmon something deep, powerful, moving and valuable— even if they approached the fish with less awe, less reverence and, consequently, less success than the natives had for millennia".*
>
> Excerpt from *The Soul Who Swims*, by Carl Safina.

This lack of understanding was to have dramatic effects, as the most superficial look at the history of the Northwest can confirm. The culture of the newcomers was of fear and later contempt for all things Indian and it translated to the attitude towards the land and its living bounty. In less than a century and a half, a blink in the eye of Time, what took millions of years to accomplish and had reached a level of sophistication hard to equal was nearly wiped out by the rude means of ranching and agriculture, activities always preceded by massive clearing of the land. From the perspective of the pioneers and the relief that must come when conquering something that causes fear, this required a courage and enterprising of its own, and it is understandable to see the elation and sense of accomplishment in the eyes of the loggers after toppling one of the giants of the forest, even if their titanic efforts and the hardships they endured served only to enrich the few families who owned the vast tracts of forestland and they themselves lived semi-indentured lives at work camps. This new approach to take what the land had to offer without giving anything back was the beginning of the end. In the manner of the ever widening ripples that form when a stone is thrown in still waters, the waves of devastation wrought upon the land started affecting all the creatures of the Northwest. Salmon, thought to be inexhaustible were amongst the first to suffer.

The rich tradition woven around salmon has also found its expression in theater. The following soliloquy "The Spirit of Salmon's Lament" is taken from "Queen Salmon" a tragicomedy that has captured the spirit of the Northwest.

We were so many once.
The sea itself would churn with the wake of our endless schools.
When we turned, in our great gyres, the head of the school
Would be half way down to Kodiak while our tail would still be deep in Siberian
Waters, pecked at by Aleut hunters brave enough to pursue us in flimsy skin boats.
From frigid Kamchatka to the balmy southern coasts, we were known as
The Providers,, who guaranteed meat to bear and eagle, and raven and human
And a multitude of others. When we entered the rivers, compelled by the sacred, fatal
urgings of our loins, a huge wave preceded us to let the hunters know we were coming.

The rivers swelled and the fishermen roared with glee at our spirit churning the
Water to foam. We were royalty visiting from a larger, more exotic realm, charging
Each valley from Siberia to Point Conception with the power of the deep, and
The exaltation of purest sex. And when that was over, our carcasses sent to the
Peaks a stench that sickened even the skunk people but spoke of oceanic riches
Being returned to the rivers, and the land, to put spine in the green growth and
Recharge the cycle of life. We were the mortar and thong that bound river and ocean,
Land and sea. We were the Lifebringers.
And now, the animals who ate us have almost forgotten our taste.
Only the oldest humans can remember the last of our glory. This cursed age
When all of nature, is made so small, so diminished. When all that stand
Of size or greatness or is so tiny and fine as to go unnoticed, is punished for its

Very existence by losing it. Oh how has the world been so reduced?
We, the salmon people are few now in so many places where we were once a multitude. What was glorious is now furtive and quick, no longer a din filled with the thundering Power of creation.
We seem a tattered remnant.The barren shadow of a once brilliant shimmering.
Why? Is it humans? They were part of the scheme once, native to
The land, brave and humble players. What is this curse we all suffer through
Them? Why must it be so? Do our people have to go down to dim perdition
Never to show our brilliant silver sides to any eyes anywhere in the universe?
Will not even the humans lament our passing?

The Spirit of Salmon's Lament. Act I, Prologue, from Queen Salmon. A Human Nature Production, 1994©

By the early 1900s, most of the big rivers had been dammed, most notably the mighty Columbia River in Washington, the biggest watershed in the Northwest, whose length and tributaries span five western states (Idaho, Montana, Utah, Oregon and Washington) and two Canadian provinces (British Columbia and Alberta) with annual returns in the 10 to 15 millions of Chinook, Coho, Steelhead, and Sockeye. At the height of the fisheries days in the 1880s, more than 2 million spring and summer Chinooks were taken, but the damming of various tributaries of the watershed have converted the once lively ecosystem into a series of still lakes and flat runs of water devoid of the power of movement. The damming of rivers was thought of at the time as the biggest accomplishment of technology and was abused to distraction, disregarding organized local opposition.

Map of the Columbia River Watershed and dams on tributaries. Source: North Pacific Water Management Division, Northwestern Division, U.S. Army Corps of Engineers

Not even the respected John Muir at the height of his powers was able to stop the City of San Francisco from invading Yosemite National Park to construct the Hetch Hetchy Dam (much later, in the 1990's during the Clinton administration, when Al Gore's visionary environmental and cybernetic election agenda – Al Gore was the first proponent of "the Information Super Highway", what we know now as Internet- brought the democrats back to power, Bruce Babbitt, the Secretary of the Interior, engaged in a much welcomed campaign to demolish dams in an attempt to return the ecosystem to its original conditions and foster a revival of the fishing industry).

But in the 1950's and 60's, when the fisheries started hurting and the environmentalists complaining in an organized fashion, the Department of Fish and Game and the Department of Energy began thinking of mitigation techniques, initiating a justly derided time that we will call the Remediation Era, a time when the most outlandish "remedies" that made true the old adage of the cure being worst than the disease were implemented, with a straight face, in the name of science to appease the growing concern of a sector of the American people, the "environmentalists," without angering the industrial sector. One of the remedies that seemed like a good idea at the time and is now a matter of tremendous concern is the hatchery or fish farm. It was thought that if for every dam constructed a hatchery was put at the bottom of the former river, even if the wild run was destroyed anglers and consumers would have their salmon, but as we will see later, this only served to compound the problem and take it into a new realm of genetic tampering and spreading of disease to wild populations. Hatchery salmon proved to be an added danger to the wild salmon runs rather than mere competition.

The degradation of terrestrial habitat has been felt most keenly in the productivity of ocean fisheries. If anyone, with all the information available, still had to make a mental effort to accept that things as far away as the North Sea and the headwaters of a small tributary up in the Klamath region of Northern California are connected and therefore mutually affected by what happens in both of them –regardless of what our conception of time and space tells us should happen-, the decline of deep ocean salmon populations has put it clearly into relief for policy makers and even more clearly for Alaskan commercial fishermen who have seen their way of life and survival threatened as well by serious competition of fishermen from other countries and regions that come in huge factory ships to vacuum up the north waters of all its fish.

Another “solution,” which does not even have the excuse of having originated during the Remediation Era but now when we know better, is the farming of genetically modified or transgenic fish (GMOs).

Remediation, failing to address the root problems as part of a greater whole, was obviously inadequate, and in the early 1970s -when much of the forest was cut, a lot of the water was diverted for hydroelectric projects to supply agricultural and city communities far south and much of the Northwest was paved over- a new conception of the problem and its solution that is now an integral part of the social and political consciousness of the Northwest emerged. Furthermore, this new understanding of nature and its processes has spawned, with typical Californian spunk, a new multi-million dollar industry comparable, in its paradigm-changing power and in how it represents the dynamic nature of collective thought, to the new conceptions that emerged in Silicon Valley. And although one is about generating money from intangible assets and futuristic technology and the other about salvaging nature and – for some - going back to earthy ancient roots, they are both about a new intelligence that bases knowledge in the transmission of information, be it via satellite connections or via the web of relationships that exist between organisms and habitat. Curiously enough, both cultures - artificial, operated independently of land location and applying cutting edge technology dotcom culture of Silicon Valley and the Restoration culture whose aim is to restore land to its original form and function and it is concerned with processes that are eminently land based- look for solutions outside the realm of the generally accepted common knowledge widening and enriching it and will perhaps meet in some distant point. After all, silicon chips are just cleverly manipulated chunks of rock packed with circuits, an electronic earth magic gadget, one could say. Arthur C. Clark said that “any sufficiently advanced technology is indistinguishable from magic”, a witty statement no one took seriously until the respected –in spite of also writing science fiction- physicist Gregory Benford further added rather tongue in cheek that “any technology distinguishable from magic is insufficiently advanced”. The simultaneous development of both these movements may be considered as independent outbreaks of collective thought that represent the value that information, and the transmission of information have to a new generation of people. Together, these trends of thought capture the typical Californian quirk of pushing the boundaries of the current

understanding, bridging arcane concepts with new thinking in an imaginative reorganization of the current reality.

The **Restoration Movement**, based on this breakthrough conception -or not new at all, since, as Freeman House, celebrated author of "Totem Salmon, Life Lessons From Another Species" would remark, this type of "discovery" is reinventing of the wheel-, emerged as a byproduct of the backlash of all that had been erased from the original Northwest and was sorely missed at a spiritual and physical level, and not surprisingly it had its roots in traditional native wisdom, deep ecology, the California environmental movement, monkey-wrenching, and the new urgency to halt the reckless destruction of a marvelous place. The Restoration movement, distilled all these sources in an ideological body called bioregionalism, "a network [with] which to study the complex relationships among communities, humans, governmental institutions, and the natural world, particularly through environmental politics, and born of imperatives like sustainable development, biological diversity, stability of the environment, and cooperation. This term came from a philosophy aimed at life out in nature. We need to adapt it to a complex reality and develop principles that are also applicable to cities." (Peter Berg, cofounder of the Planet Drum Foundation and articulator of this local conception of inhabitation of a place -reminiscent of the Spanish "Comarca", the German "Mark" or the English "Shire", ancient land concepts the European Union has picked up and is trying to promote to preserve local and regional diversity to offset the conglomeration of the European States in a Union- that aims at having administrative and economic regions coincide with natural regions).

There are now more than 400 grassroots restoration groups that collaborate with federal and state agencies and private foundations. Restoration has embedded itself in the fabric of the Northwest, becoming another thread of the big pattern. The region-wide efforts to restore the habitat of the salmon to former splendor and reshape the economy of the region have brought together—more or less reluctantly but inescapably—all the interest groups involved. Ocean fisherman, anglers, tribes, conservationists, forest activists, consumer associations, academia, chefs, hikers, schools, ranchers, ecopsychologists, loggers, and city councils have joined in an effort to salvage the salmon and themselves. This interlocking network has had gratifying secondary effects, such as bringing together government agencies that normally don't talk to each other in the bureaucratic

equivalent of opening up ecological corridors in a fragmented ecosystem. Even the big industrial cities like Portland and Seattle have a heightened sense of existing alongside, rather than in spite of, the natural phenomena, as reflected in their having a conservation of urban salmon habitat policy. The image of salmon -surging from a stream, circling a redwood stand, being fished by a bear, as lox on a bagel, as a giant angler's trophy, in the circle of species emblem, or as a determined creature navigating the city's maze of sewers- is everywhere. An annual Salmonid Restoration Conference has been held for the last 18 years to serve as a forum for the different groups and as a policy creating tool to manage salmon population and fishing practices. Salmon Nation, a recently-born coalition made of many of the groups mentioned above, is the latest manifestation of the people of the Northwest wanting to express their commitment to and identification with salmon as a way of life.

Why does this denouement seem a natural outcome in the convolutions of the history and economy of a region? This general yearning of the Northwesterners to recover their ties with the salmon as the way to maintain a sense of regional identity is the natural product of the history the salmon and the region have been weaving together for the last two million years.

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II.

A SPECULATIVE EVOLUTIONARY HISTORY OF THE NORTHAMERICAN PACIFIC SALMON SPECIES

Eggs in Redd Gravels.. Photo courtesy of Genny Anderson©

Modern fish—bony rather than cartilaginous like sharks—or teleosts, appeared 220 million years ago. They underwent significant evolutionary changes in the Cretaceous period. They had a skeleton composed partly of bone, a pair of gills, and often a swim bladder that allowed them to float and dive as required. The first types of salmon and trout appeared near the end of the Cretaceous period. The phenomenal development of bony fish led to the most striking changes in marine life. Stronger skeletons and protective scales afforded bony fish certain advantages. As a result, their populations grew and quickly spread. A new source of food had just been born. (From C.P. Hickman, "Integrated Principles of Zoology"1988 Times Mirror/Mosby College Publishing).

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The strong link between the Pacific salmon and the Pacific Northwest as described in the previous section is rooted in their long evolution together. This rich common history, that has developed -is still developing- through the ages, is essential to understand why things are the way they are now, and not because it is science, but because it is history. Before we had a name for evolution, we called the story of earth and its inhabitants Natural History, and because there are so many actors -Geography being a prominent one- involved, the History of Nature is really the stories of each one of them as they relate to each other in many different places and situations that don't follow a linear script. This heterogeneity and simultaneity is not something that comes across easily when attempting to recount complex events with dates. Keeping this feeling of complexity and circularity in mind is a good exercise for the understanding of biological cycles when outside elements like glaciations and technology get in the way of the unfolding life cycles of the organisms, and they certainly do in salmon's life. This is why chaos theory - a theory that describes the complex and unpredictable motions or dynamics of systems that are sensitive to their initial conditions and attempts to find the underlying order or cycles in their apparently irregular behavior - has become a useful tool to describe systems dynamics and therefore to interpret complex processes such as adaptive evolution, which in turn has provided much needed insight into habitat restoration. Chaos theory probably has a lot to do with the concept of biological diversity also, since it deals in development through time of complex interaction based on initial conditions.

Nobody really knows the life history of the Pacific salmon as a species. Now, in our current geological age, the Holocene, there are seven Pacific Salmon species belonging to the Oncorhynchus genra: **Chinook salmon** (*Oncorhynchus tshawytscha*), also known as king salmon because is the biggest, reaching up to 126 pounds; **Coho salmon** (*O. kisutch*) or silver salmon; **Chum salmon** (*O. keta*) or dog salmon; **Pink salmon** (*O. gorbuscha*) or humpback salmon; and **Sockeye salmon** (*O. nerka*) or redback salmon. These species range the waters of the northern Pacific and come back to spawn in North American rivers.

Coho

- Also known as Silvers
- Spend one to two years in freshwater before migrating to sea
- Require small headwater streams for pre-migration period
- Originally one of the most commercially sought after species; now depleted in many areas

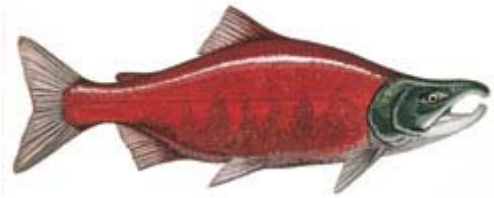
Chum

- Also known as Dogs for their canine-like teeth, or as Keta after their Nanai (Asian aboriginal group) name
- Broadest geographic range of all the species, extending from California to Korea
- Spawn low in river systems
- Migrate to sea soon after hatching
- Drier flesh well-suited for smoking

Pink

- Also known as Humpies
- Most abundant of the species
- Smallest of the species
- Often spawn in estuaries or lower reaches of rivers
- Migrate to sea soon after hatching
- Two-year life cycle with alternate even and odd year runs
- Lowest fat content of the species
- Frequently used for canning

Sockeye



- Also known as Reds
- Darkest flesh of the species
- Name comes from the First Nation sukkai, meaning "fish"
- Greatest variety of life history patterns - spawn not only in rivers but also in lakes
- Often spend one to three years in freshwater before migrating to sea
- Some populations have become land-locked, and are known as kokanee salmon

Steelhead

- Live as much as four years in freshwater before migrating to sea
- May mature without ever leaving fresh water, in which case they are called rainbow trout
- Often do not die after spawning, but will re-migrate to the ocean
- Highly prized by anglers for their fighting spirit

Salmon illustrations by Shari Erickson. Steelhead illustration by Joe Tomelleri (www.salmonnation.com)

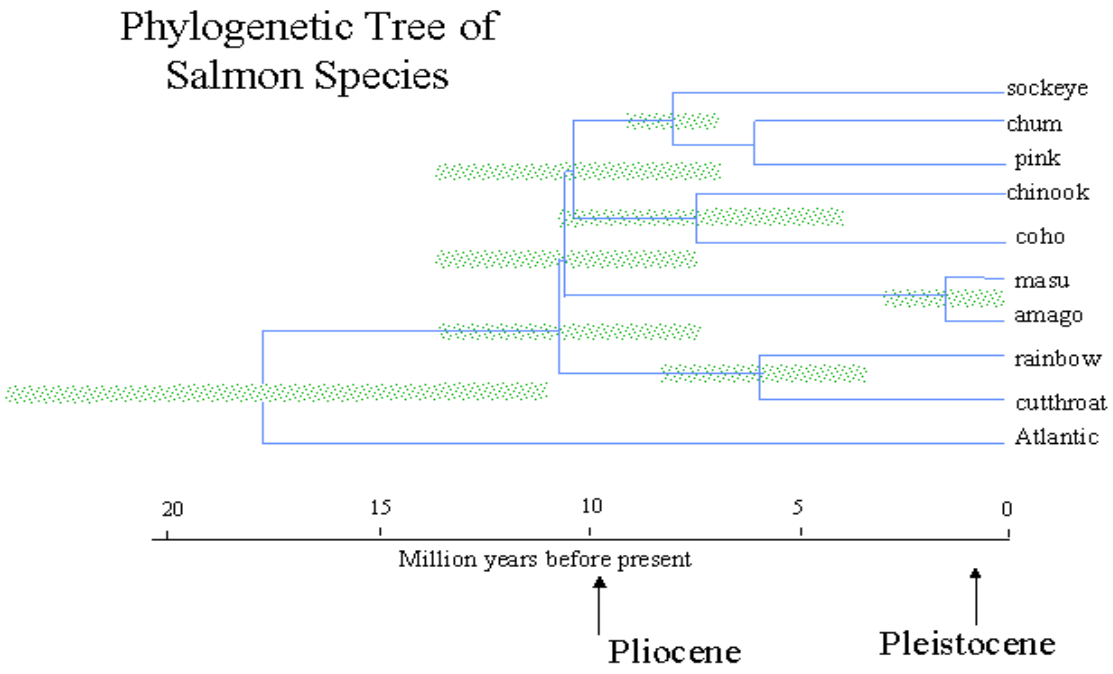
Two species occur only in Asia: Masu salmon (*O. masou*) also called cherry or yamame, and Amago salmon (*O. rhodurus*) or biwamasu. The species, as genera, share the same life strategies, but adapted to time and spatial patterns along a gradient according to their evolutionary age. Sockeye, Pink and Chum spend the least time in freshwater, being older organisms. They also spend the least time in coastal waters, migrating offshore to spend their life in the open waters of the North Pacific. Chinook and Coho are more dependent on land ecosystems, spending a considerable percentage of their life in rivers before they initiate their oceanic lives. Sockeye has even developed a race of lake dwelling fish that never go out to the ocean. These habitat-life cycle "gradations" or adaptations will have a bearing in how they survive modern world circumstances.

It is speculated that the Pacific and Atlantic salmon -whose biology differs from the one of its Pacific cousins in a crucial aspect: Atlantic species do not die after spawning and they make the return trip to their home river many times; consequently, their relationship to inland ecosystems is slightly different- evolved from the same ancestor in a divergent manner, that is, using the same stock genetic material to get adapted to different environments throughout the same geological period. This theory would make Pacific salmon between 500,000 and 1,000,000 years old, since the Atlantic and the Pacific oceans were connected until the late Pliocene, but conflicting research suggests that the Oncorhyncus genus may be 2 to 3 million years old or may have appeared a lot earlier, during the Miocene, 24 millions years ago, as the Northwest coast began to take shape. There are older fossils of other genus found so far. Fossil remnants of *Eosalmo driftwoodensis,* an older ancestor that lived 40-50 million years ago, have appeared in British Columbia, Canada, and Washington State.

Another species, *Smilodonichthys rastrosus*, existed 10-15 million years ago during a segment of the Miocene. This was a giant salmon ghoulishly nicknamed the sabre-tooth salmon because it was about 10 feet long and weighed 500 pounds, although it only ate plankton.

The most commonly held view is that ancestors of today's Pacific salmon originated about 1.8 million years ago, during the Pleistocene Age—a time when the watersheds and river systems of today began to form while the megafauna still browsed on the precursors of today's flora—and started looking like modern salmon during our last

geological era, the one we are still in today, the Holocene. *Homo sapiens* appeared also during this era, known as the end of the Ice Age, when glaciers blocked most of the Northwest river basins, like the big Columbia River watershed about 12.000 years ago. We should not let the expression "end of the Ice Age" be misguidingly final. The glaciers kept moving back and forth, changing the physiognomy of the river valleys and the flow of the rivers for a long time, and salmon, considered a highly "adaptively plastic" specie, survived this critical time finding, by trial and error, ice-free rivers (Lichatovich).



Redrawn from McKay et al 1996

This was happening while the interior of the North American continent was patchily covered by giant ferns and conifer forests generated in an earlier geological era, and a large inland shallow sea divided the land mass. Flowering plants evolved during the early Cretaceous period and quickly took over most of the ecological niches. Not because they were aggressively trying to colonize space, as nature programs would like us to believe, but simply because space was eagerly waiting to fulfill its side of the

bargain. In other words, space was also developing and the immense variation and differentiation was occurring simultaneously for the space and the organisms.

Some of these angiosperms included magnolias, laurels and sycamores; these flowering plants supplied dinosaurs with an abundance of food and spurred a huge boom in their population, as well as creating a major evolutionary upheaval in the way species adapted their reproductive strategies to the pollination needs of flowering plants, the latest in reproductive trends. A lot of the things we do today, and a lot of the ways we look at the world today, have to do with the adaptive characteristics of flowering plants and the impact they had on the evolution of animals. Our modern fauna and flora originated as a consequence of this explosive "adaptive flowering radiation of the Cretaceous" as the period between the emergence of the angiosperms and a whole plethora of insects and the appearance of the early mammals is known.

Meanwhile, the ponderous labor contractions of the earth that had begun in the Jurassic continued, giving birth to the mountain ranges in the Pacific West. This creation of orographic relief caused by thousands of tons of earth emerging explosively from the ocean's floor and giving a new verticality to the surface of the earth started the differentiation of ecosystems, creating different landscapes and elevation gradients in an elegant "fractal creasing" of the landscape, a sort of kaleidoscopic space distortion that was the perfect excuse for niches, or habitat pockets. "Niching" (a lot of different animals and plants doing different things at different times at *the same place*) was the beginning of the rapid diversification of species that must have been delighted at having a multi-faceted landscape that gave them a chance at genetical self-expression with endless possibilities: a sort of "let's see what happens if I do this" approach to species diversification. I think this specialization of space is responsible for the smaller sizes of everything since and for a lot of form-derived specialization and functional convergences in the phylogenetic lineages of the animals and plants of today. It was a clear instance of system dynamics at work, a geological attempt at "zoning" to accommodate all the new species that appeared as a consequence of the explosion in vegetation species. Darwin, Linnaeus and friends would have probably given their right arms to be there and just as probably they would have sprouted a race of one armed geniuses that survived, such was the creative ebullience of that moment in time and the availability of space-function possibility. The emergence of flowering plants was an

event of a magnitude we will probably never fully understand, since we only have the perspective of how things are now as a consequence.

Besides providing food to a whole host of animal species, flowering plants also started altering the face of the earth creating micro-habitats that operated much in a way one creates “spaces” in a home by furbishing different rooms according to the function they are intended, which in turns encourages said function (try to make an omelet on top of your TV see what happens). Animal and plant communities formed in this manner, adapting to each other according to how they could fit their functions to thrive together. Animals and plants, the ultimate space designers, had millions of years to figure out how things best worked and that is pretty much how evolution happens, by serendipitous alterations like a figuratively “dropping the hammer on the right nail”, though you need to have a hammer to begin with and in this case the “nail”, or habitat, also has a mind of its own. This trial and error approach accomplished the kind of specialization of the use of available habitat we see today, where the tiniest features of the geography encompass entire, self-contained universes, or ecological neighborhoods.

From this moment in time comes what may be the most relevant feature of the Cretaceous -true melting pot- carried to this day: that older organisms, mostly primal conifers and fishy-serpentine dinosaurs, and geological features, shared the same lively landscape with emerging creatures such as flowering plants and ancient mammals, the ancestors of the animals we see today. There was geological age overlap, and I think we can still get whiffs of it. Whether this was Arcadian or not we don’t know, but in the middle of her birth spasms, the very hot earth (no ice caps yet) was cracking along the fracture seams that are now the Atlantic and Pacific oceans, and Pangea was splitting into modern continents in what is now called continental drift.

The emergence of mountains created, by default, the river basins and a new process of differentiation of the earth crust begun. This time it was water becoming salty and vast as it drained from the middle of the land mass to the huge crevasses and depressions created by tectonic expansion, or fresh and moving fast in the chasms created between rock uprisings. This took a long time and gave the fish a choice of adapting to freshwater or saltwater along a gradient offering extreme variation. Our salmon must have found the choice disconcerting. Lampreys, sturgeons, eels, and salmon maybe

couldn't decide where to go or maybe didn't know how, or maybe they were just caught in the middle of the biggest traffic jam in evolutionary history. Out of this indecision in the face of opportunity began diadromy, a survival strategy based on migrating from open oceans to land streams and back.

Diadromy required the ability to adapt to different environmental conditions at different stages of the life cycle. This entailed having the ability to alter the morphology of body structures that could go back and forth, evolving mechanisms such as, for instance, those that can change electrolytic function from being adapted to fresh water to adapting to salt water very, very quickly, a sort of shape-changing imperative. We can think of salmon as being a different fish depending on where they are, or a fish that can live in two worlds at the same time. I am sure this has a lot to do with the space-time continuum, a concept hard to grasp for us, but apparently mastered by the salmon, that possess this peculiar ability to bridge separate physical realities. This mechanism may be one of the characteristics that have made salmon a favorite in our human eyes, so castigated by a binary "either-or" mindset, because they were alive before there was separation between land and water and between salt water and fresh water. They *remembered*, and cunningly rejected choosing one over the other, embracing both the marine and terrestrial worlds, a brave choice that allowed them to survive the hardships of geological ages…up to now. In the shamanic tradition - just another way to interpret natural relationships- each creature embodies certain attributes or wisdom expressed in the characteristics of their life cycle. In this tradition the salmon is gifted with the ability of returning home to regenerate; having the physical strength to swim upstream through turbulent waters to gain insight and its rebirth is thought to be one of spiritual knowledge.

There are two mirror-image migrating patterns: Fish that, as the salmon, breed in fresh water and mature in the pelagic depths of ocean waters are called anadromous (swimming upstream to spawn in the river). Fish that fulfill their life cycle in rivers and migrate to high sea to spawn and die are called catadromous, and somehow, even though their life histories are as interesting and even more primeval than those of their scaly cousins, these have not made it into mass stardom, maybe because they are lampreys and eels, too telluric for us to behold.

This very handy adaptive strategy is another example of niche specialization. It allows different species like salmon, sturgeon, steelhead trout, eels and lampreys, and shads to share the same space at different stages of their life cycle without fighting for space or exhausting the resources. It is also a great example of convergent evolution (when different species come to the same solution through different evolutionary paths), which, once established, set the ground for geographically induced divergence that gave rise to the five species of North American Pacific salmon. And let's not forget the interplay with the environment. This kind of evolutive pattern gives the "habitat" and terrestrial plant and animal species a source of food and purpose and tremendous scope for feeling adequate in the coevolution scheme. Let's hang on to this idea, as we have to stop thinking of habitat as mere background that receives passively the effects of random things happening to it.

How habitat has shaped the development of the species is reflected in how each growth stage of the life cycle of salmonids is marked by the need of a very specific set of environmental conditions that match *exactly* the main features of healthy river channels, such as particular sequences of riffle, run, glide, cascade, pool etc., naturally, this also applies to the ocean part of the life cycle, but little is know of the habitat-fish relationship in salt water. Healthy rivers are dynamic entities that manifest their aliveness by interacting with their surroundings. They meander placidly, fall precipitously, scour deep pools that create reservoirs of cold temperature, bubble in riffles over the surface gravels in shallows, slide languorously in heavy glides, or thrash mightily against the channel boundaries, interacting with the land forms that they travel through, being affected in turn by the vegetation that develops along their margins attracted by the easy bargain of giving shade in exchange for water -the riparian flora- and the vegetation that holds the slopes in place -the upland forests-. This is really a beautiful and dynamic way to buffer themselves against changing conditions, although "buffering" is a poor way to describe such display of creative and interactive vitality. Healthy rivers are the biological and ecological repository of knowledge of a watershed from the headwaters to the estuary, transmitting with their passage this enormously complex network of information to plants and animals of everything that is happening in the upper reaches. They keep the landscape "informed" of upstream conditions.

When the young spring **smolts –** young fish at the last stage of the river life cycle, when the salmon is mature enough to swim out to sea- begin their journey downstream to the ocean from the headwaters of their birth, they become intimately acquainted with each section of the river as they travel through varied landscapes, each with its characterizing features. While they progress downstream, their bodies change gradually as they get introduced to the different micro-habitats that make up the river's length, receiving the imprint of the river as they swim on the finprints, so to speak, of their parent's winter upstream journey in a crucial learning rite of passage. The river has taken their parent's bodies -whose carcasses have become part of the living landscape- and reciprocates by rearing and teaching the young fish, which bond with the river much as other animal offspring bond with their parents. Flowing along in their moving liquid nursery the salmon enacts all the stages of growth, in the celebrated act of ontology recapitulation of phylogeny, but outside the egg, which necessitates a nurturing landscape. The process of bonding and imprinting of the river's water-land anatomy on the young fish while their own animal anatomy is developing must leave a strong shared chemical track that they will follow as adults on their return trip to the mother stream.

This process of metamorphosis by stages, from the just hatched **alevins**, to **fry**, to **parr**, to **smolt** (ready to go to the ocean) is called **smoltification.** It entails morphological, physiological and behavioral changes that prepare the young fresh water fish for life in salt water by adapting, by means of thyroid-induce endocrine changes, their osmoregulatory and navigational mechanisms. The smolt stage is of critical importance to understanding the homing process because it is during this period that salmon "imprint" to some attribute of their natal tributary that serves later to identify it when they return as adults to spawn (Hassler & Scholz, 1988). Salmon's "almost preternatural sense of smell allows them to detect the particular chemical signature of the water of their natal stream in concentrations of parts per trillion" (Smith 1985).

This is also the time that their genetic information is exposed to the particular and unmistakable characteristics of their home stream or "natural habitat" while their bodies are configuring according to the characteristics of that stream in terms of ecological parameters such as where and how find food, protection, or deal with competition, bonding with the year cohort, predation and reading the water to see what's coming next. This is called adaptation, how to survive in a certain place with certain strategies,

or “how to be a salmon here.” Another way to think of this is that the stream is the physical manifestation, the recognizable three-dimensional shape conjured by the adaptive code encrypted in the genes of each salmon run. That is why we hear things like “salmon are so adapted to their home stream habitat as to form separate genetic units” (what the NOAA scientists call ESUs or Evolutionary Significant Units and everybody else “stocks” or “runs” indistinctly. See Appendix I for listing status and maps), meaning the information absorbed during the developmental stages of the life cycle through interaction with the inland habitat is encoded in their DNA, passed on to their offspring, and constitutes the molecular user manual to survive in the ocean and return to the home spring that taught them how to be salmon - a deliciously suspicious Lamarckian approach, no doubt.

Coho

Pink

Chinook

Sockeye

Chum

Cherry

Fig. Comparative drawings of six of the seven species of pacific salmon (Cherry is one of the two East Pacific species) showing the startling differences between their marine morphology (upper fish) meant for long distance swimming and the male and female river physiognomy adapted for reproduction..

This is why degradation of habitat to the extent that makes it unrecognizable to salmon is an event of such magnitude that cancels out the flexibility that characterizes the mechanism of adaptation and can cause their extinction. In the same manner, understanding this association between each stage of the life cycle of the salmon and the morphology and dynamics of their home river is the key for successful habitat restoration tactics.

And evolution goes on. The forces that are shaping the current natural history of salmon are now compounded by human influence, expressed through the impacts of technology –one of our own adaptive strategies- on the shape and chemistry of land and rivers. We are still in the Holocene (the last 11,000-12,000 years), also known as the Age of Man – to us, that is- because our numbers and the particular way of interacting we have with the rest of the creatures of the world are impacting the environment in an order of magnitude close to that of the glaciations and with similar catastrophic consequences, such as mass extinction. Up to our time in history the forces shaping the earth have been geological and cosmic; now the element of man-wrought artifact technology has come into play, affecting the substrate of earth much in the way of tectonic forces, changing its shape and function but *too fast* for organisms to adapt to the new conditions and evolve coping strategies or viable mutations. The damming of rivers has radically altered the physiognomy of inland habitat and has altered the water cycle throughout the depth of the earth's crust. Overfishing and polluting of the ocean has mangled the marine ecosystem's dynamics. The icing on the cake, the unchecked consumption of petroleum has put a smoke plug around the earth's atmosphere that has been thus diabolically prevented from healing itself because we have systematically extirpated the forests, the earth's lungs. This severe injury to our planet has gone as far as impacting even the mighty, cosmos-driven weather patterns.

Clearcut in progress in a steep slope of Rainbow Ridge (2002) The denuded hills, once they trees that hold them together are cut (along with all other vegetation) erode easily with the first rains, ending up as sediment in the river. Courtesy of Trees Foundation.

Global warming, polluted and depleted marine feeding grounds coupled with the alarming trend of fresh water scarcity and degraded terrestrial habitat are the four most influential evolutionary factors that salmon are facing now in terms of environmental conditions. Large-scale ocean regime shifts, both cause and effect of climate change, are correlated to salmon productivity. The major ocean production cycle appears to be a 40-year cycle of rising temperatures for 20 years and declining temperatures for 20 years. The 20-year period of cooler ocean temperature in the North Pacific from the mid 1970s to the mid 1990s appears to have contributed to a record abundance of marine stocks. Now current ecological indicator indices predict a trend toward lower marine productivity and more survival problems for pelagic fish. Recent studies have noted that returning salmon were of smaller sizes and of older ages, suggesting that feeding competition between salmon—known as density dependence—may be a limiting factor in salmon production. These data suggest that the ocean's carrying capacity may have been reached. The ocean having deteriorated to such an extent that it cannot longer support historic numbers of fish. Competition (among members of the same species as

well as between members of different species including the newly engineered artificial salmon species) has been demonstrated and may limit salmon productivity (Trout Unlimited´s Alaska Salmonid Biodiversity Program).

At the molecular DNA level of evolution, salmon are confronted with a new and scary adversary: genetically modified hatchery bred salmon occupying their home streams and causing havoc of a magnitude we cannot yet conceive. In the last 100 years, at least 27 salmonid species and 13 subspecies (40 taxa) have become extinct in North America. Contributing factors have ranged from introductions (27 of 40) to hybridization (15 of 40) to over-harvesting (6 of 40).. In the last 100 years, wild salmon abundance in the Pacific Northwest and California has declined 90% on average for *all* species. On the Pacific coast of the United States alone, salmon have been lost from 40% of their one-time range, and stocks are threatened or endangered in another 27% (Trout Unlimited´s Alaska Salmonid Biodiversity Program).

Besides the diseases caused by penned living conditions that affect both hatchery and wild fish, where pellet food and pellet excrement become one in the manner of ill-managed pig breeding factories, these livestock races are cheated of their basic attribute, the freedom that makes them salmon, their roaming lifestyle. Prevented from traveling river and sea, they are forbidden the learning of the stream and the ocean and are forced to live each stage of their life cycle in the same place, never knowing what a riffle is or what to do and not do in one. This is suicidal in terms of evolutionary intelligence, the mechanism of genetic memory, the tool used to adapt to environmental constants and changes and passed on to offspring so they can survive. This privation affects also the health of the inland ecosystems, no longer receiving the marine cargo of nutrients and information ferried by the salmon into freshwater ecosystems that is an essential part of the forest's nitrogen-carbon cycle.

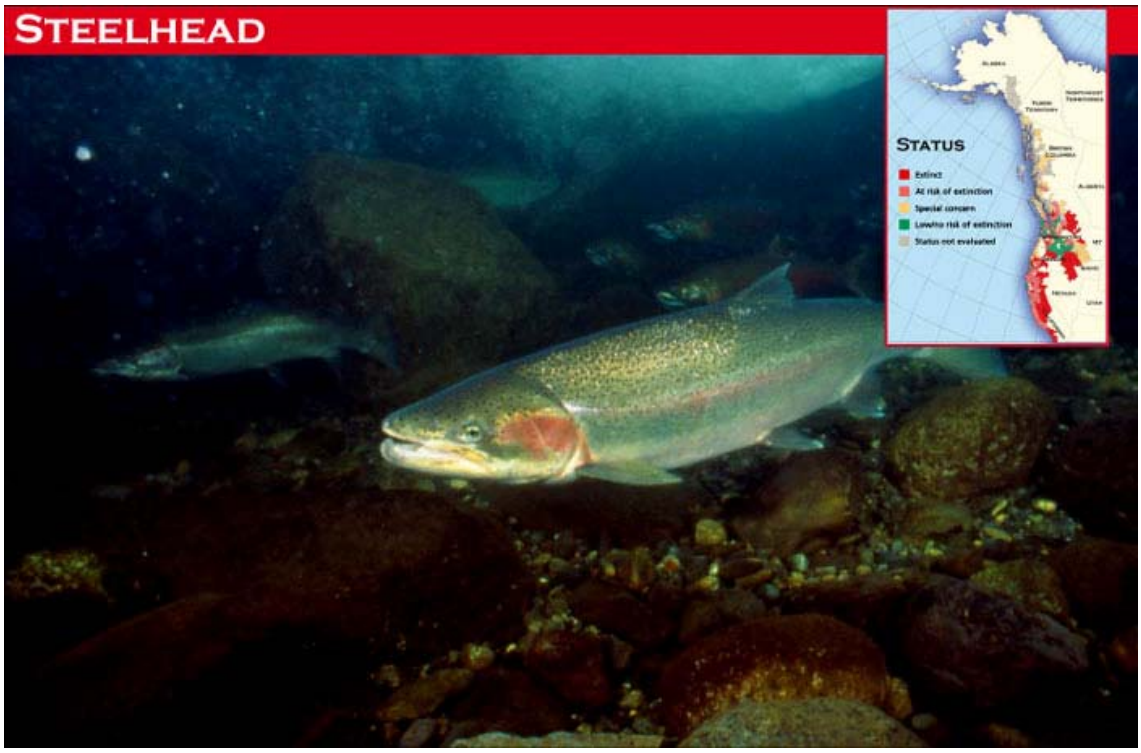
The following pictures and maps on the status of the Pacific species of salmon are from salmon Nation.


CHINOOK
STATUS
Extinct
At risk of extinction
Special concern
Low/no risk of extinction
Status not evaluated


CHUM
STATUS
Extinct
At risk of extinction
Special concern
Low/no risk of extinction
Status not evaluated


PINK
STATUS
Extinct
At risk of extinction
Special concern
Low/no risk of extinction
Status not evaluated


SOCKEYE
STATUS
Extinct
At risk of extinction
Special concern
Low/no risk of extinction
Status not evaluated



In spite of this display of species-wide fundamental lack of grasping the realities of life on this planet, we humans are also part of the web of life and continue to evolve along with everybody else –or at least everybody else left-. We too partake from the universal evolutionary mindset, however intoxicated by tool-frenzy. Edward O. Wilson, the father of –controversial- sociobiology and more recently of the concept of

“consilience”, puts us in our evolutionary place: “If mankind were to disappear, the world would return to the rich state of equilibrium that existed ten thousand years ago. If insects were to vanish, the environment would collapse into chaos.”

We would have truly estranged ourselves –terminally so- from the natural world if we had not learned anything from the salmon and did not feel the urge to save them and preserve their wildness. This deeply felt urge to heal the environment so that other species can survive is really our own survival imperative making frantic noises at us. One of the forms this has manifested in our geological time is as a way of life known as Watershed Restoration, but before exploring human involvement in salmon dynamics we need to know more about the life cycle of salmon.

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III
WATER OF LIFE, LAND OF REBIRTH
THE PACIFIC SALMON'S JOURNEY FROM OCEAN TO RIVER AND BACK

Female sockeye preparing the redd for spawning. E.R. Keely, 1998©

"Water's flow constantly links life and death. It is the mediator between the two, and its surface provides a common frontier in nature where they meet. Death is continuously being overcome there."
Theodore Schwank
Author of Water, Element of Life

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CYCLE OF CHANGE

Every year about 10 billion (Welch, Carlson) juvenile salmon pour into the waters of the Pacific Ocean from the rivers of the North American coast and begin their journey from their natal rivers to the deep sea. They travel in sequential waves that surge from the river mouths from northern California to Alaska and join the massive migration that takes them around the Alaskan Panhandle to the Bering Sea in a cyclical reenaction of their evolutionary history. Through the cycles of time, anadromy, the strategy that allowed them to survive the Pleistocenic split of the waters and later the glaciations. To switch from fresh to salt water and back has become their ontogenetical motor, defining the complexities of their life cycle. Through time, it has become an ecological parameter ingrained in the survival mechanisms of a whole region of earth that depends on the transformation abilities of this fish to maintain its biological balance.

From the species perspective, anadromy has been its own reward, pushing salmon to the limit of fitness at each stage of its life cycle. If the salmon's migration cycle is the live pulse of the water cycle that keeps the region alive, the peculiar characteristics of this environment have endowed the salmon with the near miraculous ability to transform their body structures to accommodate the physiological mechanisms needed to read the elements and adjust to them. At each stage of their life cycles at sea or at the river, they are so attuned to their environment that "their endocrine system forms a chemical link between the organism and the environment" -as W.S. Hoar a devoted researcher of salmon pointed out already in 1965- an interaction that blurs the line between what we consider animate and inanimate. In exchange for extracting this much fun from their habitat all the time they are willing to die for it… but not without a swashbuckling finale in the best operatic style where love – evolutionary love expressed in this case as marathonian sex- is only achieved moments before everybody dies singing.

Chinnok waiting to enter the stream. Andrew Hendry©©

The salmon's migration routes and patterns are synchronized with the coastal water currents that travel counterclock wise - those that seen from the air are lighter blue, like sea rivers-, but the adult life history in saltwater, as the juvenile fresh water cycle-

differs in the timing and dispersal patterns, as each of the five species reflects their specific adaptive strategies to place.

Chum and Pink, the oldest species and less reliant on freshwater habitats, are swept by the coastal current far out to the deep ocean feeding grounds, away from the their natal rivers, while the more modern Chinook and Coho remain on the continental shelf's water year round. Sockeye is extreme at both ends. It may spend up to 3 years traveling further out in the ocean after having spent the same amount of time in rivers or lakes (or like the Kokanee, never leave the lakes).

Each species divides itself into separate runs, or independent viably genetic populations, in different river systems, or according to Geiger and Gharrett (1997) "the total number of mature salmon returning in a given year from ocean-rearing areas to coastal waters", the definition that sometimes is confused with "stock", a general way to say "the salmon we are talking about, whether a distinct management unit, or the total fish out there. Stock in this sense is different from run in that the run is a very distinct unit of individuals of the same species returning to their shared natal stream. Different runs, adapted to various tributaries of the same river system are part of the larger stock of that species. The stocks operate as evolutionary significant units that reproduce sympatrically and have a different temporal and spatial distribution that other stocks.

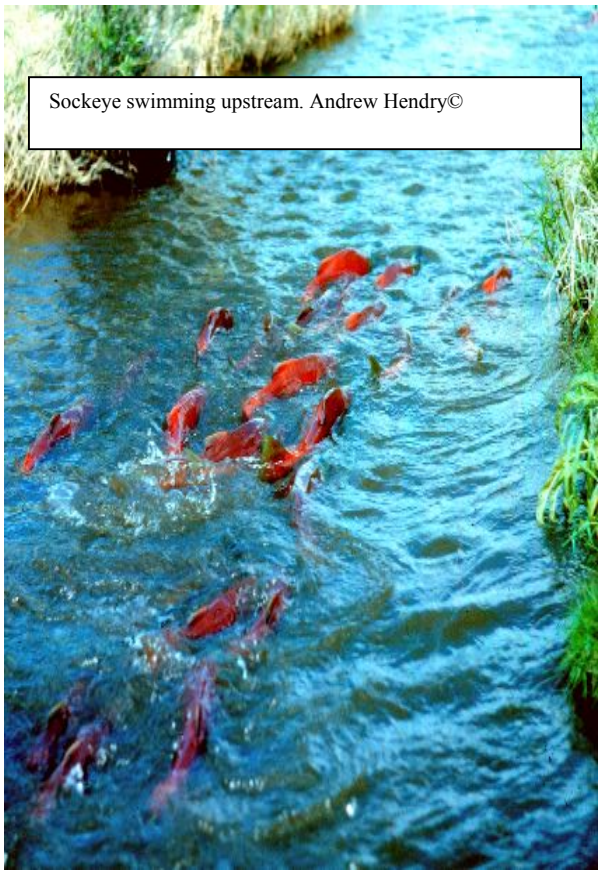
The young smolts that have just undergone the transformation that allows them to make the transition from fresh to salt water jump on the marine currents and are carried away from the continental shelf off British Columbia and the Alaska panhandle at speeds up to 10 times what they could achieve on their own. Their years in the ocean are spent traveling in mixed species schools while becoming potent aerodynamic swimming machines, because that is what they do. They roam, and they learn, incorporating movement into their physical development. At any given time of their life the salmon have different navigational tools they need to be where they are at. At sea they activate their inner compass and get attuned to celestial navigation, while in the stream they develop a magnetic strip down their sides that reads the earth's movements.

At sea the stocks intermingle in giant shoals, but as they approach maturity they begin a movement to coastal waters. As they leave the ocean pastures and head closer to land the fish begin to differentiate in groups made of individuals of the same stocks and they

disperse in search of their own spawning waters, where each run in turn heads for their own home tributary.

LIVING COMPASSES: THE HOMING INSTINCT

When their biological clock signals the time to reproduce, the individuals that make up the different runs turn tail together and separate from the school's "group mind", beginning the search for their natal waters. This has also a seasonal component, as day length decrease after the Summer Equinox, their plasma levels of gonadotropin increase, triggering the production of steroids that triggers the migration mechanism. Another metamorphosis process begins for the salmon. As their sex drive kicks in, their metabolic energy is diverted from digestion to the production of gonads. These reproductive organs begin then to be generated by recycling the digestive tissue that will no longer be needed as their homing drive starts.



Sockeye swimming upstream. Andrew Hendry©

Little is known about the orientation skills salmon need to return to a stream after years in the ocean, traversing through different marine and terrestrial environments each offering their own physical and chemical clues that may require different sensory capabilities for navigation – most of the research to date has been done with hatchery fish, not wild migrant individuals-. Despite these challenges, homing is generally precise, although straying does occur, and it is both part of the adaptive plasticity of salmon and a survival mechanism when faced with catastrophic events that destroy their habitat (examples of strays founding new runs in rivers different from their natal streams are documented from events such as the eruption of Mount St. Helen, dam

construction in the Columbia river and other catastrophic events). This philopatry, the tendency to stay or return to a home base, has resulted in reproductively isolates spawning populations with specialized adaptations - however, though the adaptations are genetic traits, the imprinting process is a learned, not an inherited process- for their natal habitat (Dittman & Quinn, 1996).

In 1951, Hasler and Wisby proposed the "imprinting hypothesis," postulating that recognition of the home stream results from a relatively rapid odor learning process during a sensitive period called the smoltification process. In 1971 Nordeng speculated that smolts that migrate to the ocean, release population specific odors called pheromones that are used by mature adults as cues to guide them back to their home stream. Evidence supporting both the imprinting and pheromone hypothesis has accumulated over the last two decades (Hasler and Scholtz 1983; Smith 1985). These observations are consistent with the hypothesis that homing salmon are guided by a map and compass system on the open ocean (Quinn,1982), though some evidence indicates that only compass orientation need be invoked (Blackbourn, 1987).

Experiments with Atlantic salmon (*Salmo salar*) indicate that the general orientation towards the coast did not require experience gained on the outward journey but that more precise homing did indeed depend on such experience (Hansen et al. 1993).

Juvenile salmon are able to orient to the sun's position, to polarized light patterns and to the earth's magnetic field (Groot, 1965; Quinn, 1980; Quinn and Brannon, 1982; Hawryshyn et al. 1990). Biogenic magnetite crystals, which may be used for magnetoreception, have been isolated from the head or lateral line of several salmon species (Walker et al. 1988; Moore et al. 1990; Ogura et al. 1992). It remains to be demonstrated whether these sensory mechanisms are involved in ocean migrations and how they are integrated with other orientation systems.

As the returning adults approach the coast, they rely less in celestial and magnetic navigational mechanisms and begin following their nose to detect the particular signature of their home waters, a complex chemical trail that contains all the smells they learned as younglings. These retrieved memories must hit their starved brains like searing irons and probably activate physical processes that facilitate navigation in a

biofeedback loop. Hasler and Scholz (1983) proposed that the process of olfactory learning and homing is intimately linked to hormone levels at different life stages, so maybe they have such a hormonal charge that the mating imperative is the only thing they can focus on. Although there is no available research confirming this point, it is probable that the very act of swimming upstream, tracking back the downstream migration they did as smolts triggers also another hormone-mediated remembrance mechanism, since as Dittman and Quinn point out in their much quoted study *Homing in Pacific Salmon: Mechanisms and Ecological Bases*, the thyroid activity influences and is influenced by migration.

Once they reach their stream, they start swarming up near the mouth of the rivers waiting for the storms that will carry them onto fresh water, - or will increase flow until it opens up the estuaries that are blocked by seasonal berms- and presumably in a frenzy of anticipation that wipes out all other thought, including danger from predators. Something akin to berserker battle fury that obliterates the survival instinct and allows this fit survivor to narrow its focus enough mass together and become easy prey for the 137 species, at least that feed on them (see Box) besides de famous Kodiak bears we have seen in so many pictures.

According to Ed Hunt from Salmon Nation this is a list of the species that prey on salmon:
Harlequin Duck Osprey Bald Eagle Caspian Tern Black Bear Grizzly Bear Northern River Otter Killer Whale Cope's Giant Salamander Pacific Giant Salamander Pacific Coast Aquatic Garter Snake Red-throated Loon Pied-billed Grebe Clark's Grebe American White Pelican Brandt's Cormorant Double-crested Cormorant Pelagic Cormorant Great Blue Heron Black-crowned Night-heron Turkey Vulture California Condor Common Goldeneye Barrow's Goldeneye Common Merganser Red-breasted Merganser Golden Eagle Bonaparte's Gull Heermann's Gull Ring-billed Gull California Gull Herring Gull Thayer's Gull Western Gull Glaucous-winged Gull Glaucous Gull Common Tern Arctic Tern Forster's Tern Elegant Tern Common Murre Marbled Murrelet Rhinoceros Auklet Tufted Puffin Belted Kingfisher American Dipper Steller's Jay Black-billed Magpie American Crow Northwestern Crow Common Raven Virginia Opossum Water Shrew Coyote Gray Wolf Raccoon Mink Bobcat Northern Fur Seal Northern (Steller) Sea Lion California Sea Lion Harbor Seal Pacific White-sided Dolphin Gyrfalcon Peregrine Falcon Killdeer Spotted Sandpiper Snowy Owl Willow Flycatcher Tree Swallow Violet-green Swallow Northern Rough-winged Swallow Bank Swallow Cliff Swallow Barn Swallow Harbor Porpoise Dall's Porpoise Snapping Turtle Western Pond Turtle Western Terrestrial Garter Snake Common Garter Snake Pacific Loon Common Loon Yellow-billed Loon Horned Grebe Red-necked Grebe Western Grebe Sooty Shearwater Brown Pelican Great Egret Snowy Egret Green Heron Trumpeter Swan Mallard Green-winged Teal Canvasback Greater Scaup Surf Scoter White-winged Scoter Hooded Merganser Red-tailed Hawk Greater Yellowlegs Franklin's Gull Mew Gull Black-legged Kittiwake Pigeon Guillemot Ancient Murrelet Gray Jay Winter Wren American Robin Varied Thrush Spotted Towhee Song Sparrow Masked Shrew Vagrant Shrew Montane Shrew Fog Shrew Pacific Shrew Pacific Water Shrew Trowbridge's Shrew Douglas' Squirrel Northern Flying Squirrel Deer Mouse Red Fox Gray Fox Ringtail American Marten Fisher Long-tailed Weasel Wolverine Striped Skunk Mountain Lion White-tailed Deer Black-tailed Deer Minke Whale Sperm Whale Humpback Whale Northern Rightwhale Dolphin

By the time the most immediate goal of reaching fresh water is achieved, their stomachs have nearly disintegrated and they have ceased feeding, directing all their metabolic energy to develop not only gonads, but other traits associated with reproduction that are differently expressed by the sexes. Such is their stamina fuelled by their reproductive urge and the visceral need to return home, that they complete a journey of many miles, sometimes hundreds of miles, on their reserves while they undergo a tremendous transformation.

Chinook turning over the gravels. This is what the female digging the nest looks like from above. Note the complexity of the riparian vegetation. Thomas B. Dunklin©

Nothing in the most tragic classical literature compares to this massive celebration of Eros and Thanatos. Neither males nor females stint in the preparations to make their nuptials the truly culminating experience that is. A feat of endurance, courage and survival imperative that seems aimed to transcend the merely biological. The males concentrate their energy in growing extravagant sexual adornments turning from their ocean-swimming streamlined aerodynamic shape to a more colorful and aggressively attractive fighting shape – with features like the hard beak of Chinooks, the hump of Pinks, the bright red color of Sockeyes or the macho stance of Chums-. The females

turn to the business of turning their muscle into eggs, until almost 30% of their body mass is consumed to produce the ova. However, let's not forget we talk about the plastic species per excellence, and many runs follow other patterns, such as entering fresh water many months in advance before moving on to the spawning grounds.

The homing migration, like everything in the salmon's life and in nature at large, is not a simple response to stimuli. They are literally putting "all their eggs in the same basket", they only have one chance at reproductive success, and then they die, so they have to judge their moves carefully. Regardless of whether they rush to the headwaters to spawn or remain for months at the estuary waiting for their chance, they will be watching out for changes in atmospheric pressure, water turbidity, water temperature and dissolved oxygen, parameters that fluctuate daily and are more and more influenced by human activity. Low levels of oxygen and high water temperatures generally inhibit upstream migration (Hallock et al.1970) and can have fatal consequences.

EROS AND THANATOS AT THE SPAWNING GROUNDS

Chinook males are ready to reproduce once they enter the stream and would reproduce anywhere were it not for the more cautious females that will hold off until they find the perfect conditions for their offspring to survive even though they are rapidly becoming a living mass of eggs.

Redd. Male sockeye waiting for female to be ready

Depending on the species, their upstream trek to the spawning grounds at the headwaters may take from a few to hundreds of kilometers. Sockeye and Chinooks are the hardiest of the Pacific salmon family, traveling as far as 1,000 miles (1,600 km) upstream to spawn. Chums, Coho and Pinks spawn closer to the sea.

After having survived the oceans perils and the predation trap at the estuary, having altered radically their body structure from salt-water swimming to fresh-water reproducing organisms, they still face the most difficult part of their journey…on an empty stomach. Ahead lays an obstacle race of waterfalls, dammed stretches, shallow waters, log jams, weirs. Some species have to travel 50 km a day of this while they fend off anglers and other predators and what is worst, poor water quality in terms of low levels of oxygen brought on by sedimentation or pollution aggravated by the degradation of riparian vegetation. In the worst case scenarios, more and more common as domestic water use increases in remote places, there is no water at all. What desperation!

Let's start by following one of the species. Chinook males are ready to reproduce once they enter the stream and would reproduce anywhere were it not for the more cautious females that will hold off until they find the perfect conditions for their offspring to survive even though they are rapidly becoming a living mass of eggs.

I'm the Queen of the Pool, Queen of the River
And I ain't no fool cause I'm a life-giver
And if you-----Love me so,
You'll wait with me----Until I go
Home, Home, Home, Home

I'm the Queen of the Pool, Queen of the River
And up at the Headwaters I'll love you forever
But 'til then--Dont be fast.
When your in love ---You make it last
At Home, Home, Home, Home.

I Just want to be free
Just want to be wild
I dont want to be smoked
Or canned or boiled

So if you if you like my style, if you dig my motion
Let's take a trip all the way from the ocean
And don't lose hope,
Don't get caught.---Soon you'll get
What you sought
At Home, Home, Home, Home.....ooeeah.
Queen of the Pool, Act III in Queen Salmon

"It is not uncommon, especially during the painful drought years, to see female Chinook, or king, salmon, sitting quietly in a pool, waiting the return of the rains, while the males swim around in anxious circles, occasionally prodding the females. In this circumstance, the females usually tolerate the males up to a point. If the males fail to get the message, the females, with a snap of the head, send them packing." (David Simpson, personal communication)

The female salmon selects her spawning grounds swimming slowly along the bottom and probing the gravels with her extended lower fins. The perfect site is usually at the lower lip of a pool just above a riffle (Burner 1951; Briggs 1953). These sites combine the right size gravels and the right mixture of cool but tranquil pool water with enough riffle turbulence to provide oxygen to the eggs and keep the nesting gravels clean of sediment.

The redd sites are also selected for the subsurface water qualities, since the survival of the eggs is dependent on the quality of the water, in turn dependent on the surface and groundwater interactions at the hyporheic zone, the layer below the stream bed where they interface (Malcolm et al, 2003) and where the female buries her eggs. Groundwater contributes to stream flow and drives flow when rainfall has been low, or during floods, that is, it takes over the "running" of the channel's flow during surplus or scarcity conditions. Oxygen levels are usually lower in hyporheic water than in stream water but the conditions vary widely even in adjacent sites, because the chemical quality of groundwater is altered during passage through soils and rocks, proving how complex are the interaction at this layer and how the judgment of the spawning female in selecting the site is crucial for the survival of the eggs. Presumably part of what the upstream migration accomplishes in activating thyroid and other neurogenetic hormones is an understanding, or a remembrance of water quality and dynamics at certain spots.

Female preparing the redd and vigorously digging the gravels although she has not taken any nourishment for weeks. Manu Esteve©

Once the female has found a satisfactory place, she begins to dig a series of holes with her tailfin removing the bedstream to sweep out fine sands and leave the right size gravels -another fine-tuning decision since the relationship between salmon egg size and nest gravel size is another stream-specific adaptation- but having no anchor point, this requires a tremendous stamina and muscle power.

x

She digs a few of these nests in an upstream direction forming an oval depression called a "redd". This is the cue of her readiness to the males and the mating begins once she accepts one of them. Male and female quiver in place next to each other and open their mouths while they simultaneously release eggs and milt, then the female covers the milt-covered eggs and moves slightly upstream to her next nest repeating the mating several times and sometimes with several partners, willingly or accidentally- as unmated onlookers will release sperm outside the ritual of mating (alternative mating strategies are documented, such as sequential or simultaneous polyandry, or different females pooling to share the same redd, and others).

Coho pair spawning with the characteristic open mouth stand. At this point they are nearly spent and it takes all their worth to keep their position in the stream. The cloud behind them is the combined release of eggs and milt. Manu Esteve©

By the end of the spawning time, a period that can last between 5 and 15 days, as many as 10 to 12 male salmon may have attempted to spawn with a single female. The fertilized eggs are buried 20 to 60 cm below the gravel surface with the excavation material dug from the next nest in the upstream sequence of the redd. Female Chinook salmon sometimes dig false redds (but do not deposit eggs there) before and after they build true redds. Unlike females of other salmon species, female Chinook salmon may defend the redd with its up to 8.000 eggs from intruding females for 5 to 9 days after spawning (Briggs1953; Vronskiy 1972).

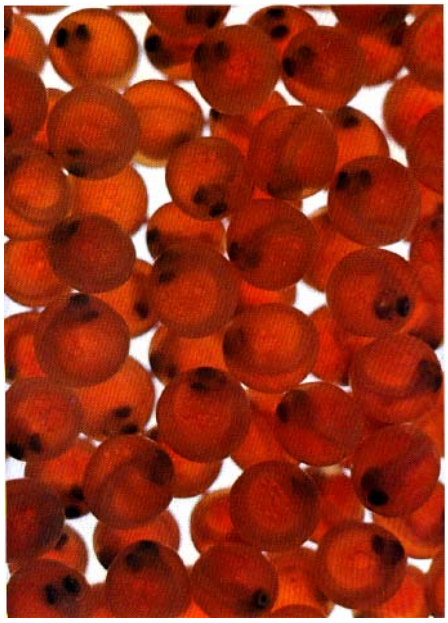
Once their mission is fulfilled the salmon deteriorate rapidly, exhibiting large open wounds from fighting and digging, usually aggravated heavy fungal infection. Life expectancy after spawning is 2 to 4 weeks. The spent carcasses of the spawned out salmon become instantly part of the river food chain at large and long after they are dead the protein provided by their parents will sustain the young emerging fish, that depends heavily on this post-mortem food source. After the ebullience of the spawning season is over the forest is permeated with the stink of rotten fish mixed with the fresh green aroma of emerging buds and flowers. This foul-sweet stink is the bouquet of life. This stink is the bouquet of life.

Spent carcasses of spawned salmon drifting in the stream. Thomas B. Dunklin©

It is now realized what a critical role salmon play in the survival of their own species. Marine derived nitrogen (MDN) has been shown to be vital for the growth of juvenile salmonids (Bilby et al. 1998; Bilby et al. 1996). The presence of abundant salmon carcasses in a stream can significantly increase the mean fork lengths of juveniles, optimizing their chances to survive the downstream journey by having the appropriate size, and up to 40% of the carbon in a Coho smolt can come from nutrients derived from decaying carcasses of the previous generation of salmon (Bilby et al. 1996). Juvenile salmon consume salmon eggs as well as feeding directly on the spawned-out carcasses. Juvenile fish also benefit from an increased abundance of aquatic invertebrates (Wipfli et al. 1998; Kline 1990) and increased algal growth enhanced It is now realized what a critical role salmon play in the survival of their own species. MDN (Marine Derived by the release of nutrients (Wipfli et al. 1998; Minshall et al. 1991; Ritchy et al. 1975).

REBIRTH FROM DECAY: THE CYCLE OF LIFE CONTINUES

EMBRYONIC DEVELOPMENT: EYED EGGS



These eggs, deposited from 10 to 700 miles (16 to 1200 km) from the sea and laid in the fall, incubate over the winter, even under several feet of snow and ice, and always covered from direct sunlight. About a month after they have been deposited in the gravel, dark spots, or eyes begin to show. This eyed stage means that the embryo is developing normally and is now able to withstand considerable movement. It is essential during this time that water flow and temperature are suitable. The period of greatest mortality in the salmon's life cycle is in the egg-to-fry stage. The duration of the incubation period depends on water temperature and on the species. At first, (7-10 days) the head and body regions begin to form. The eggs are very fragile at this stage. Any movement

may prove fatal to the little creatures which are covered only by a thin shell-like membrane.

There is a great deal going on within this sheltered nursery. The embryo is receiving its nourishment from a yolk sac which is attached to its underside. The yolk is made up of a mixture of water, fats, protein and salts. This yolk sac provides the young salmon with all the food it needs for its development. Besides food, this tiny being needs oxygen as part of its growing process. As the young salmon grows, it needs more and more oxygen from surrounding water. Many biologists believe that at some point the egg shell becomes limiting. The animal may not be able to extract enough oxygen from surrounding water, triggering the hatching process. This hatching process is a very well timed event. When the organism within the egg has grown and developed to the point that its transparent capsule is too confining, it is ready to break out. Enzymes are released which dissolve the egg shell. When the shell is broken, a wiggling little alevin emerges. Once the alevin has discarded the membrane of the egg, it can absorb oxygen from the flowing water directly through its gills.

When fertilized eggs are maturing into embryos, their redds are vulnerable to sedimentation and floods. Sediment suffocates eggs by blocking oxygen, and floods wash out the gravel nests so carefully and painstakingly dug by the parents. Loss of stream bank vegetation also harms eggs and embryos, because it causes erosion and increases water temperatures.

HATCHED ALEVINS: A TADPOLE LIKE STAGE

In the late winter, the eggs hatch into **alevins**, tiny creatures with huge eyes attached to bright orange yolk sacs on which they are wholly dependent. This fixed food supply must last for two or three months. It contains a completely balanced diet of protein, carbohydrates, vitamins and minerals. The vitelline vein,

running through the centre of the sac, picks up oxygen from the water. If there is an adequate supply of oxygen, the alevins growth rate will be determined by temperature. They grow rapidly under the gravel for three to four months. The fish at this stage are totally protected from predators and other hazards, but good flow of pure water is critically important to survival of alevins. Changes in the environment can affect the rate of development in young salmon. Higher water temperatures will make the alevins develop faster. However, faster development may be coupled with a reduced total growth. This happens because in warmer waters metabolic processes such as digestion and respiration are much less efficient. The time of emergence as **fries**, or fully formed fish, depend not only on species specific life histories, but also on environmental factors.

Ontogenetic niche shifts -occupying a different habitat space at different stages of the life cycle that are accompanied by morphological, physiological and behavioral changes- are ubiquitous in nature (Jones et al, 2003). However, in most species little is known about phenotypic plasticity in the timing of shifts and in the associated characters. Following a period of endogenous feeding on yolk, salmonid alevins emerge from their gravel nests into the open water and start feeding exogenously (Laurila et al, 1998) found that the alevins timed emergence in response to environmental chemical cues. Predator cues from burbot (*Lota lota*) delayed emergence, while cues from the competitor brown trout (*S. trutta*) tended to induce earlier emergence. Predator cues also influenced the daily pattern of emergence: more alevins emerged in the morning when the burbots were absent. Their results indicate that alevins exhibit flexible ontogenetic niche shifts in the timing of emergence in response to predator cues, and that the responses are predator-specific. As timing of emergence is a major determinant of territory acquisition, these responses are likely to have an impact on later fitness of the fry.

NEWLY EMERGED FRY: IMPRINTING TO THE RIVER

Alevins lose their sacs, and emerge from the gravel as fry in May and June. About an inch (2.5 cm) long, they are free swimming, and look like translucent fish prototypes. No longer protected by the redd, they are also easy prey for larger fish. In the river, or a nearby lake, depending on the species, they feed and grow for periods ranging up to a

year or more. Sockeye fry move into a lake for a year, Pink and Chum fry swim directly to the sea and Chinook and Coho have longer stays in the river, sometimes up to a year.

This stage is called emergence. Once the yolk sac has been absorbed the alevin, now called a **swim-up fry**, equipped with all the fish-swimming organs it needs, and must leave the gravel in search of new food sources. The fry leaves the depths of the sheltering gravel guided by two systems: gravity and stream flow. Up to now they had been leaving in the hyporheic zone and the attraction of the earth and the groundwater currents are still their reference. The fry emerges from the stream bed by swimming straight up, against gravity. These tiny free-swimming fish maintain a nearly vertical position in the water on their journey upwards. They gain altitude in short stages. A steady, vibrating tail motion is the force which enables them to reach the surface of the water. At this point the young fry is still heavier than water. Its main aim in this astonishing feat -from someone so small- of defying gravity is to reach the surface to take its first gulp of air from outside the water and inflate its swim bladder.

This upward journey under ideal conditions presents no real problems. However, if the gravel is covered with silt or heavy debris, the young salmon will actually attempt to 'tunnel out'. The fry is fairly well equipped for this since its skin is tough, scale-less and covered with a protective mucous membrane. Its gravely surroundings have made it adaptable to being fairly mobile in very cramped quarters. The fry is capable of backing out of an unsuitable passage, butting against barriers such as sand, burrowing through the ground for considerable distance and curving its body and moving snake-like through narrow passages. On breaking the surface, the fry snatches air with a sideways snapping motion of its head. Then it drops back, keeping its mouth and gill covers tightly closed. With each gulp air travels through a duct in its upper gut into the swim bladder, but several gulps of air may be necessary before the tiny creature achieves neutral buoyancy. Any fry that takes in too much air may be seen swimming head down to avoid floating to the surface. Tiny bubbles trail from their mouths as they get rid of the extra air. This is done from dusk to midnight and resumes before dawn. A few hours after emergence all the fry will have achieved neutral buoyancy. Hundreds

and hundreds of fry will be swimming in a normal horizontal position before dawn in their home stream. They have emerged (from R.W. Zabel's Dissertation).

And now the real learning begins. The new stage of the journey is called imprinting when the newly emerged fry learns to be a fish of its stream. This process of learning activates the physiological mechanisms necessary to process it. Guided by the river, the fry is on its way to create the recognition sequences that will allow it to come back to its natal spring to die years later. However, this is not easy. Although in a reductionistic manner we can tally the same physical parameters for every stream, water temperature, rate of flow, size and porosity of the gravel etc., the way they mix and interact in each particular stream and all along its length is unique and therefore creates a unique signature. Young salmon are able to detect immeasurably small traces of elements present in their environment. The smell of the rocks, plant life and other aquatic organisms will have an everlasting influence on the fry that becomes thus "programmed" to recognize it and return. This process begins as soon as the fry emerges, and it is ongoing and complex, as the input of new cues and variations is constant and differs from the next as it moves along the water and it is intimately tied to its physiological development.

Recognition leads to territoriality. Rearing fry establish territories in the stream. Biologists are still not certain of when the imprinting process begins exactly. Some studies have shown that the salmon are most affected by their surroundings after they have emerged from the gravel. It could be important that the sequence in which imprinting occurs may correspond exactly to the reverse sequence of stimuli that the returning spawner receives on the way home. In other words, the fry are influenced in fresh water by the natal stream first and lastly by the estuary just before they enter the ocean. On the return migration they enter the estuary first then follow their nose back to the natal stream. After looking at experiments (with hatchery fish) in odor imprinting after hatching and after down-migration and transplantation to these sites, Hasler and Scholz concluded that the memory of the home stream is not inherited but learned, and that homing is connected with this period of rapid and irreversible learning, or imprinting, of the cues that identify the home stream at the time the young salmon begin their downstream migration. After three or four years at sea –depending on the species- the salmon recall what they learned as smolts from their long term memory and will be able to find their natal spring.

When the spring rains come and freshets appear, they begin moving downstream with the new water. The initiation of movement makes them become **fingerlings**. The fingerling stage is divided in parr, parr-to-smolt and downmigrant smolt, as they undergo further transformations and imprinting. At this stage they are still tiny, but they have grown from the size of a pine needle to about 10 cm. long.

Floods provoked by torrential spring rains may prematurely expose the alevins turning into fries to higher currents when their bodies are not ready to swim yet. Construction of dikes and land development along streams or rivers reduces the number of side channels with slower currents and robs them of needed refugia. Diking and dredging also reduce the amount of shallow habitat found along the edges of streams or rivers, where fry can rest, feed, and avoid predators such as smallmouth bass.

PARR TO DOWNSTREAM MIGRANT: SMOLTIFICATION

Parrs are the vertical bars salmon fry exhibit at this short intermediate step between being a relatively carefree creature that has been nourished, by the foresight of their departed elders (the careful packed egg-yolk first, then directly on their carcasses of their progenitors, and later indirectly by the insect abundance promoted by the decay of the carcasses) and the loving attentions of the river, to a creature that has to get ready for a completely different life in salt water after undergoing still major changes. Acquiring the parr markings is the sign of more developmental changes to come, and the fish is then called an alevin.

The processes that take place during this period are so important in the salmon's life that they have a name to themselves. **Smoltification** means the development of these physiological, morphological and behavioral transformations and it also means the time it takes to make it happen, during the downstream migration that is a rite of passage, at the end of which they will be salmon fit to hit the waves as a fully prepared salt-water creature. In this process the role of the stream and the riparian habitat are crucial. Before smoltification, the fish exhibit positive rheotaxis (Thorpe and Morgan, 1978), that is, they maintain their position facing upstream. After smoltification, their attachment to substrate is overcome with the desire for movement, the rheotaxis is

reversed allowing the alevins to move with the current, and so the downstream migration towards the sea begins.

Their body becomes silvery and the weight per unit length drops. They look streamlined and fit to swim having achieved the condition factor (Wedemeyer, et al. 1980). And now it is hormone time. It is at this point that the links between organism and environment are formed via the endocrine system and there is an abundance of tissular thyroxin (Hoar, 1965). The pituitary-thyroid axis appears to be the endocrine system most directly involved in controlling smoltification and triggering mechanisms directly related to salt adaptation, such as increasing gill Na^+-K^+ ATPase activity (Zaugg, 1982), a requirement to regulate hypo-osmotic conditions and to adapt to the increasing tolerance to saline water and a preference for it (Barron, 1986).

Smoltification is a complex process, and events are coordinated so that fish are ready to enter saltwater at the appropriate time. Flagg and Smith (1982) determined that juvenile Coho with visuals signs of smoltification suffered no loss of swimming stamina when transferred from freshwater to seawater, while juveniles without these signs did suffer a loss in swimming stamina. Fish that weren't transferred from fresh water to sea water at the proper time appeared sluggish, potentially increasing their susceptibility to predation. Flagg and Smith (1982) also determined that mortality associated with salt water stress was is inversely related to levels of thyroxin and Na^+, K^+ ATPase, which are indicators of degree of smoltification. Godin et al (1974) demonstrated that artificially increasing thyroxin levels in Atlantic salmon smolts leads to increased migratory behavior. Observations also show that some species of salmonids revert back to a freshwater adapted state if they don't reach saltwater within a certain time frame (Hoar, 1976).

Many aspects of juvenile salmon downstream migratory behavior are not well understood and are quite variable among species, and in some cases, among stocks. It is possible to generalize some types of behavior across species, but with other types of behavior it is important to note differences. Again, the cues for the onset of migration are a combination of endogenous or genetical factors and exogenous or environmental factor. As Groot (1982) stated, "environmental factors interact with endogenous rhythms to modify the organism morphologically, physiologically, and behaviorally to a state of migration readiness, or migration disposition." The physical and physiological

changes mentioned above prepare the fish for migration, but exogenous cues may actually trigger the onset of migration. Several people have demonstrated the importance of photoperiod (Hoar, 1976; Giorgi, et al., 1990). Holtby et al. (1989) indicated that a combination of seasonal timing (perhaps cued by photoperiod) and temperature are important in determining when Coho smolts initiate downstream migration. High flows or "freshets" may also induce the juveniles to move downstream.

During this period of transformation and migration, the smolts are specially affected by unstable river and stream channels conditions caused by urban development, especially in what pertains to paved surfaces.

THE ESTUARY: FROM RIVER NURSERY TO DEATH TRAP

The last stage of life in the river is the estuary. As an intertidal space where sea water and river water mix, is the perfect waiting room to really prepare before jumping to marine life. The tides supply the estuary with ocean nutrients that supports teaming populations of microscopic organisms. The peak of plankton production occurs during the late spring, when salmon juveniles are migrating through this food abundant area, but of course everybody around knows this and lies in wait ready to prey on the defenseless smolts. The length of time spent in the estuary is very species - specific. Pink salmon appear to pass through very quickly. Chinooks may spend months in the area. A lot depends on the estuary itself. For the species which spend any time in estuarine waters their growth rate is astonishing and their chances of surviving the ocean migration are enhanced. However, destruction of riparian and upland habitat, development and water extraction have subverted estuaries into death traps as temperature increase in detriment of dissolved oxygen and water levels are lowered to the point that estuaries become muddy puddles without enough oxygen for aerobic life. These conditions may close off the estuary exit to the ocean and trap entire season runs until they are exterminated by conditions and predators.

Estuaries, the farthest stretch from the headwaters and almost marine in nature, reflect of necessity, the dynamics of the whole river system. Degradation of habitat upstream, destruction of the riparian vegetation that buffers the water, daily and seasonal temperature fluctuations and mostly the water lost to non-river systems (people) impact

the estuary brutally, transforming it from a thriving place of exchange into a stagnant pond.

The Mattole estuary, to use an example of an unusual river in that it is not dammed nor has any other man made obstructions along its course, is reduced to a shallow bathtub the marine currents alone cannot revitalize because of human mismanagement of forest and water resources(Mattole Restoration Council, 1995).

River conditions are critical for salmon migratory and reproductive success. Currently salmon stocks are below historical levels, some stocks below 10% of former abundance. Because deforestation (loss and degradation of habitat) was quickly identified as the single most lethal cause of extinction, the salmon restoration movement, from the start, focused on the forest. They are now focusing on water use. Let's hope they succeed in their efforts and salmon return to their heydays.

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IV
SENSE OF PLACE:
THE EMERGENCE OF THE RESTORATION ERA

East View of North Cape with Mendocino Cape in the background in the Lost Coast of Northern California
Photo courtesy T. B. Dunklin©

I was born in this valley and here's where I'll stay
Livin and a-lovin and workin evry day
Fish leapin in the water, birds singin in the trees
This valley's home to me

My valley, this is my valley
here's where my heart's at home
my valley, this is my valley
this is where i belong

My daddy was a logger and i'm my daddy's son
And we get out a load of logs before the day's half done. Then the saws lie quiet and the woods are still
That's how we pay our bills

Guess we cut too many, the timber's lookin small
the corporation would pay us, if we took them all
but folks are making such a fuss, we're gonna have to choose.Trees. Fish. we all might lose.

Things will get much rougher now the timber boom is through. We can pull together and live as neighbors do. I may not like the way you dress or everything you say, but here's where we all will stay

It's OUR valley, yes it's our valley
here's where our hearts at home
our valley, this is our valley
this is where we belong.

My Valley. Words and music by
Shiela Hahn and Michael Evenson (*)

The valley is alive. The river sings and swells with life. The land struggles towards health, against odds, always producing marvels. There are other valleys but none more beautiful.

David Simpson,
A modern hero with a twinkle in his eye[1]

(*) "My Valley," a mighty catchy tune (a lively blue-grass tune sung by a strapping young woodsman) was composed in cabins in the woods and riding the Wild Cat windy road in foraging trips to town as part of the making of Queen Salmon, the musical-epic-comedy that captured the spirit of time and place of the Mattole Valley as nothing before or after. Read the articles in the Reference section for more information (Human Nature).

[1] David Simpson with Jane Lapiner are the founders of Human Nature, a truly Mattolian product of homegrown wit wrapped around boundless love for the land and an uncanny comedian's sense to put the finger in the wound.

The salmon's love of the mother stream and the watershed's joy at the homecoming of its fish has been so enduring a force through the ages as to imbue with special character vast regions of earth, their people and their cultures. This strong identity-giving sense of place has permeated human consciousness, as the oral and written traditions of the region—old and current—reflect, but most vividly in the particular awareness of belonging to a place. This awareness has given rise to bioregional thinking, a perception of the place of humans in nature that has evolved, inevitably, into watershed restoration. Those eager for tangible evidence of how these interactions continue to influence the evolution of people and place only have to go to any of the watersheds that still have their own native salmon run to see for themselves. We will go to the Mattole Valley in Northern California, a sparkly gem set in the dreamy landscape of the Lost Coast and a place where recent historical events enacted by Old Timers and New Settlers—and a whole cast of secondary characters ranging from judges and forest defenders to logging companies and federal government agencies—has, as does anything to do with salmon and ancient forests, the rich flavour of epic myth.

The second human migration to the Northwest took place during the late 1960s and early 1970s. Like the first white settlers, these pilgrimaged in search of freedom and the self-sufficiency of homesteading in a wild remote place, but their outlook was fundamentally different, being a product of different times. Their generation had seen what the economy of extraction had done to the wild open spaces of the West and the subsequent rise to mainstream of the various nature conservation groups as a nation-wide environmental movement.

Many New Settlers will readily admit that their move north and west was not motivated by an affinity with the environmental movement or tenets, at least not consciously. Michael Evenson, an early New Settler said they were "*following a cultural imperative that reverberated in our hearts like the songs of humpback whales singing in the ocean inspires life there. It was interesting. Everybody was hearing the voice of the land in their hearts. We discussed this at get-togethers. It seemed like the place was alive and talking to us in the voice of animal spirits, tree spirits, rock spirits. We all heard it and thought every single person could hear it, but no. We found out not everybody could. You can never deny a miracle that you experience personally. And so we went about building culture and cultural institutions according to our sense of right and wrong to*

man and creation. The copying of the native American rituals came later" (Personal communication).

North Fork junction with main stem of the Mattole in the middle reaches of the valley.
Thomas B. Dunklin©

A significant number of the new settlers had been the frontrunners, and some famous at that, of the counterculture movement that coalesced in San Francisco, spurred by the political and social upheaval wrought by the Vietnam War, the activism and civil strife that surrounded it, of the "Summer of Love" and the peculiar mix of intellectual and front trench activity that was the Berkeley Free Speech Movement.

The sense of doom and unrest that the assassinations of King and Kennedy provoked in the nation at large were also spurring force to do things differently to survive. There was a segment of the population willing to migrate to the wilderness to begin again, to raise their children in a newly created culture. Their oral and written traditions, being a product of times of crisis and renewal where the elation of creation and destruction coexist, contained the seeds of what later would be named the "spirit of the peaceful warrior" in what was later to become a much more consolidated ecological or "green" movement.

They were pioneers also in the ideological realm because there was a muscular component to their intellectual background brought by the immediate physical reality of living in a primitive subsistence economy where lunch talks back.

They produced, and continue to produce today, the philosophical foundations of the bioregional movement, bringing together a new awareness of nature, a love of land drawn from Native cultures and their own modern sensibilities, the incomparable exultation of the physical bonds between creatures and land bolstered by working outdoors, the desire to heal the widespread destruction, and a new social consciousness.

The following words by Peter Berg and Raymod Dassman -founders with Gary Snyder of the regional thought-shaping Planet Drum Foundation- capture very well the spirit animating this "back-to-the-land" times:

> *Reinhabitation means learning to live-in-place in an area that has been disrupted and injured through past exploitation. It involves becoming native to a place through becoming aware of the particular ecological relationships that operate within and around it. It means understanding activities and evolving social behavior that will enrich the life of that place, restore its life-supporting systems, and establish an ecologically and socially sustainable pattern of existence within it. Simply stated it involves becoming fully alive in and with a place.*

Some of the more high-profile people in the Mattole Valley (loosely speaking since a typical trait of mountain people is that they are *all* characters larger than life who could fill in as someone else's Totem Animal) had been relevant characters in these political and social movements and had an extensive network of ties with the other actors and thinkers of these emergent movements. When they made their home in the Mattole, their having to confront daily with the realities of homesteading and learning subsistence skills in a wild place, their having to learn the hard way under the sardonic eye of the Old Timers —although being Diggers and Mime Troupers and generally fun-loving, they translated hardship into hilarious skits—, added the dimension of physical immediacy to their conception of nature and man's place in nature, and infused a first-hand, cell-imprinted wisdom of the place into brain constructs. One early and powerful manifestation of how much more enlightened the narrative-powered hippy culture was over mainstream culture was that their creative urge went the way of organized entertainment instead of organized crime. Each season of the year is celebrated with a

Cabaret, an event that brings all but the most cantankerous inhabitants of the Valley together. Neighborly rivalry, culture-clash, and plain daily life events are re-enacted in skits that have the audience holding their sides with laughter as their exploits are comically enacted by their neighbors. There is live music from a local band made o whoever is least drunk, and food is served on café tables just like in old-fashioned cabarets. This event is so important to sustain the spirit through homesteading hardship that a community center was built just for that, making Petrolia the only town made of gas-pump, general store, post office, and theatre hall instead of city hall

This integration of experience, of absorbing into their bodies the essence of the place, ignited many a personal epiphany of the type in which one can grasp with searing clarity that land and people are made of each other, they are of each other, and life is too short to waste it ignoring this. This recognition - reinforced by the community ties that are so strong in places where one is at the mercy of the elements and may go hungry if there is not enough fish in the river- brought clearly into perspective that the welfare of the valley and its creatures included the survival of humans as well. Self-defense and anguish for the destruction of something irreplaceable incarnated in the protection of salmon. The network of like-minded people reinhabiting the Northwest started a grassroots movement that focused on the restoration of salmon habitat.

The spark was the near extermination in 1974 by local poachers of upstream migrating salmon trapped by low water levels brought on by a 3-year drought. A healthy river system has checks in place to weather water cycle events such as this, but the "Standing Timber Tax", combined with the decline in the ranching economy boom, induced ranchers to cut the trees on their land just to avoid adding that tax to their already hard-to-meet land payments, leaving a lot of the slopes denuded of forest. In the absence of enforceable standards and practices, or even a logging working ethic, this cutting was done inexpertly and brutally and left the landscape scarred with badly built skid roads and the river defenseless against the avalanche of sediment load that bled from the hills and choked the channels. Without vegetation to shade and cool the stream and with the channel made shallow by sediment and debris, the river braided, impeding passage to fish and obliterating the spawning grounds with silt.

It took a catastrophic event to bring this to the attention of the policy makers. The floods of 1964 and subsequent massive landslides (Bull Creek Redwood Forest and the

infamous Cuneo Creek land slide that took half the face of a mountain away) brought such havoc to some of the most spectacular alluvial flats redwoods – documented enough in the media as "California's Big Trees"- that the public's outrage at the damage was heard. The logging practices were reformed and written in the Forest Practice Act of 1972, amazingly enough the first of such legislation to exist in redwood country.

This is what David Simpson and Freeman House saw happening and prompted them, with Gary Petersen, a fisheries graduate student from Humboldt State University, to established the Mattole Watershed Salmon Support Group (as told by Bob Doran, staff writer from the *Northcoast Journal*, Arcata.):

> *It was obvious that something needed to be done or we were going to lose our salmon. Everyone wanted to see something happen: the ranching community, the logging community, as well as the environmentalists who were a much weaker element in the community then. John Vargo wrote a beautiful paper: a watershed analysis of Mill Creek. It really was the first document of its kind to come out. There was a public meeting called by a group of small commercial fishermen, basically back-to-the-landers who fished out of Shelter Cove and lived up in the Mattole headwaters. They called a meeting at the Redwood Monastery, a Trappist monastery that has quietly played a very important role in the life of our community. About 30 people came together including the late Nat Bingham, who had been a commercial fisherman and became a leading voice for salmon enhancement in Northern California. Jerry Kreger, who had worked as a road geologist for the Forest Service in Alaska, told us about the stream-side hatch boxes used there. We liked the small-scale concept and investigated further. Bingham was the first on the North Coast to build and use one. The culvert under the county road had been replaced after the 1964 flood and they put it in at too steep an angle. It had become a major obstacle to fish passage. We urged the county and Fish and Game to fix it; that's really when our efforts started. We showed the county engineer a manual on fish passage from British Columbia with some suggested solutions. The level of the creek bed leading to the culvert was raised so the fish didn't have so far to jump. Large rocks were placed to create a series of pools. Baffles were welded inside the pipe to slow the water and supply resting spots. The jagged edge was fixed. By 1980 my friend Freeman House had settled in Petrolia. He and I and a young master's candidate from Humboldt State, Gary Peterson, initiated the Mattole Salmon Group in 1980 to implement the hatch boxes, although it took two years of negotiation with the Department of Fish and Game to approve their plan, in part because it set several precedents. The Mattole is remote and Fish and Game had basically written it off as a productive salmon river. They were understaffed, and it was difficult for them to get people out here. For that reason it was apparent to us that either the*

residents had to do something or no one would. What was different about our approach was that we asked them to allow us to go in and take wild fish for their eggs. We asked the state to allow us to put weirs (fish traps) in the river which was against the law. We asked to take our fish closer to the spawning grounds than sports fishermen were allowed to. And we were doing it all as amateurs which flew in the face of an attitude of professional fisheries biologists. The Mattole Salmon group began its hatch box program in 1980.

So modestly was the project that was to have an epochal effect launched; counterculture and cowboy culture clashing happily into a new concept that required both radical thinking and old country savvy.

Freeman House, cofounder of the Salmon Group, author of "Totem Salmon: Life Lessons from another Species" and lifelong champion of the Northwest native inhabitants at the MRC's office.

After doing fish surveys and beginning habitat improvement and stream restoration projects, it soon became apparent that to fix the fish's situation, the land had to be

healed first. Realizing that there was a connection between the aquatic and the terrestrial ecosystems, and that this connection was crucial for the health of the salmon, in fact, that the health of the salmon and the health of the watershed were one and the same thing, was the brilliant insight of those involved in the Salmon Group. It was a turning point.

The reality that all is interconnected, that we are all part of the web of life, is now common knowledge. This knowledge, although constantly contested by resource-extracting enterprises, permeates to a lesser or greater degree modern environmental practices and legislation, but it was not always there. The concept of Watershed Restoration as a means to preserve salmon habitat had been conceived. Freeman House's own personal account of how this came to happen describes this process beautifully (See Box) .

EXCERPT FROM "A WATERSHED RUNS THROUGH YOU" BY FREEMAN HOUSE

When you see that it's the same water that falls as snow and rain, rushes down nearby rivers, passes your lips, brings back the salmon -this is when you know your watershed. If you are hip-deep in a cold, rising river on a winter night, attempting to net a 30-pound Chinook salmon, and your goal is to bring the fish and its burden of eggs out of the water alive, your concentration becomes marvelously focused. The world of worries beyond the pool in which you work fades away, might never have existed. And you may feel as intensely alive as you did when you were eight years old. When the memory was fresher, I wrote this: "To enter the river and attempt to bring this strong creature out of its own medium alive and uninjured is an opportunity to experience a momentary parity between human and salmon, mediated by slippery rocks and swift currents. Vivid experiences between species can put a crack in the resilient veneer of the perception of human dominance over other creatures. Information then begins to flow in both directions, and we gain the ability to learn from salmon, from the landscape itself." [The indented quote within the quote comes from "To Learn Things We Need to Know", also by Freeman House, in Helping Nature Heal, ed. Richard Nilsen]

Were I to write that paragraph now, I would add that such experiences may destroy the illusion that we humans are in any way separate from the places where we live.

When my wife and I became propertied people near northern California's Mattole River a quarter century ago, some large part of my motivation for moving was to join my neighbors in an effort to sustain and preserve one of the last half-dozen genetically native Chinook salmon runs in northern California. Earlier, I had spent a few years as a commercial salmon fisherman and had become enamored of the drama of the various species' great thousand-mile tours of the Pacific, always to return to their home rivers

to reproduce. At the same time I had learned of the devastation being brought by industrial fishing and the steady degradation of the fishes' watershed homes. I left that work feeling much as I imagine some of the last buffalo hunters must have felt.

Our first efforts in our new home river were aimed at increasing the survival rate of the eggs that had been deposited for millennia by our native Chinook salmon. So much bare soil had been exposed by the timber boom of the 1950s and 1960s that when two "hundred-year" storms hit, one in 1955 and the other in 1964, the nature of the river was completely changed. What had been a stable, deeply channeled, well-shaded watercourse some 65 miles long was transformed into a shallow, braided, overheated stream devoid of clean spawning gravels and deep, cold rearing pools. Salmon need clean, cold water even more than we humans do, and they need an ample supply of clean gravels. If the gravels are cemented with silt, oxygen can't reach the fertilized eggs and the eggs suffocate. Without pools deep enough to remain cool through hot summers, the juvenile fish die. Since 1964, the number of returning spawners had declined precipitously.

Our early efforts were encouraging. Capturing a few wild fish each year and depositing their hand-fertilized eggs in tiny backyard incubators tended by residents resulted in an 80 to 90 percent egg-to-fry survival rate compared to perhaps 10 to 15 percent in the damaged river.

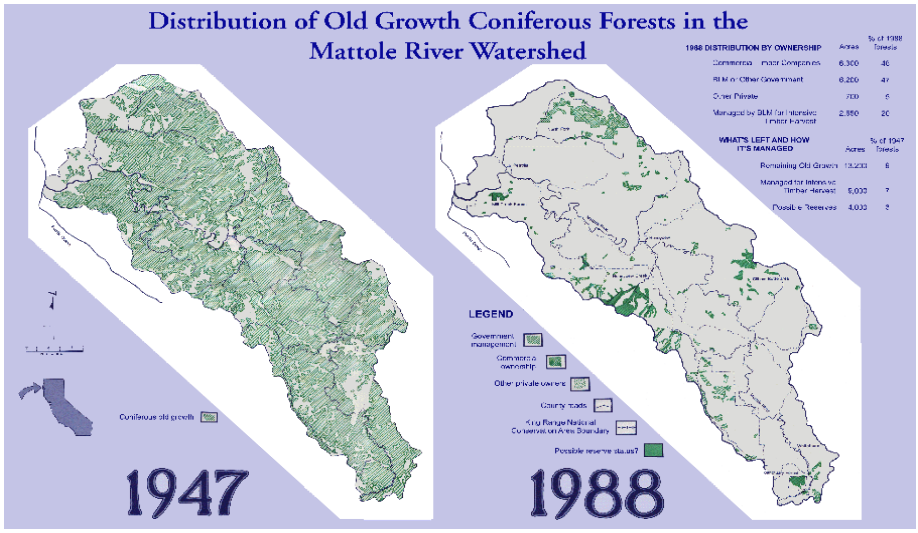
Despite this success, we knew this was no enduring solution. The degraded river system was going to take generations to repair itself and that would happen only if the land management practices that had caused the damage were transformed into methods more benign. If we were not to build ourselves, with our inevitable capacity for human error, into a natural system of reproduction that had functioned perfectly for thousands of years, we would need to expand our goals. We needed to invent rehabilitation projects that would hasten the recovery of the river.

Along with most of my neighbors, I'm one of the dwindling few who take their household water directly from the Earth by tapping into a nearby spring. Each time I take a drink, I think, "If water's not sacred, what is?" Our watershed runs through us. If we were to rehabilitate our watershed, we would need to convince our neighboring land-owners and residents that the watershed not only ran through their individual bodies, but through the well-being of our common community. Each one of us was going to need to examine his or her daily activities and evaluate how they contributed to good watershed citizenship.

A watershed is a simple construct. Since water runs downhill, every drop that falls runs down one side of a hill or ridge or another and gathers into swales, creeks, and sub-drainages that eventually combine into a river system that gives the watershed its name. Most every person, urban or rural, consciously or unconsciously, has some visceral experience of their watershed each day—through glimpses of waterways or ridge lines that surround and infuse their local places. Yet in the early 1980s, when we began our effort, the word either didn't exist or was used incorrectly in many people's vocabularies. When I talked to groups of college students who occasionally toured our facilities, I would always begin by asking how many of them knew what a watershed is. Few of them raised their hands.

Twenty-some years later, everyone in my tiny watershed knows they're part of it, and it's difficult to find a drainage (at least on the West Coast) that isn't home to a watershed council.

In 1983, the Mattole Restoration Council (MRC hereinafter) was founded to handle such an ambitious basin-wide approach, serving as an umbrella coalition group that included the Mattole Salmon Group and other groups focusing on different aspects of restoration, like tree planting. The first thing they did was to engage the valley by reaching out to the residents providing and requesting information of their environs. This was a wildly successful campaign that led to a valley-wide survey campaign. The fruit of this communal effort yielded a map of what was left of the Ancient Forests. That map said it all. Everybody, including government agencies like the California Department of Forestry and the logging companies, knew there was not a lot of forest left, but seeing it in a map the harsh reality could no longer be ignored. This map has been the main reference for the work of MRC and has inspired the formation of many other watershed restoration groups in the Northwest and elsewhere.



Distribution of Old Growth Coniferous Forests in the Mattole River Watershed (1947-1988). Courtesy of the Mattole Restoration Council©

The MRC's dream was to turn the valley into a restoration economy based on sense of place. They envisioned local people making a living by restoring the habitat and rearing native king salmon and native Douglas fir. The MRC tree planting program became a

local employer, with the visionary efforts of Randy Stemler and friends that engaged the available man and woman power and involved federal programs and private sponsors who actually paid people to gather native seed, grow the seedlings in nurseries, and plant trees rather than cut them. It was a woodsy approach to the modern management practice that gives workers shares in the company they work for, so they have a personal involvement in the outcome. It was also a precursor tactic for the reforestation programs of modern logging companies. The money to fund salmon restoration came partly from the Legislature and partly from another ground-breaking source, the self-imposed tax that California's commercial fishermen adopted to fund these types of projects, even while most of them were driven out of business, for they knew they had to support a long-term vision. Freeman House captures this sentiment and the mission of the MRC as information clearing house to keep the residents abreast:

> *I work out of the conviction that what's required for salmon populations and whole ecosystems to endure into the future is a rather dramatic cultural shift. We must change the way we think of ourselves and identify ourselves in relationship to the landscape and to our food. That's why the Restoration Council has always felt it important to keep supplying the population of the Mattole with information about where they live and the other species that live there. If we want to focus on this particular population of salmon, which is unique in the world, we have to begin to take seriously our identity as residents of watersheds.*

But once you have the knowledge you cannot sit idle, and the residents had to face the logging issues. They had become advanced students on forest legislation and resource management issues and had a working relationship with the local regulatory agencies, Fish and Game, California Department of Forestry, U.S. Forest Service, Coastal Water Commission, etc. They were perhaps the first private citizens to become experts and participate in Timber Harvest Plans reviews as an organized group, a process only the anointed few (Registered Professional Foresters and Judges) can understand. Being inside the belly of the beast sent the community in a near state of defensive-offensive war.

With the immediate reality of renewed logging in the foreground and the forces of time and place shadowing the background, the community of the Mattole, with much inner conflict, confronted the State and the Federal government. Some of the most

recalcitrant Old Timers joined in the effort to get some accountability from the out-of-state multinational logging corporations, giants like Louisiana-Pacific and Pacific Lumber that lorded it over the State and Federal bodies like in the good ol' Wild West times.

Michael Evenson (one of the earliest back-to-the-landers that had helped survey the big ranches before they were subdivided and conversant with the old ways and the lay of the land) took them on. His deposition before a panel of experts in one of the Eureka heated hearings on a sweeping logging permit awarded to the Pacific Lumber Company reflects the climate of the day and the intensity with which resource issues affected people's daily lives. It also transmits the flavor of what it was like to live as a homesteader and how this changed with the new tactics of the logging corporations (see Box)

MICHAEL EVENSON´S DEPOSITION DURING ONE OF THE HEARINGS CONCERNING THE LOGGING PERMIT REQUESTED BY PACIFIC LUMBER

My name is Michael Evenson. And I'm a member of the California Coast Province Advisory Committee. That is a federally chartered advisory committee. I came here from a lot of personal history, timber falling back in the 60's. We didn't even think about clearcutting then, although we're supposedly responsible for all the problems that happened. In those days we left trees that were 18 inches or smaller; and now we're told that's wrong, that we were high-grading, but we certainly knew better than to clearcut. And as I kept working in the woods I realized -- in those days we didn't work in the winter, either. You hunted and fished and picked huckleberry and did Christmas trees and things like that. You didn't cut timber in the winter. We knew better than that then. And we made our living however we could in each season, and logging was just one of our seasonal work. Now, the way it's going and the way this Habitat Conservation Plan (HCP) has it, it's clearcut and it's work through the winter and doing everything else. There's no time for fishing. And now you don't even care about fish, because you know, well, that clearcutting leads to landslides. It's been shown up and down the coast. And when they say, "Oh, well. We had a heavy storm. That's why it slid" -- but not that's not the truth. That's not the truth. Those kinds of storms are normal. You guys [pointing at panel members] -- your agency and your agency -- are never on the ground. How much ground time have you put into this HCP? Damn little. You don't know what you're talking about if you're going to go and say that this HCP is going to work. You've got to put your people on the ground.[interruption that testimony time has expired] I have a lot of things I wanted to say, but I guess I won't say them. A couple things real quick. A registered professional forester (RPF) Beck was saying that they were generating $170 million from the timber operations; and if you're going to divide that by 1500 workers, that means that those 1500 workers generated $113,333 per worker. If they're getting paid 30,000, that means that there's 83,333 left for Hurwitz. That means that for every three trees cut, one goes to keep the economy of Humboldt going and two go to Charles Hurwitz. But I don't want to beat up on Charles Hurwitz anymore. He's been beat up a lot today and he doesn't seem to answer. But you're putting an HCP together that is a "one size fits all." You all know it's wrong. Every one of your scientists, every one of your -- all your field people say "one size fits

all" doesn't work; and yet you're going along with this. I know in the Mattole, because I got a place there where I ranch and I've been losing land to sediment in the river, that these landslides are not -- are not going to stop if you're going to clearcut. But you have a duty. You are to uphold the Endangered Species Act. Not you, John [John Marshall from the California department of Fish & Game], but you've got other things to do. But in the Endangered Species Act, it's the law of the land. We keep being told that the Endangered Species Act is going to change; don't mess with things. It's the law of the land. People here are law-abiding citizens trying to uphold the law, and you're listening to liberal politicians in DC tell you how to interpret the law. You got to stand up. This process is supposed to put a feather in your cap. But that feather is going to poke right through the hat, and it's going to land in your head. It's going to bother you the rest of your life. If you let things go down and you set the bar so low that everything can go on over it, it's not going to be something that you're going to be able to live with, and we're going to remember, all of us are. Ten years from now these guys [pointing to the bleachers full of Pacific Lumber workers] won't have jobs. They know that. But you're going to be living with this and we're going to be living with the results.

**Habitat Conservation Plan. A measure implemented to halt the damaging practice of clearcutting, cutting all the trees in an area without regard for age or productivity. Clearcut was a favored practice because it was easy and cheap, you got there, cut it all down and left, leaving grievous scars on the hillsides that were almost impossible to fix.*

The history of the Mattole Restoration Council was not all roses. Though most of the residents partake of the philosophy of inhabitation it fosters, there has been ongoing conflict among landowners of different mentality – living in various geological ages' reality as it were- as to how the land should be used and who should do the telling.

The revival of a new style of take-it-all-out logging, pure wanton destruction that ignored even the basic laws of supply and demand, made things even more difficult and urgent. Again, the residents' inventiveness came through with a mighty good lubricant: Political theatre delivered as epic musical comedy. Jane Lapiner and David Simpson, who had met doing theatre in San Francisco, founded Human Nature, a theatre company that specializes in distilling daily life situations into unforgettable archetypes.

Their chaotic productions pulled off against tremendous odds (such as 7.0 earthquakes) enrolled the Mattolians in an effort of turning strife into theatre that turned them into a tribe and managed to capture the spirit of what was really happening. David Simpson, recalling those times, says "It's the most fun I have ever had."

“Queen Salmon” was Human Nature’s first production. It premiered in 1991, at a time when community conflict was at its height in the Mattole. This is how they tell it:

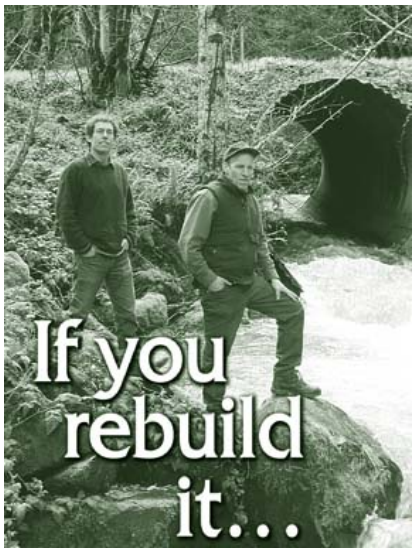
> *While we were working the fish traps on the river we used to make up songs, about the hard work, about the salmon. An early trap song was called "My Girlfriend Is a Fisheries Biologist." It became part of Human Nature's first musical comedy, Queen Salmon. We had the Alabama-Pacific forester singing that song. He was in love with the Fish and Game biologist, but she would have nothing to do with him until he started seeing things the right way. People were at each other's throat. We had just endured Redwood Summer; Fish and Game was pushing for a zero-net-sediment discharge. California Department of Forestry coordinated a couple of public meetings. One at the Turf Room in Ferndale drew about 250 people, most of them just there to vent anger about regulation, about government, about environmentalists. It was really nasty; it nearly turned violent. It was all more food for Queen Salmon. We were creating this show about a community in conflict, between the logging and ranching elements and the newcomer environmental restorationists. It showed how a mutual love of salmon brought the community together. The play's satirical barbs poked fun at both sides; the intent was to get people to laugh at themselves, and through laughter to defuse tension; even the Pacific Lumber executives enjoyed it. The question was, did it change anything?*

Did it? Have the King Salmon runs swelled the river back? Have the ancient forest come back? Are they teeming with Marbled Murrelet, Olympic Salamander, Spotted Owl, Tailed Frog? Has every householder and decision-maker altered their visions and actions to accommodate the needs of the land? Has a region wide consciousness being swept by the salmon in need has made humans see that they themselves are also in need? The answer, as always, is going to be both yes and no.

Had it not been for the efforts and foresight of all those involved in the recovery of the native runs of Mattole king and silver salmon, they would most probably be extinct right now. If it weren´t for the personal titanic and unsung efforts of some residents like Ellen Taylor, who has spent the last of her hard-earned dollars working as physician assistant, suing the State and several logging companies, some majestic trees would not be now on Rainbow Ridge and some legislation would not have been reviewed. The maligned but nevertheless epic deeds of Earth Firsters! and Forest Defenders have preserved some creatures that, although on the brink of extinction, are still hanging there because these saintly – and therefore unkempt- champions of nature are willing to

put their own lives and limbs on the line and bear the unwholesome burden of forever deal with the judicial system. There is a whole panoply of unnatural and risky behavior put to such end throughout the valley and throughout the region. Would you dive in ice cold water at dawn and dusk storm or not, day after day, to do submarine counts of downstream migrant salmon? A retired emergency room nurse and pioneer river guide does. No matter she is a grandmother. With her hip long mane of violet blue hair this beautiful mermaid gets in her wetsuit to gather information about fish, water and river bank vegetation in a way that has captured these interactions we keep talking about. Maureen Roche's insights and athletics, very similar to those of the fish she champions, have contributed and inspired other people committed to salmon, like David Fuller, from the Bureau of Land Management, to polish the ultimate and less invasive river survey method: habitat-typing a stream habitat inventory procedure that will classify and quantify fish habitat in terms of channel features (see Section on Scholars´ Debate).

If people like Gary Petersen and Dave Kahn were not willing to endure sleepless nights spent in chest waders checking the trap or ministering to the hatch-box, or take hair-raising rides to install huge rock or woody structures in the river, maneuvering heavy equipment down steep slopes, or planting trees with a 30 pound hoe and saddlebags full of seedlings in the near vertical faces of landslides, all of them backbreaking, extremely unpleasant endeavors that the local men, women and children perform unfazed, things in the Mattole watershed would be very different now.



Seth Zuckerman, one of the editor/authors of "Salmon Nation, People and Fish at the Edge," and former director of the MRC and David Simpson, cofounder of the Salmon Group next to a culvert in a problematic tributary for salmon passage ("If you rebuild it…will they come back? Northcoast Journal March 2, 2000 by Bob Doran)

If conservation biologists turned journalists like Seth Zuckerman, former director of the MRC and now circuit rider for the Ecotrust Foundation, would not have applied their considerable talent and first hand knowledge of salmon dynamics to learn and write about salmon issues and contribute to the formation of a watershed network, every remote watershed would feel isolated in their struggle to keep their runs alive and well, instead of feeling part of a greater constituency with political swing. In all these instances the answer is a most emphatic yes. The salmon, the forest, the watershed and the whole Northwest is better off because of the restoration ethic.

Cover of the Northcoast Journal featuring Jane Lapiner and David Simpson, founders of Human Nature, the legendary theater company that created Queen Salmon and changed the thinking of a whole region (North Coast Journal, 2003, Bob Doran)

On the other hand these very efforts to keep the valley beautiful and thriving have attracted yet another wave of settlers that have brought with them, as those before them, another set of ideas and outlooks that clash with the previous ones. Cycles are cycles and it is always "Now". In 2005, these new breed of settlers are affluent "designer ranchers" that are driving the property values up. The prevalent social trend engulfing restoration is gentrification. As before, this is good and bad. It opens a new fork on the road of evolution of people and place. The new neighbors have more money to make better roads that don't bleed sediment, but this lets them encroach further up. They have embraced alternative technology and can afford state of the art household energy systems like last generation hydro and solar power, but drive to town everyday for parts

diluting the original “low-impact” point. Can we blame them? They are also after self-sufficiency, but is it a sustainable self-sufficiency? Maybe they will come up with another revolutionary life-style change we cannot fathom right now. Like ranchers before them they keep the open spaces open, but they want swimming-pools and vineyards that suck the river dry.

In the last few years -since 2002- the headwaters of the Mattole have dried up *completely*, because of human over consumption of water.

The “hippies” made the valley beautiful again and brought the hope of recovery for all. Their commitment to sustainability is also part of the pattern now. For example, the Mattole Restoration project keeps on with its role in water conservation and timber harvest plan review. The Sanctuary Forest and the Middle Mattole Conservancy have incorporated fiscal strategies like land stewardship grants to preserve vast tracts of the last remaining old growth Douglas fir (Gillam Butte) and they have implemented successful fund-raising and coalition-building campaigns to purchase private and public land at the Headwaters of the Mattole to provide natural refugia and ecological corridors.

But as new ideas and people come to the valley, that may be an already endangered paradigm, or not? It seems that the trick to conciliate the complexity of human relationships with the relationship between land and themselves, so the land doesn’t take the brunt, is to keep alive the sense of place that bound them together to begin with.

Maybe another wave of new inhabitants of the valley will add a hitherto unsuspected layer of connection that would further the survival of their animal neighbors. Just like mother’s old teapot is a piece of junk to her children but it becomes “grandmother’s valuable antique teapot” to grandchildren that see in it the wonder of a bygone age, the perception of the values of a generation do change with time and the eye of the beholder.

Meantime, unless the second generation of restoration-minded people don’t themselves make a contribution to the paradigm they follow, so it can overlap a new layer, again,

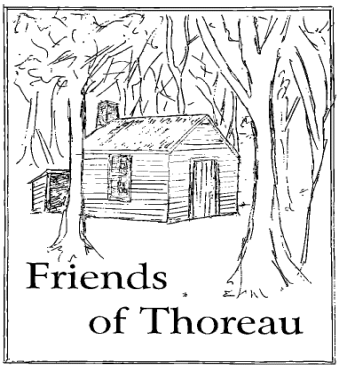
and work with the new reality of the "Sonomization" of the Mattole Valley -eminently unsuited for this suburban travesty-, the newer settlers will just be bringing another threat to salmon in the form of urban encroachment as they turn the valley's hard won preserved wildness into a quaint and unreal version of Old Times.

So in this sense no, restoration has not been a panacea. It could not have been, since its full meaning is based in strong personal convictions that are hard to transmit to others not so inclined, but it has laid the ground for a new understanding. A region-wide perspective of the current social and political climate reveals yet another layer of reality. Social dynamics are also an adaptation process that each "native run" of humans processes at the speed or efficiency they are equipped to, and like their biological counterpart's it does not follow a linear process. Efforts like Salmon Nation are garnering many of the political and social players to go beyond restoration. The Alaskan government policies and many States and City ordinances passed by the constituency to protect habitat and fisheries coexist along with the anti-environmental policies of the current US government. Only time will tell if enough critical mass can be built to swing human practices to sustainability, but one thing the restoration movement has impressed in everybody that has been touched by it is that immediacy and closeness to the species is what activates the connection between us and land. And that is really our only hope for a miracle.

****

Miracle of miracles.
A glorious new light bathes us in the first glimmerings of hope. Could we be done with skulking in shadows,
awaiting the ultimate in an endless series of blows.
My heart feels like it could burst.
Humans helping salmon!Miracle of miracles. Can it be?
Well, then. let the holy joining of male and female begin again,
but this time with new hope that the world-renewing
power buried in our hearts and loins shall prevail.
Generation shall once again and always succeed generation, and each of us, doomed from the moment of our seed's bursting forth, from the instant of our parenthood, shall know ourselves to be as eternal as the ancient procreating universe. We must die that we must live and so it is and always will be. WE WILL LIVE, the salmon, the humans who are our siblings, the streams and forests, the valleys and the sea will live.
The earth shall survive.
LET THE DANCE BEGIN

Last soliloquy of the Spirit of Salmon



The Meaning of Salmon in the Northwest: A Historical, Scientific and Sociological Study

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Scholars´ Debate

1.- Traditional knowledge of the local and indigenous communities.

Chapter I of the Main Page of the Case Study describes how through elaborate stories, art, traditions, and ceremonies Native Americans expressed reverence to salmon and "set detailed ground rules to regulate their use". It elaborates on how the wisdom of those stories contained a valid approach to sustainability, or what in today's lingo we call a "management tool," and proposes that a mythopoetic approach to nature is a prerequisite to begin to understand some of its processes, concluding that some of the best research to date has been illuminated in this way using as an example Tom

Reichman's research. This approach to ecology (and especially ecological management) is revolutionizing the science of biology in many areas.

James Wilson, representing his wife's twin sister, performing the Salmon Ceremony. Kwagiulth The Kwakwaka'wakw people of British Columbia people believe that if the salmon are not thanked properly they will not come back the next year, or that something bad will befall the salmon stock. This notion comes from the Kwakwaka'wakw belief that animals are part of the Animal Kingdom, which is made up of beings who can transform themselves back and forth between their animal forms and their human forms. Animals give themselves up freely in order to provide food for humans. At one time, thousands of years ago, humans and the Animal Kingdom beings could communicate with each other. However, over the years, humans have lost their power to see animals in their human forms. This belief is expressed in one of the Sewid family dances called "Anus and the Animal Kingdom." The Kwakwaka'wakw people believe that animals, such as the salmon, allow themselves to be caught, and that if their remains are treated correctly, the animal will return home and become another animal, and eventually sacrifice itself again. Therefore, if the Animal Kingdom is not properly thanked for its sacrifice there will be no more food.

Kwagiulth Museum & Cultural Centre, Quadra Island, BC©

The most clear expression of the interest of culture as a tool for the real understanding of biodiversity in general, and even of the intricacies of gene structure is the value of traditional knowledge (TK) of indigenous and local communities, whose protection has been officially recognized by the Convention on Biological Diversity to be one of the most important mechanisms for *in situ* conservation of biodiversity (article 8 J: "*Each Contracting Party shall, as far as possible and as appropriate: (j) Subject to its national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider*

application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices;"). The international debate about how to protect TK is been subject to international negotiations within the Convention itself as well as in other for a such as the Intergovernmental Committee on Genetic Resources and Traditional Knowledge of the World of Intellectual Property Organization (WIPO). What do you think are the different ways of protecting TK? Do you think globalization is a main cause of the disappearance of TK because it obliterates the cultures which are its custodians and depositaries or do you think it is a question of misappropriation of TK via modern intellectual property rights such as patents? (think of Plant Hunters and Pharmaceutical research).

2.- Salmon as a keystone species? The role of Nitrogen.

Professors Tom Reimchen and Morgan Hocking from the Department of Biology at the University of Victoria in British Columbia must have had the insight of attributing to the salmon the characteristic of being a sort of keystone species to the habitat when they planned their research in a remote area in the Queen Charlotte Islands, a favorite salmon feeding grounds for brown and black bear. By following Nitrogen 15, a stable isotope more prevalent in the sea than in air or land, they have discovered that up to 50% of the nitrogen found in a forest, the main significant nutrient in the chronically nitrogen deficient northern forests, comes along with the salmon, and it is passed, eaten, scavenged, rotted, and photosynthesized to be incorporated in the biomass, vegetal and animal of the forest. Bears play a big role in this spreading of nitrogen-rich nutrients, and we can now say that salmon, bears, and trees are part of the same food chain. This is of course revolutionary news. It means the flow of nutrients is bidirectional, but also that there is no such a thing as "surplus." "*Resource managers treat salmon and humans as a two-species ecosystem, where people are the single users and can take the biological surplus, but what we call surplus is in fact what all the other species use, be it bears, seals or trees*," says Prof. Reimchen. The role the salmon plays in the enhancement of ecosystem productivity is all encompassing and has been well documented, and therefore its decline may have more far-reaching ecological implications in the terrestrial forest food webs than previously recognized. (Extracted

from *The Sacred Link - Bears, Salmon and Ancient Forests*, an article based on the study "Salmon-derived nitrogen in terrestrial invertebrates from coniferous forests of the Pacific Northwest," in BCM Ecology 2002; 2:4, published on line, 2002 March 19, by Morgan D. Hocking and Thomas E. Reimchen). Can one attribute such role to the salmon? Isn't it an exaggeration? Has there any case been documented in which the disappearance of salmon has produced changes in the ecosystem of the Redwoods? When making these reflections keep in mind the newness of the information and how it relates to "record-keeping" of available nitrogen levels, the time elapsed since the last nutrient input and how other factors (storage, starvation economy etc.) may play into it. The point is to always consider all the influences that may play on causal relationships. Also explore the issue of "surplus" and how it plays in our current resource management practices.

3.- The issue of salmon hatcheries.

One of the most debated problems with salmon is the issue of hatcheries. "It takes 3 to 5 pounds of fish meal and fish oil to produce 1 pound of farmed salmon, so hatcheries actually reduce rather than increase the amount of fish protein available" (Naylor et al., *Effect of Aquaculture on World Fish Supplies. Nature, Vol.405, June 29, 2000, pg.1017-1024 and Dr. Rebecca Goldberg, Murky Waters: Environmental Effects of Aquaculture in the United States.* Environmental Defense Fund, October 1997).The interbreeding of hatchery-reared fish with wild stocks dilutes the genetic pool of hard won adaptations and leaves the resulting offspring more vulnerable to the parasites and diseases of their natal spring. It strips them effectively of their defenses. "The survival rate of hybrid eggs is lower, and those that make it have only half of the genetic information they need to survive and reproduce. This depletes the wild stocks and adds one more debilitating factor to the dangers they already face. It also puts them at risk when fishing quotas are raised on account of more fish being released, and they get caught in the nets along with the farmed fish which were initially bred to save them." (Seth Zuckerman and Jim Lichatovich "The Problem with Hatcheries"). More recently the issue of the dangers of eating hatched salmon has reached the public. During the 90s nutritionists advised Americans to eat salmon two or more times, or up to 8 ounces, per week because the oils in these fish contain omega-3 polyunsaturated fatty acids, which are thought to be

particularly healthful. Consumption of these fatty acids is associated with a decreased risk of repeated heart attacks. But in 2003 the Environmental Working Group (EWG) released a study that found that those fish raised by aquaculture contained more PCBs than wild-caught fish did. The study was not peer-reviewed or published in a scientific journal. The EWG report fanned fears of PCBs acting as human carcinogens as well as possible estrogenic compounds (so-called "endocrine disruptors"). Estrogenic compounds, it was feared, could mimic human estrogens and lead to infertility, some cancers, or other hormone-related disorders. A study published in early January 9th 2004 in the journal *Science* concluded that farm-raised salmon -especially those from Europe - had far higher levels of such cancer-causing agents as PCBs and dioxin than their brethren hauled in from the open sea (Hites RA, Foran JA, Carpenter DO, Hamilton MC, Knuth BA, Schwager SJ. "*Global Assessment of Organic Contaminants in Farmed Salmon*", in Science 2004; 303(5655):226-9.. The authors concluded that eating farmed salmon more than once a month could place adults at a higher risk of developing cancer. They recommended that farmed salmon should be eaten once a month, perhaps every two months as they pose cancer risks to the human beings. The UK's Food Standards Agency (the study was conducted on Northern Scotland fish farms) urged people to keep eating salmon despite the findings, released at the end of last week. It pointed out that the dioxins and PCBs found in the study were within safety levels set by the World Health Organization and European Commission. It seems that the markets were not really affected by the news. Was it really then exclusively a media coverage issue? Are we, on the other hand superseding our survival instinct to maintain the standards of industry?

In America, the different agencies set different PCB limits:

- FDA: the current FDA limit of PCBs in all fish is 2 ppm
- Health Canada: the current Health Canada's guideline for PCBs in fish is 2 ppm.
- EPA: the Environmental Protection Agency guideline on PCBs is much stricter.

It recommends that fish with PCBs level between 0.024 to 0.048 ppm should be eaten 8 oz a month.

The average level of PCBs in salmon is 0.027 ppm (parts per million)

There is an obvious discrepancy in the limit set by various human health agencies. Even if the strict EPA guidelines were known to be the right ones, they are based on the amount of PCBs that are thought to be capable of causing one additional cancer case in 100,000 people over a 70-year lifetime. So, what does it all mean?

4.- Environmental impacts of farmed salmon

Farmed salmon, or salmon raised in pens and fed pellet food, as other domestic livestock, has also triggered the debate of the environmental impact caused to almost pristine areas such as the many straits off the coast of British Columbia (see Rosamond L. Naylor, Josh Eagle & Whitney L. Smith, *"Salmon aquaculture in the Pacific Northwest: a global industry with local impacts"*, in Environment, Oct, 2003). What is the myth and what the science behind the different positions in this debate? Think of this development keeping in mind the main tenet of the Case Study: that there is a de facto relationship between how organisms live out their life cycles and the physiognomy and dynamics of a landscape, and therefore altering one of them has instant impacts on the other one and how the response to these changes opens up more variables we care to understand. In this type of scenario the changes across intervals of time: immediate (catastrophic) and evolutionary (longer than our life spans) and the ecological implications of farming based on historical knowledge of what the domestication of terrestrial species has done to terrestrial landscapes must be considered.

5.- Genetically engineered salmon, a modern "tragedy of the commons"?

There are patents pending from Aqua Bounty Farms, a company, based outside of Boston that is injecting human growth hormone into the DNA of Atlantic salmon to make them four to six times bigger. And it is in the process of obtaining approval for mass marketing by the Food and Drug Administration (FDA), an agency that rarely bothers to connect human food consumption issues to environmental impact studies or the Endangered Species Act. In Canada, transgenic young Coho salmon, treated with added growth hormone at the West Vancouver (BC) Research Laboratory, were three

times longer and thirty times heavier than their non- genetically modified counterparts of the same age.

One suspected environmental impact of all farmed fish is that escaped individuals will compete with wild fish for habitat and food. The genetically engineered or modified organisms (MGO's) add a new layer of danger to this premise, since behavior has a strong correlation with morphological structures. Another potential problem is that the genetically modified salmon might breed with the wild salmon. The transgenic fish would grow much faster and therefore could potentially consume large amounts of food that could adversely affect the remaining wild salmon. The consequences of interbreeding could be many and hard to predict.

A study conducted at Purdue University advises against it, demonstrating that genetically modified fish could lead to the extinction of wild populations if released into open waters (Richard D. Howard, J. Andrew DeWoody and William M. Muir, *"Transgenic male mating advantage provides opportunity for Trojan gene effect in a fish*"). Genetically modified fish had a mating advantage over wild species due to their unnaturally large size. Using computer modelling, the Purdue scientists showed that it would take only 60 genetically modified fish in a population of 60,000 wild fish to cause species extinction within 40 generations. They based their study in the "Trojan gene" hypothesis: researchers have found that female fish tend to cue in on size of the males as a mating preference.

On the other side, the scientists whose work created the salmon say the nightmare scenarios are greatly exaggerated. They tout the fish as affordable protein that could help feed starving nations (an argument that is always produced to counteract unknown or unresearched risks and has rarely proved true. It brings to mind GM crops such as corn, rice and soy that where meant to "solve the hunger problem in the third world" as well, a problem that was most emphatically not resolved by this approach). And it is true that few critics say eating the fish would be dangerous.

"For environmental groups, nothing sells like fear," says the CEO of Aqua Bounty Farms. "Rather than have a rational discussion about benefits and acceptable risks, they'd rather scare the bejeezus out of the rest of us."

So, what should be the FDA's decision based upon? Current and historical knowledge of other introduced "crops"? The economic interests of businesses? The health of the consumers? The health of the ecosystems as bases for the health of consumers? Should agencies such as the EPA consider more than one or two variables when making decisions whose reach will not be known until years to come? Should companies be allowed to develop "genetically modified organisms" without knowing the future effects of their actions on consumers, the environment and the earth at large? And a question that is seldom asked: Should we as consumers and therefore financers of these experiments demand to be considered as stakeholders of the process rather than mere recipients of unknown consequences? If the point of business is to create money wealth, aren't we as consumers entitled to a piece of the pie (money wise)? On the other hand, Are we entitled to curve the rights of corporations to make a profit when they use the world at large (allegedly a property of ALL of us) as a raw resource assuming a de facto ownership they actually do not have?

6.- Salmon and trout species taxonomization.

Salmon and trout have made the life of taxonomists an interesting exercise. Until 1988, Steelhead (the anadromous form of rainbow trout) was classified in the genus *Salmo* along with Atlantic salmon, brown trout, and several western trout species. With additional osteology and biochemistry data, biologists have now reclassified Steelhead as members of the genus *Oncorhynchus.* The reason for this is that new information suggested that Steelhead is more closely related to Pacific salmon than to brown trout and Atlantic salmon. As such, the American Fisheries Society-American Society of Ichthyologists Committee on Names of Fishes voted unanimously to accept *Oncorhynchus* as the proper generic name. For full scientific details, see Smith, G. R., and R. F. Stearley. 1989, *"The Classification and Scientific Names of Rainbow and Cutthroat Trouts"*, in Fisheries 14 (1): 4-10. As such, the scientific name of Steelhead was changed from *Salmo gairdneri* to *Oncorhynchus mykiss*.

Another variation of response to adaptations to local conditions through the geological ages is the Kokanee, or silver trout, the landlocked subspecies of Sockeye salmon that is

the exception to anadromy. The Kokanee spends its entire life in fresh water and usually does not attain the size of its sea-migrating cousin.

Does the exception really confirm the norm? Is species taxonomization totally scientific? How are the different species determined to be such? Is it a question of reproductive capability or of DNA sequencing? Are all these issues "pacific" science? Linneus's binomial classification, which for him was just a way to organize a vast array of knowledge in a manageable form was not prompted by phylogenetic thought (at least not consciously), however we have pretty much kept a nomenclature system that works very well. What does this say about taxonomy and what does it say about the assumptions we make about taxonomy representing the phases of evolution? What does it say about evolution as biological mechanism rather than a classification device for our own peace of mind?

7.- Flowering plants.

The Case study examines the evolution of the trees known as the coastal redwoods (*Sequoia spp.*). A Taxodiacea, in spite of not being a flowering plant appeared during "the amazing flowering explosion of the Cretaceous," about 100 million years ago, when a lot of new plant species appeared on earth. Its adaptations, like those of all the relicts from those days, are still good today. They are relict species (species that have retained their original traits as adapted to an earlier geological period rather than changing according to current circumstances).

Our modern fauna and flora originated as a consequence of the "explosive adaptive radiation of flowering plants in the Cretaceous." They appeared on Earth quite recently, about 130 million years ago, during the Cretaceous period. But once they took firm root about 100 million years ago, they swiftly diversified in an explosion of varieties that established most of the flowering plant families of the modern world. Actually, even the animal kingdom as we know it today, after the disappearance of the dinosaurs, cannot be understood without them. The origin of flowering plants (the angiosperms) during the early Cretaceous triggered a major adaptive radiation among the insects: new groups, such as butterflies, moths, ants and bees arose and flourished. These insects drank the nectar from the flowers and acted as pollinating agents in the process. But they were not the only ones affected. As a food source flowering plants provide us and the rest of the animal world with the nourishment that is fundamental to our existence. The flowering plants changed the way the world looked almost as soon as they started to exist.

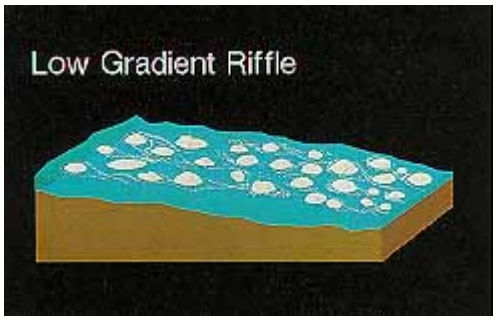
Can one say, as Walter Judd, a botanist at the University of Florida, that "If it weren't for flowering plants, we humans wouldn't be here?" If we follow this kind of logic can we say that "we are the plants we keep", or in other words, our world would be different according to the different floristic composition of our environments? How does this relate to the changes that we will see with the Greenhouse effect as colder climates and coastal communities disappear or are fundamentally altered? What does this say about forest conservation?

8.- Habitat typing.

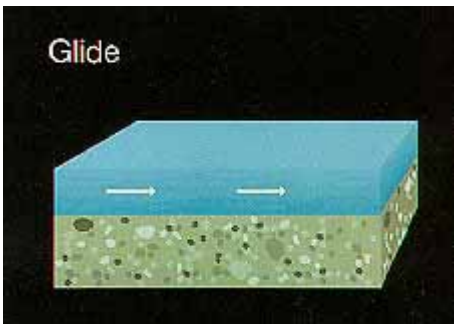
Habitat typing is the methodology used in the Restoration of the salmon watersheds. It is a breakthrough discovery to typify riparian habitat that ties in as many components physical and biological that serve to characterize a site, not the least the species floristic composition and the distance to the stream. Maureen Roche, from the Mattole Salmon Group, and David Fuller, from the Bureau of Land Management, are two of the most notorious proponents of this method.

Since 1990, all agencies in northern California have used habitat typing methods originally described by Bisson et al. (1981) to gather data on many fish habitat parameters. More recent publications (McCain et al. 1990, Hawkins et al. 1994) have clarified the hierarchical system of habitat classification that allows one to look at stream habitat as a simple sequence of pools and riffles (level 1), a sequence of pools, riffles, and runs (level 2), or as assemblages of more than twenty types of habitat types (level 3) that stem from the basic types of units. This classification system allows one to stratify (i.e. respect natural patterns of variation) when attempting to quantify biological or physical attributes of the stream. For example, Hankin and Reeves (1984) found that the precision of stream fish population surveys could be drastically improved by using habitat typing information. The habitat typing results alone can be used as indicator of fish habitat condition. This technique is reflected in the Fish Habitat Relationships program, established by the US Fish and Wildlife Service to research and develop information on fish ecology and to coordinate effective applications of this knowledge in managing and protecting our fisheries. By relating life stage requirements of specific species to physical habitat parameters, we are aiming at our main objective: developing a methodology to manage fisheries through the management of habitat.

Some examples of basic habitat types (www.krisweb.com)

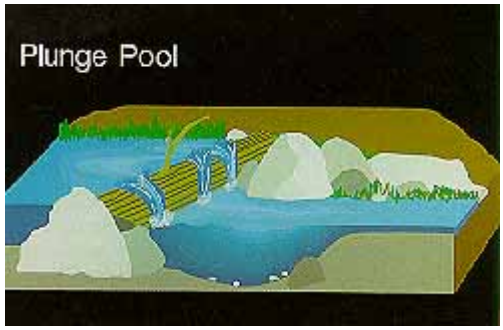


Riffles are areas of swifter flowing water, where the surface is turbulent. Young-of-the-year steelhead like low gradient riffles but coho generally do not. The flowing water delivers insects for food and the broken surface provides cover from predators.



Glides are slow moving areas in the stream, where the surface is smooth. Often, streams suffering from cumulative watershed effects have a large percentage of flatwater habitats, such as glides and runs, and riffles. Pools often have filled in and represent a small percentage of habitat types.

Logs, root wads, boulders or stream banks can cause backwater pools to form as water swirls around the obstacle. Coho salmon almost always rear in pools formed by large wood.



Plunge pools are formed where water falls over a boulder or log. The falling water scours a hole where juvenile and adult fish often hide.

Why is "habitat typing" such a revolutionary tool for the management of endangered species?

9.- Chemical imprinting of young salmon.

The Case study describes how the process of imprinting of the river on the young fish while their anatomy is developing must leave a strong shared chemical track that they will follow as adults on their return trip to the mother stream.

Although scientists have not yet fully decipher the chemical or physical bases of the salmonids "homing" instinct, pheromones and the sense of smell, along with awareness of the earth's magnetic field are considered elements of it. See "*Homing in Pacific Salmon: Mechanisms and Ecological Bases*" by Andrew H. Dittman and Thomas P. Quinn (J.of Exp. Biol 199, 83-91). It offers a rare informative discussion on this issue, as most of the homing research has been rudimentary done by artificial hormone imprinting during the Parr-to-Smolt phase in hatchery fish, that are reared in the same water all their lives. Dittman and Quinn realized this left out a big hole in terms of the absent interaction with the river and studied the pheromone imprinting-homing relationship in wild salmon. Their results are very interesting.

But, can they be found to be conclusive?

10.- The salmon navigational tools

The salmon have different navigational tool. At sea they activate their inner compass and get attuned to celestial navigation, while in the stream they develop a magnetic strip down their sides that reads the earth's movements.

While scientists puzzle out painstakingly each of these mechanisms by wearisome devices like tagging, satellite tracking, electrofishing and other invasive or terminal methods, they rarely stop to think outside our own five senses, which would probably eliminate the need to destroy what we are studying. Question: Is this is the old Sherlock Holmes say: "after you eliminate the impossible whatever is left, however improbable, is the truth"?

The rationales behind research design affect research outcome sometimes obliterating the obvious, sometimes altering the reality. Are there not more simple explanations to the salmon migratory skills that don't need intrusive research or render it useless?

11.- Some economics: Is salmon the savior of the redwoods?

Deforestation (loss and degradation of habitat) was quickly identified as the single most lethal cause of animal species extinction. The salmon restoration movement, from the start, realized that preserving the forest intact was crucial for the survival of the salmon. Water depletion from watersheds is also a common link between the survival of the forest and the fish. No water, no fish, no forest. Was the original intent of the movement to save the salmon or to save the forest? Is the survival of salmon a forest issue? Is the survival of the forest a fisheries issue? Isn't this type of either/or thinking harmful in terms of ecosystem preservation? Can the salmon economy save the redwoods better than any redwood preservation policy on its own merit? This Case Study emphasizes the need to start seeing the "components" of an ecosystem the ecosystem in itself; therefore, an we think of water, the survival of either the forest or the animal species as separate issues at all?

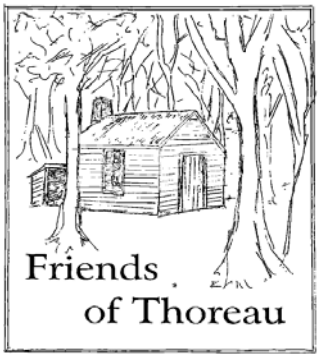
12. - Water

"It is easy to see, then, how any impediment to the free flow of water would have far-reaching consequences on the shaping (the unshaping, rather) of the habitat, and such impediments are precisely what the water policies agencies have been advocating since the 1800s, policies that—unknowingly at the beginning and in blatant disregard of available knowledge now—have been paving the way for the current wave of salmon extinction we are witnessing, comparable only to the mass extinctions of the Pleistocene, but there was an Ice Age raging then."

In a purely rhetorical manner I would like to explore the possibilities opened by comparing prevalent scientific mind frames against the dynamics of the natural world and vice versa because they bear on the spirit of what the paper wants to transmit, mainly how human attitude rather than action influences natural processes. When Darwin formulated his theory of the evolution of the species he patterned it heavily on the political and social trends of the time, the beginnings of the industrial revolution

being shaped by Malthusian thought, class struggle and a widespread mechanization of manufacture and resource exploitations. "The survival of the fittest" tenet reflects this perspective that in turn has served as a model for business ever since in the "big fish eats small fish" mindset. (This approach is now being contested in the scientific community as other evidence turns up). However, the opposite is not true. The raging debate we saw in the 1990's to open up the ways of commerce has nearly criminalized any thought of regulatory policies that may prevent the globalization of businesses on the grounds that. Were we to be coherent with the exchangeable attributes we bestow on the natural world and the world of commerce, we could see that attempting to regulate the free flow of water (the currency of life) its global reach, causes and effects should be equally anathema.

Rather than to open up a debate about the goodness of this argument, the idea is meant to trigger the thinking about the effects of the social trends of the time on our perception of natural processes and hence the formulation of scientific theories. See R.C. Lewontin's *"Biology as Ideology: The Doctrine of DNA"* (Harpers-Collins. Originally published in 1991 as part of the Massey Lectures) has an interesting discussion about the issue of the mutual influence of societal trends on the scientific outlook.



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Works Cited and Additional

Guiding Students´ Discussion

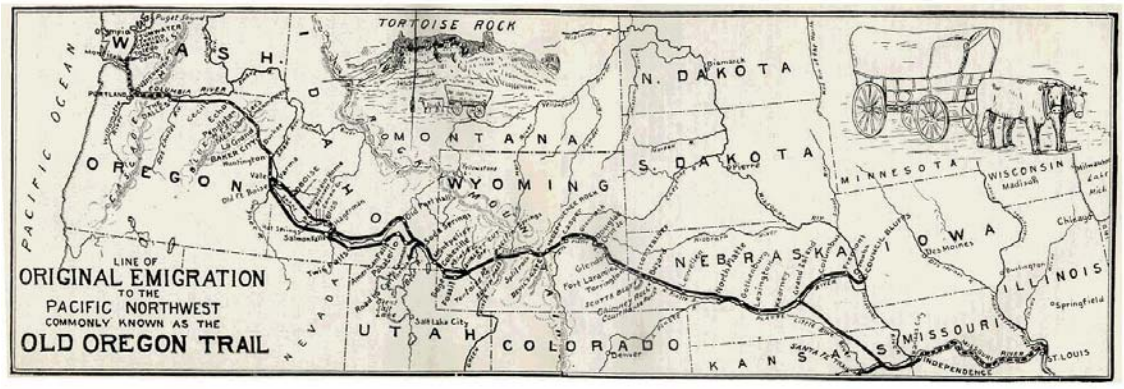
1.- The first explorations and migrations: The routes to the Far West

It took a long time originally for the first European Americans to really get settled in the West Coast. After the Lewis & Clark expedition the routes via de Missouri that they had negotiated in 1804 were not followed because of their extreme difficulty. It was not until 1823 that the so-called "South Pass" became known. Actually, it was not really "discovered" but "rediscovered: Jedediah Strong Smith, one of America's greatest explorers of the Far West, began his life as an explorer in 1822, when he joined the pioneering fur trader William Ashley and set out in order to find sources of beaver and otter in the West.

In 1823, exploring the Black Hills region of the Dakotas, despite being hurt by a grizzly bear, he was able to reach what is modern-day Dubois, Wyoming, where he camped for

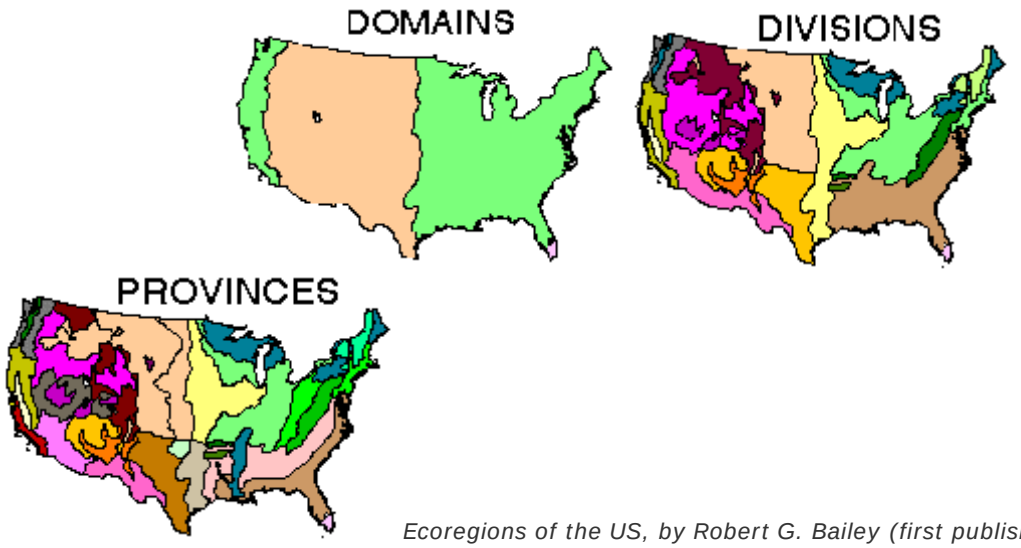
the winter and to recover from his wounds. It was during this stop at Dubois that Smith learned from the Crow Indians about an easy pass through the Rocky Mountains. The following spring, Smith and his men followed the route described by the Native American and discovered that the Rockies could be easily crossed through a pass that was later to be named the "South Pass." Smith's discovery of South Pass was actually a "rediscovery," since employees of John Jacob Astor's Pacific Fur Company had crossed the pass in 1812 when returning to St. Louis from the Pacific. The Astorian discovery, though, remained unknown, so Smith is credited as the discoverer of the route. Ideally suited for heavy wagon traffic, the “South Pass” greatly facilitated the mass movement of settlers bound for Oregon and California: the Oregon Trail became the path of migration of thousands of Americans to the Far West, in particular after the issue of the sovereign claim to the Oregon territory were settled with the British by President Polk.

The students should use this opportunity to review the epic histories of the first arrivals to the West Coast before and after Lewis & Clark. From the debate about who were really the first Americans and when did they really arrive, to the stories of the Spanish-Russian confrontation that set the status quo of the limits to the Russian expansion from Alaska, and to the accumulation of capital triggered by the fur trade of the Astorians. Did this mean that the Oregon Trail, the so-called “super highway” to the West was really an easy task? The students should be introduced to the epic lives that ordinary men and women had to undergo even as members of Oregon Trail migrations by “virtually” accompanying one of the families from Saint Louis to one of the final destinies of the Trail.

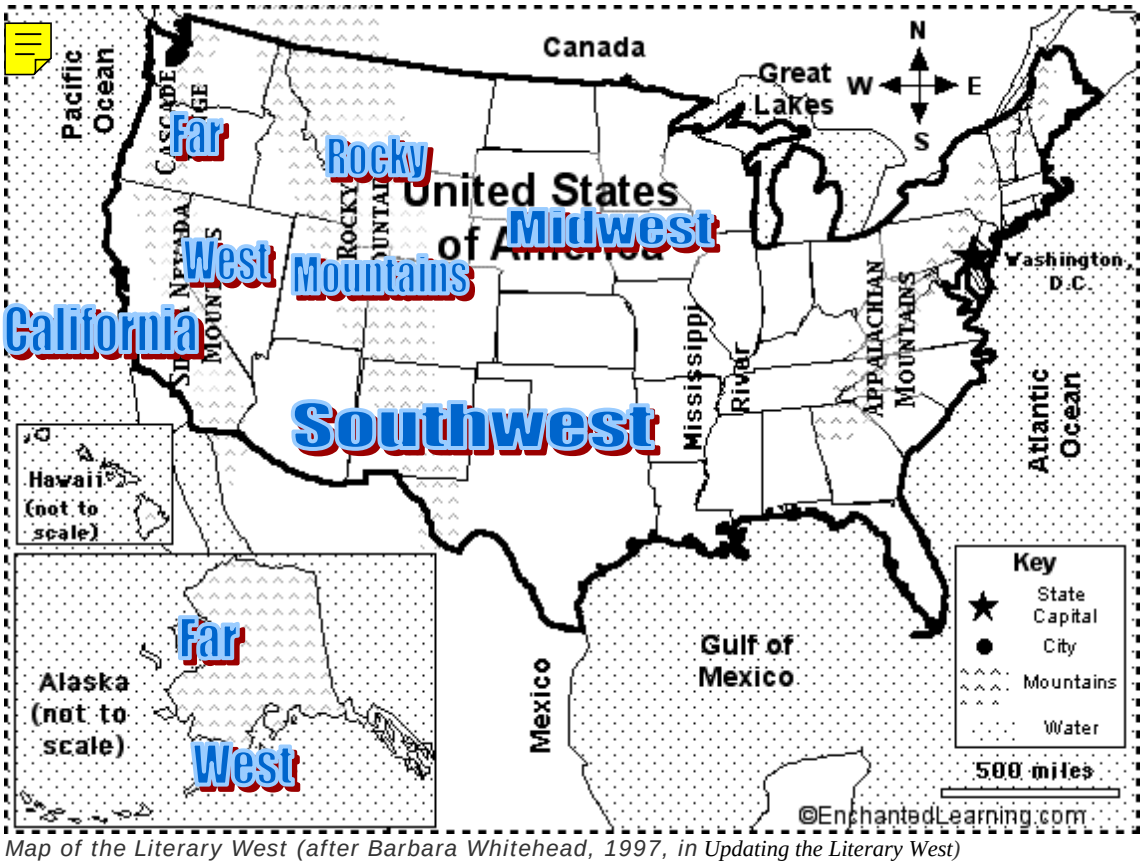


2.- The "sense of place" of the Far West as a bioregion.

The notion itself of the Far West, is it geographically or culturally based? Is American culture based on a homogenous perception of place? Is the idea of "sense of place" based on ecoregions, such as the famous 295 from Kevin Lynch or, at least, the officially recognized by the USDA Robert Bailey´s 52 "provinces", or rather on a broader appreciation of space and landscapes in which space and culture are interwinned (the so-called "bioregionalism")? See the maps below 1) of the North American Ecoregions (US/Canada/Mexico Commission for Environmental Cooperation) and US Bailey´s divisions; 2) of the "literary" landscapes of the West of the US; and 3) of the bioregions of California (by two different institutions)…. Can the students identify the main traits of each of these different regionalizing schemes?



Ecoregions of the US, by Robert G. Bailey (first published in 1976 and revised in 1994-1995), of the US Forest Service



Map of the Literary West (after Barbara Whitehead, 1997, in Updating the Literary West)

California Bioregions by Forests Forever

Bioregions of California by the Albright Seed Company a Division of S&S Seeds

The student should be guided into the debate that the bioregionalists have introduced in American culture, which is universal thinking *per se*. "*Historians of every period of American history have long concerned themselves with region, though in widely varying ways. For historians of the twentieth century, region is often a matter of government policy, of voting patterns, of shifting economic fortunes. For historians of the nineteenth century, questions about region tend to be questions about national identity, about the relationships among slavery, frontiers, and industry. For historians of the eighteenth century, the Revolution and nation-building tend to be preoccupying problems. For historians of the seventeenth century, questions of origins, of the migration and evolution of culture, are the major concern*" (Edward Ayers, American Regionalism, Manuscript, 9/15/95).

In the Twentieth Century, during the 1930's, a group of artists founded a new movement known as the American Scene Painters, or American Regionalists. This group had mainly two different subgroups: 1) the **Social Realists** like Ben Shahn (1898-1969), Jacob Lawrence (1917- 2000) and Jack Levine (1915-), who focused on the urban social struggle and hardships faced by everyday people during the depression; and 2) the **Regionalists**, who decided to show a possible better world, concentrating in rural America as a positive image and included artists such as Thomas Hart Benton (1889 - 1975), John Steurat Curry (1897 - 1946) or Grant Wood (1892 - 1942).

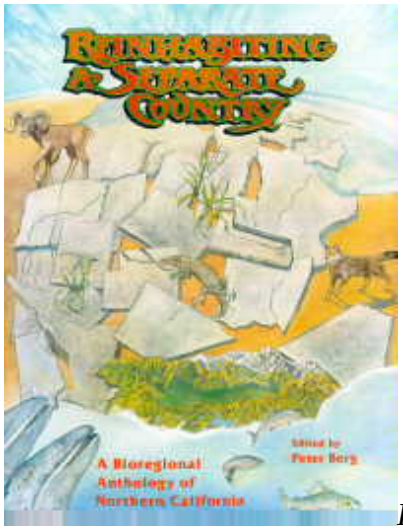
In the 1970s, writer Peter Berg and ecologist Raymond Dasmann, both affiliated with the San Francisco environmental organization Planet Drum Foundation, popularized the term "bioregion". Bioregion can be defined as "*a part of the earth's surface whose rough boundaries are determined by natural rather than human dictates, distinguishable from other areas by attributes of flora, fauna, water, climate, soils and landforms, and the human settlements and cultures those attribute have given rise to*" (Kirkpatrick Sale, 1991). "To live bioregionally is to live aware of the local ecology, steeped in the natural and indigenous history of the place and committed to making choices that help to balance human impacts with the carrying capacity of the environs" (Forests Forever, last visited April 2005). The bioregionalism movement, which is still active today, calls for defining areas based not on ecologically meaningless political boundaries but instead on natural geographic boundaries and characteristics.

Even if one can agree that "*the kinds of subjects that make up modern history –legal, social, gender, ethnic, science, technology, and environmental issues- cannot be taken on without sophisticated reference to places or what people think about places*" (Dan Flores, The Natural West, 96), the question remains about whether this is best addressed by a localist/particularist or via a bioregionalist approach. Both can lead to biased (not the passion that triggers the well informed research) provincialism or transcend it. The goal is to teach the student how to distinguish value-full works from particularism. The Section on Works Cited and Additional contains a critical comment on the best literature on the different US bioregions articulated by Flores.

An additional element can be added to this discussion. Bioregionalism was born in the countercultural world of Californians such as Gary Snyder, Raymond, Peter Berg, or Stephanie Mills who advocated the back-to-the-land approach. Berg defined it a "*a kind of spiritual identification with a particular kind of country and its wild nature [that is] the basis for the kind of land care the world so definitely needs*" (Berg, 1977). The narrative of the case study itself should allow the students to capture the elements that constitute a bioregional approach. How can one transcend the particularism of the Northern California/Oregon/Washington region into the universals of the Far West bioregion? To put it in Dan Flores´ words (who puts it on the mouth of a typical Montana University student): "*So, if aridity is the defining characteristic of the West, then Alaska doesn't belong, and the Pacific Northwest doesn't either? And you mean that those high, wet lifezones disqualify the Rocky Mountains?*" How can one, nevertheless, sustain that "the American West as a whole comprises a distinctive, singular region?"

Does the existence of salmon (by means of its life cycle and its adaptations to the Northwest habitat) help us articulate the concept of bioregion?

If a particular species- salmon in this instance- can serve as the palpable link between geography, natural community and human community, does this make a case for how this kind of (bioregional or mytho-historical or cross-species) approach to *place* and *sense of place* may hold the clues for effective preservation policies?



Reinhabiting a Separate Country: A Bioregional Anthology of Northern California. Edited By Peter Berg.

3.- Homesteading & getting around.

In The Great Race West we have seen depicted in many Hollywood movies, the families were allotted the first lands they could take and stake for free. This happened mostly in the inland states of Idaho and Montana. Later, when the Wild West pioneers had "pacified" the country for the railroad sufficiently to go west, the government of the United States sold surveyed parcels of forest land so the occupation was effected by families of homesteaders rather than companies. How did the famous eastern logging companies get around this? Having in mind that the homesteading of the territory is one

of the main features of American history (the ideal Jeffersonian grid system surveyed to create a nation of free citizens, and the homesteading policy of President Lincoln, devised to ensure that no new slave supporting territories would sprout), it should have been very difficult for the companies to overcome these institutional mechanisms so deeply rooted in the minds of the officers of the federal Government in charge of administering the distribution of property.

The eastern logging companies put in place a policy of lending the money to buy the parcels to their workers and indenturing them until they could pay it back in the classical "company town catch". Only men were allowed in these work camps and they had to buy all their necessities from the employer at exorbitant prices, preventing most of the workers to meet the payment deadline, which were grounds for confiscating the land deed. In this manner the corporations acquired, illegally, contiguous parcels of forestlands that made up vast tracts of the Northwest. (See Luisa Molinero, *A Brief Natural and Social History of the Redwoods*).

Was this policy a unique feature of the forest sector? What other economic sectors allowed for the by-passing of the homesteaders/grid principles? How this institutionalized fraud has enmeshed itself in the history of the creation of Public Lands (mostly bought with taxpayer's money from the same companies that appropriated them illegally during the colonization of the West) and how has this affected the public's perception of what public land, the ultimate commons, should be "utilized"?

4.- Local vs long distance fisheries.

The Alaskan salmon fisheries are much healthier because their land habitat is less degraded, having practically no inland human population, but now they have to share their fisheries with the rest of the region and fight off-shore Asian factory ships. At the wake of the 21st Century,…are there "wild west" wars in the sea? Are fisheries fights a common scenario in the Northern Eastern Pacific Ocean? Can the situation be compared to the well known fisheries wars of the Northern Atlantic?

The students should also be introduced to the notion of "community-based" fisheries as the new institutional setting from which environmental justice can be fostered. Are fisheries the only natural resource were environmental justice programs can be put in place? The case of the local Northern Pacific community-based fisheries can be compared, for example, with the community based forestry analyzed in the Section on Guiding Students Discussion of the Case Study "*Farming in the Elkhorn Slough Watershed, Environmental Justice & the Hispanic Community*", in http://www.iuien-uah.net/es/cgi-bin/inv/linea1.php

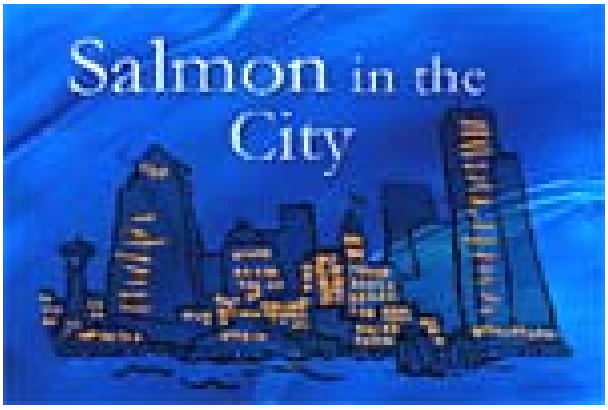
5.- Urban fauna.

The idea of getting along in one's own ordinary life by interacting daily with backyard wild animals is deeply embedded in the American psyche. Books on "backyard fauna" are a normal component of most American home libraries. Familiarity with some species well adapted to urban settings such as raccoons, possums, otters, seals and in extreme cases black bears gives Americans a different perception of co-existing along other species, even in the cases when these urban denizens are considered and treated as "pests."

The main page of his case study offers some glimpses of how big cities are trying to re-familiarize modern urban dwellers with the salmon, so that this wonderful fish becomes a sort of neighbor or co-citizen. To achieve this they will have to, figuratively, lift a layer of development to uncover the complex system of over the ground and underground waterways, exposing a different physiognomy of the city itself. For these projects to be successful the citizenry has also have to contribute by changing some hard-wired habits and rethinking concepts of refuse-sewage-disposal to keep the waterways clean.

Will an immediate effect of the policy of making the city "habitable" for animals be to make the city more "habitable" as well for humans? Will the process of "animalizing" the city make it more humane? Will other species benefit as well? (see e.g. the City of Portland Tree Enhancement Project).

The students should be introduced in more detail to the recent development of the City of Seattle and Portland's salmon recovery plans/Anchor Salmon areas and the Salmon Safe Certification Initiative. They should explore alternative ways through which this policy could be implemented.



One way they can approach this topic is by analyzing the strategy put in place by the Seattle City Light and Seattle Public Utilities Percent for Art, and supported by City Salmon Team and Seattle Department of Parks and Recreation, in order to foster awareness of the recent listing of Chinook Salmon as threatened under the Endangered Species Act of the United States. Twelve public art projects, from sculpture to poetry to animation, were located in communities around the Northwest and addressed the wide implications of the salmon recovery issue.

6.- Infrastructure obstacles.

The main page of the case study offers also some hints about the problems created by paved surfaces. During rainy months, paved surfaces speed the flow of stormwater into

river and stream channels, creating fast-flowing currents that can harm juvenile salmon. These currents can move large rocks, sweep away the food juveniles depend on, and carry sediments that fill in the pools with slower moving water. During months with little rain, paved surfaces cause the opposite problem. They contribute to periods of very slow stream flow, causing water temperatures to rise above levels that are beneficial for juveniles. Dikes and levees prevent juvenile salmon from swimming into off-channel habitat which supplies food and refuge. Lawn chemicals, oil, and other pollutants can also injure or kill juvenile salmon. Pesticides and other chemicals in urban runoff, for example, reduce the number and variety of aquatic insects that salmon can find to eat. They also mask smells that smolts imprint on so they can identify their natal streams when they return as adults. When smolts swim through developed urban areas, they find limited shallow habitat with brackish water, making it more difficult for them to adjust to salt water and to feed and grow larger for their ocean voyage.

Harley Soltes. The Seattle Times, Friday, November16, 2001, 12:00 a.m. (Pacific Time)

The students should be introduced into the programs that are being devised and implemented to overcome this problem and incentivated to design new policies.

7.- Salmon Nation

Salmon Nation is a coalition-building effort sponsored by the Ecotrust Foundation and backed up by financial institutions. It is an effort to revive the economy and identity of

the area by means of recovering salmon habitat and the equivalent of European regional identity s but based on the identification with a species. Are there any equivalents to this "animal-based" constructions in the US? What about Europe?. The students could be confronted with different animals which are nowadays regional symbols to see whether they can identify the bioregion with which the animals are associated.

What countries/bioregions can be associated to these symbols?



8.-Geological overlaps.

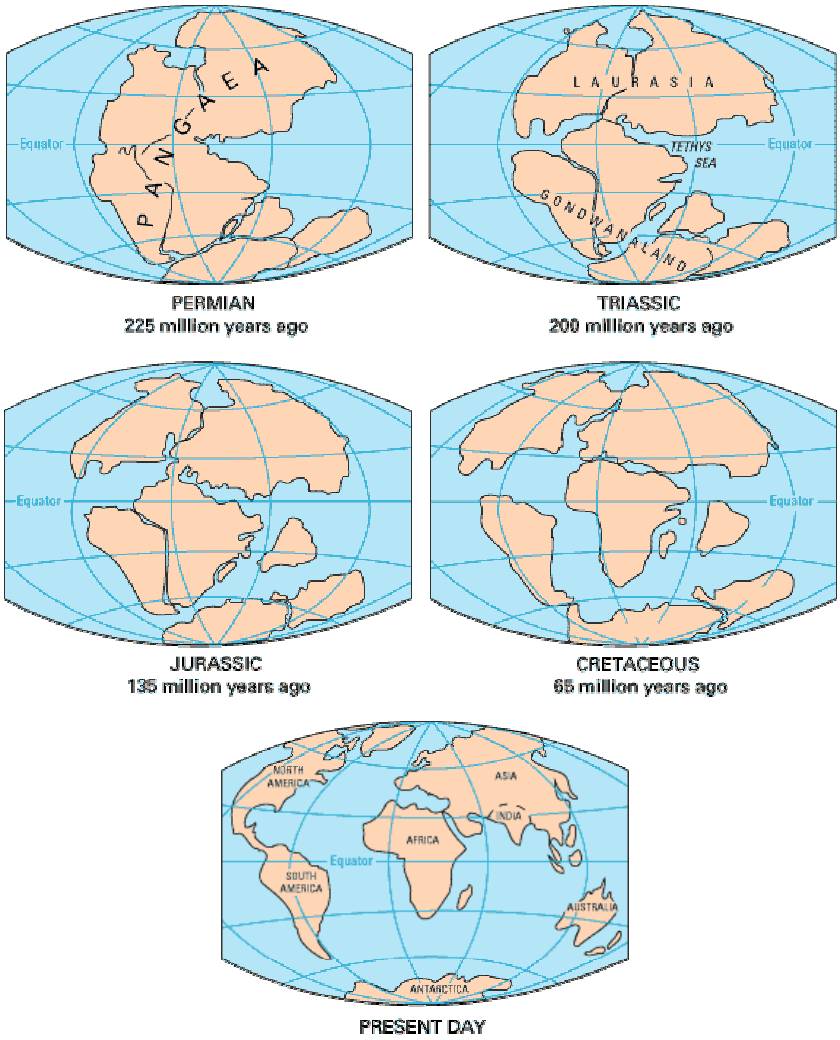
The main page refers several times to how some areas are the ideal habitat to species that appeared during different geological times. These species share the same lively landscape with emerging creatures such as flowering plants and ancient mammals, the ancestors of the animals we see today. Geological overlap implies species adapted to different geological ages living together. Sort of a geological edge-effect. Can the students identify, on their own daily environments, examples of that happening? The co-habitation with the world of archeobacteria could be used as the main example.

The students search can be carried farther to make them think of the immense value that extremofiles have for modern science and economy. An even farther, to the analysis of how much of our own body is simply shared, in terms of genetic structure, with "lower species".

9.- Continental Drift.

The idea that continents could drift was laughed at by the scientific community until developments in geology made Plate Tectonic Dynamics provable, but this did not

happened until the 1960's. So it took 50 years for the initial hypothesis of Alfred Wegener ("*The Origin of Continents and Oceans*" , expanded version of 1915 of his 1912 lecture, first translated into English in 1924) to get recognition. It is now as consolidated a part of mainstream scientific culture as the law of gravity or the Earth as a sphere.



The students should nevertheless, be introduced to how difficult it is for new scientific paradigms to become part of the scientific and cultural heritage. The importance of geology, in this case, can be emphasized by making the students think, first, on how the idea of evolution itself owes so much to geology by introducing them to recent works that have revisited the scientific fights to reformulate geology in Nineteenth Century England such as Simon Winchester´s "*The Map That Changed the World: William Smith and the Birth of Modern Geology*" or, even more interesting, by getting them exposed to Darwin´s thoughts during his Voyage of the Beagle (see, for example, as a wonderful introductory book, Alan Moorehead´s "*Darwin and the Beagle*", 1969). As an example of how the formation itself of the North American continent is considered

the moment from which the history itself of the US can be described/taught, see Tim Flannery´s bestseller, "*The Eternal Frontier, An Ecological History of North America and its Peoples*", 2001. Making the students choose a period of US geological, pre-homo sapiens, history in order to describe how their home bioregion looked then, is a wonderful exercise that will certainly produce new insights in the way in which their sense of place can be refined.

10.- Encoding information in the DNA.

The case study explores, as a "deliciously suspicious Lamarckian approach", the possibility that the information absorbed during the developmental stages of the life cycle of the salmon through interaction with the inland habitat is encoded in their DNA, passed on to their offspring, and constitutes the molecular user manual to survive in the ocean and return to the home spring that taught them how to be salmon. It is based on the fact that Lamarck's theories, long out of the favor of the Darwinian scientific community are timidly coming back as recent research debunks the Weissman's Barriers tenet (the theory of the continuity of germ plasm which proposes that the contents of reproductive cells are passed unchanged from one generation to the next unaffected by changes of other parts of the body, and precluding the possibility of acquired characteristics), part of our lifetime's scientific doctrine (Edward J. Steele, Robyn A. Lindley and Robert V. Blanden). On the other side, other theories of evolution find the key on the origin of species "by merger and acquisitions of gene sets in prolonged successful association of two (and even more) different organisms" (Piel, reviewing Lynn Margulis´ and Dorion Sagan´s, "*Acquiring Genomes, A Theory of the Origins of Species*", 2002). The case study should allow the students, by interiorizing how salmon came to be, to discuss the history and the different approaches to Evolution.

11.- On "consilience".

The case study, when evaluating the results of aquaculture in the genetic traits of salmon when deprived of their life-cycle voyages, reflects on how we humans are also

part of the web of life and continue to evolve along with everybody else and partake from the universal evolutionary mindset. The students should get exposed to the notion of "consilience", the term coined by E.O. Wilson to encompass "a natural and shared thread of intelligence throughout the human species that runs through us all, connecting us to our surroundings in a sort of basic understanding". What does it really mean? What examples of consilience can be found, articulated and discussed? Is consilience really a serious theory? What do the main critics of the idea say about it?

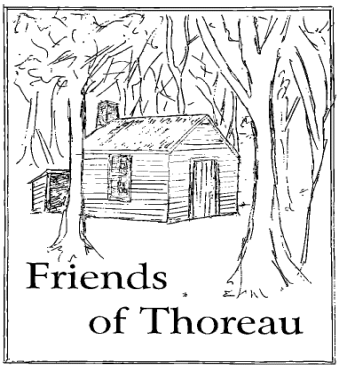
12.- On the "science" of Restoration management.

The case study describes how Restoration grew as an idea following direct action when David Simpson, Freeman House, Gary Petersen and others from the Mattole Salmon Group began their hatch box program in 1980: "*We asked to take our fish closer to the spawning grounds than sports fishermen were allowed to. And we were doing it all as amateurs which flew in the face of an attitude of professional fisheries biologists*". That is very late in the 20th Century, when conservation biology claimed to have reached its full maturity. Isn´t it a surprising late development in an allegedly rapidly moving world? It's worth thinking that people had to go backwards in time (and space, meaning from city to wild country) to actually arrive at a revolutionary idea. Isn´t most of what ecology is about the same? Just rethinking the world back again from a different perspective? Or should it just be approached the other way, by emphasizing that only hard work and scientific rigor can help and be used in restoration projects? One way to push the students to confront this dilemma could consist in the identification of an environmental program really close to them and have them exposed to the hard science that explains why there is a problem at all and how environmental science and engineering can contribute to its solution. Then ask them to devise citizens´ actions that could contribute (even crucially) the success of the scientific solution.

13.- Who are the custodians of biodiversity?

The case study ends its analysis by focusing on "institutionalized" mechanisms that were not even imaginable when Restoration began, It speaks, for example, of the

incorporation by the Sanctuary Forest and the Middle Mattole Conservancy of fiscal strategies like land stewardship grants to preserve vast tracts of the last remaining old growth Douglas fir, and of the purchasing of private and public land at the Headwaters of the Mattole to provide natural refuges and ecological corridors. Is private action a real possibility in conservation? What does the notion of stewardship amount to? Can private law arrangements and contracts provide conservation easements?



The Meaning of Salmon in the Northwest: A Historical, Scientific and Sociological Study

Luisa Molinero
(Supervised by Enrique Alonso García)
Friends of Thoreau Environmental Program
Research Institute for North American Studies
University of Alcalá, Madrid,

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Detailed accounts of the biology of all of the salmonid species that inhabit B.C. can be found in the Pacific Fishes of Canada (authored by J.L. Hart, 1973, Fish. Res. Bd. Can. Bull. 180) and Freshwater Fishes of Canada (authored by W.B. Scott and E.J. Crossman, 1973, Fish. Res. Bd. Can. Bull. 184).

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All the life history generalities and the descriptions of general species life stories is taken from Zabel's Disertation and "Curriculum Connections: Life Cycle of Salmon" http://salmonid.sd73.bc.ca/program.html, BC Salmonids in the classroom Project.

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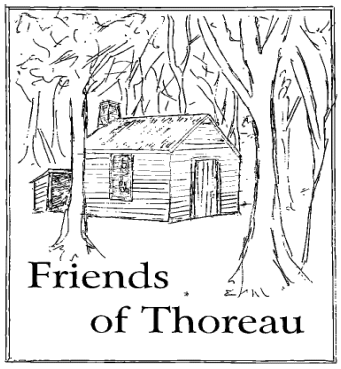

The Meaning of Salmon in the Northwest: A Historical, Scientific and Sociological Study

Luisa Molinero
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University of Alcalá, Madrid,

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Guiding Students´ Discussion
Scholars´ Debate
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Links to Online Resources

All the life history generalities and the descriptions of general species life stories is taken from Zabel's Disertation and "Curriculum Connections: Life Cycle of Salmon" http://salmonid.sd73.bc.ca/program.html, BC Salmonids in the classroom Project

Stewardship Newsletters & Magazines

- Alternatives Journal: www.alternativesjournal.ca/alts.htm
- Awareness Magazine: www.awarenessmag.com/
- Canadian Geographic Magazine: www.cangeo.ca/
- Conservation & Ecology News: www.vcn.bc.ca/cwg/NewsandEvents/cen.html
- Ecologist Magazine: www.theecologist.org/

- E/The Environmental Magazine: www.emagazine.com/about.html
- Environmental News Network: www.enn.com/index.asp
- Environmental Science & Engineering Magazine: www.esemag.com/
- Fresh$_2$Outlook: www.freshoutlook.ca
- Gatherings: Ecopsychology journal: www.ecopsychology.org
- Green Teacher Magazine: www.greenteacher.com/
- Journal of Ecosystems and Management, BC: www.siferp.org/jem/home.asp
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- Stormwater, the Journal for Surface Water Quality Professionals: www.forester.net/sw.html
- Watershed Sentinel, Cortes Island, BC: www.rfu.org/wss.htm
- Watershed Talk, Fraser River Aboriginal Secretariat Newsletter: http://www.frafs.ca/newsletter/index.php
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Puget Sound and Coastal Washington Hatchery Reform Project
http://www.hatcheryreform.org/

National Marine Fisheries Service—NOAA Fisheries
http://www.nmfs.noaa.gov/

Northwest Indian Fisheries Commission
http://www.nwifc.wa.gov/

Salmon Nation
http://www.salmonnation.com/

Mattole Restoration Council
http://www.mattole.org/links/

Salmon in the City/Parks
http://www.kcts.org/affairs/features/salmoncity/index.asp

http://www.salmoncity.net

http://www.salmonsafe.org/urban/parks.cfm

Salmon hatcheries

http://www.governor.wa.gov/gsro/sosreport/2000/hatcheries.htm

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Regional Fisheries Enhancement Groups
http://www.wdfw.wa.gov/volunter/index.htm

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www.tu.org

U.S. Fish and Wildlife Service
http://www.fws.gov/

Washington Department of Fish and Wildlife
http://www.wdfw.wa.gov/

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http://www.planetdrum.org

http://www.feasta.org/documents/shortcircuit/index.html?sc2/bioregions.html

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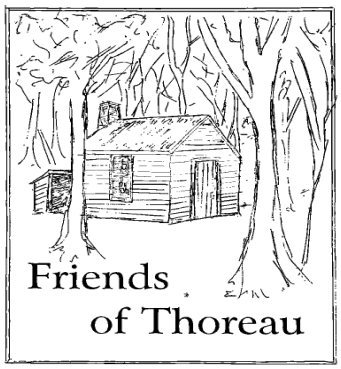

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Illustration Credits & Acknowledgements

The photos and descriptions of species taken from:

Salmon Nation http://www.salmonnation.com/

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Salmon Ceremony Photo courtesy of the Kwagiulth Museum & Cultural Centre, Quadra Island, BC©

All the photos by Natalie Fobes are taken from her Salmon Documentary with One World Journeys

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David W. Welch, Program Head, High Seas Salmon Research, Oceans and Sciences Productivity Division, Pacific Biological Station, Nanaimo, BC. H. Richard (Dick) Carlson is a research scientist at the Auke Bay Laboratory, National Marine Fisheries Service, Juno, Alaska

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APPENDIX: LISTING STATUS AND MAPS FOR THE SIX SPECIES OF PACIFIC SALMON NATIONAL OCEAN

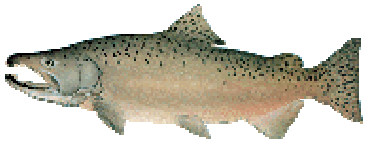
CHINOOK SALMON

Oncorhynchus tshawytscha

LISTING STATUS: CHINOOK

Select an ESU name below to view detailed information about each ESU* - including further links to ESU maps, Federal Register Notices, and Status Reviews.

** An Evolutionarily Significant Unit or "ESU" is a distinctive group of Pacific salmon or steelhead.*



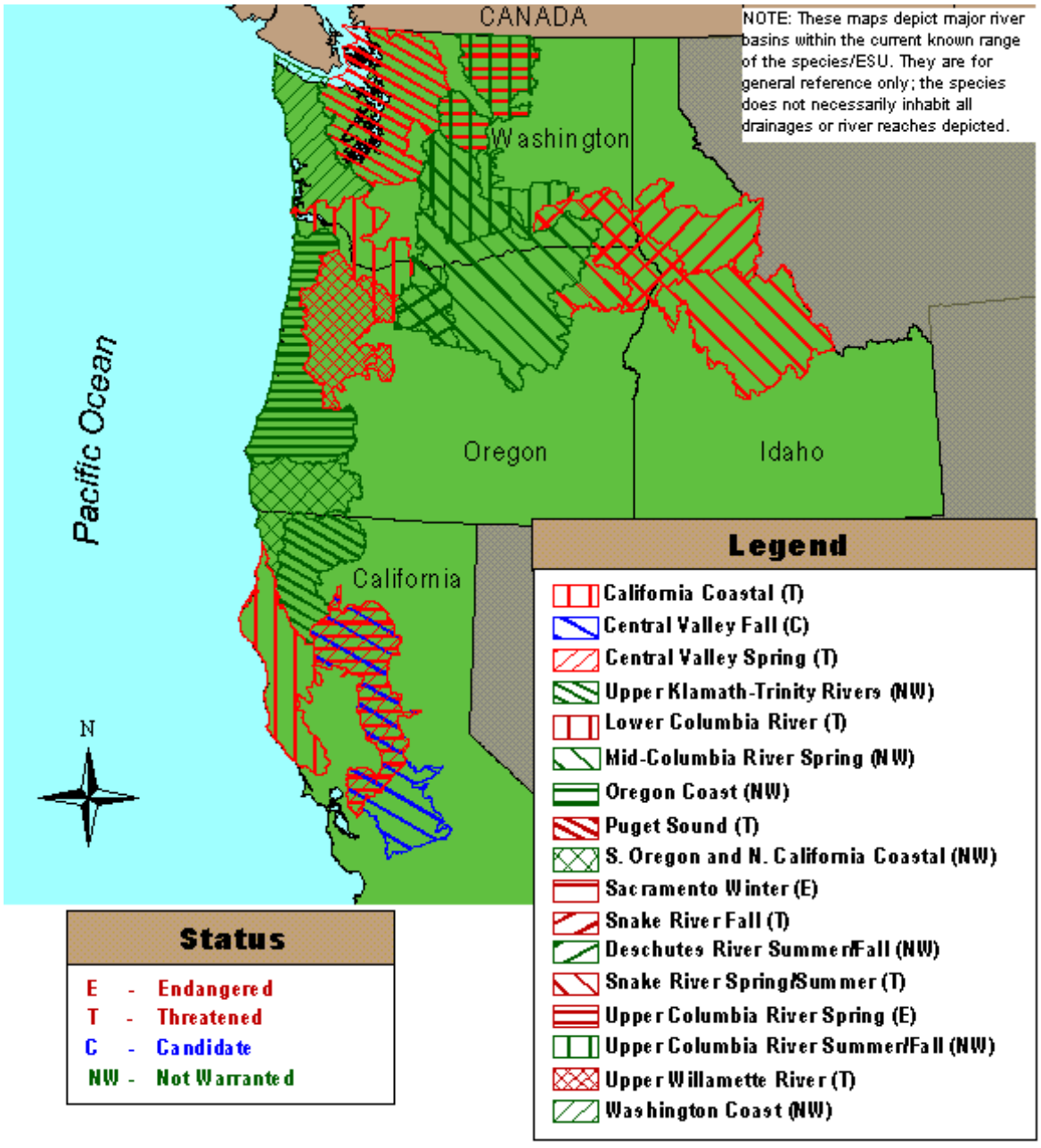
ESU Name	Listing Status[1]
Sacramento River Winter-run	**Endangered**
Snake River Fall-run	Threatened
Deschutes River Summer/Fall-run	Not Warranted
Snake River Spring/Summer-run	Threatened
Central Valley Spring-run	Threatened
Central Valley Fall and Late Fall-run	Species of Concern
Southern Oregon and Northern California Coastal	Not Warranted
California Coastal	Threatened
Puget Sound	Threatened
Lower Columbia River	Threatened
Upper Willamette River	Threatened
Upper Columbia River Spring-run	**Endangered**
Upper Klamath-Trinity Rivers	Not Warranted
Oregon Coast	Not Warranted
Washington Coast	Not Warranted
Mid-Columbia River Spring-run	Not Warranted
Upper Columbia River Summer/Fall-run	Not Warranted

CHINOOK SALMON

Oncorhynchus tshawytscha

CHINOOK LISTING STATUS MAP

** An Evolutionarily Significant Unit or "ESU" is a distinctive group of Pacific salmon or steelhead.*



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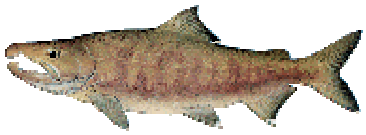
CHUM SALMON

Oncorhynchus keta

LISTING STATUS: CHUM

Select an ESU name below to view detailed information about each ESU* - including further links to ESU maps, Federal Register Notices, and Status Reviews.

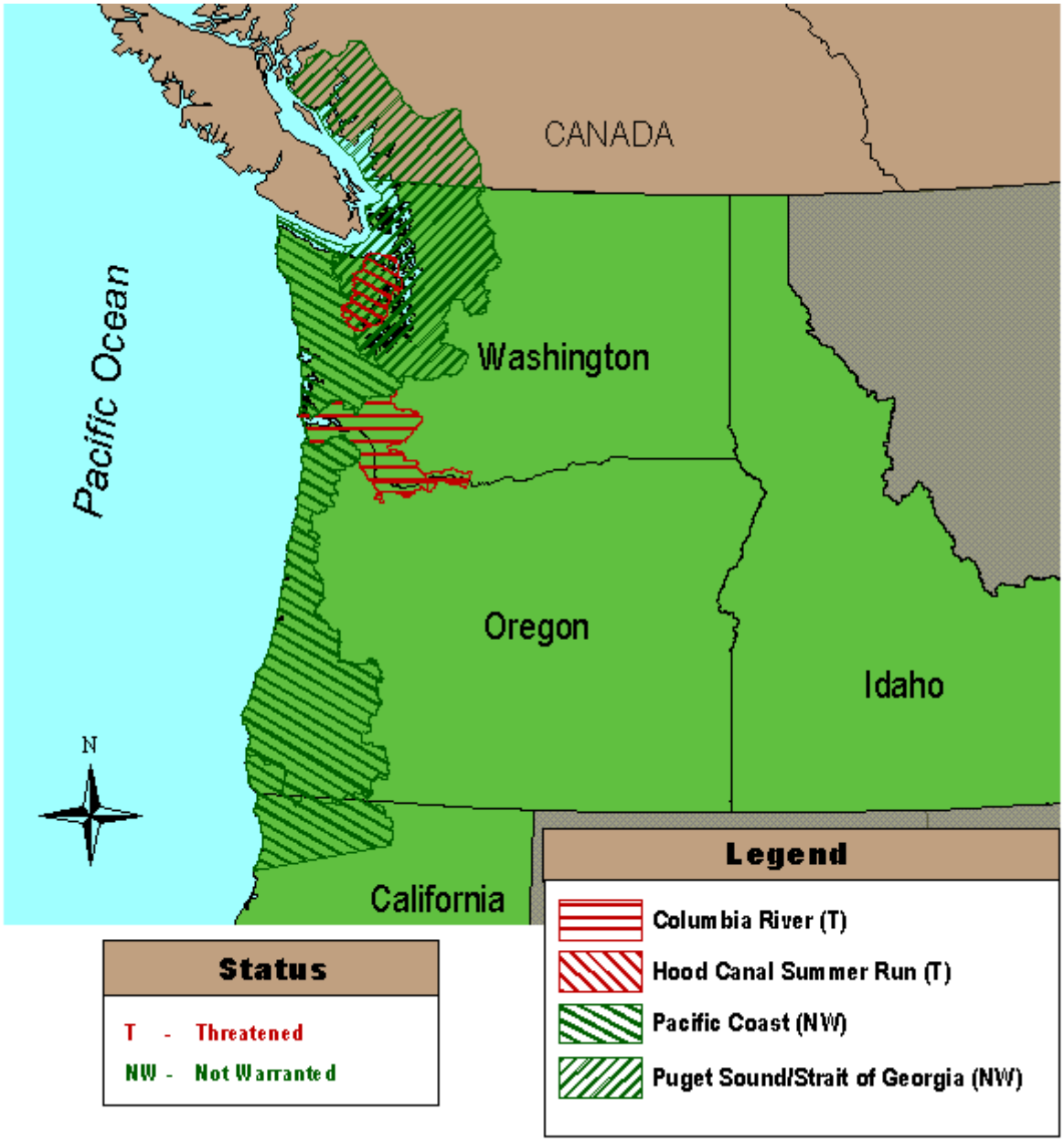
** An Evolutionarily Significant Unit or "ESU" is a distinctive group of Pacific salmon or steelhead.*



ESU Name	Listing Status
Hood Canal Summer-run	Threatened
Columbia River	Threatened
Puget Sound/Strait of Georgia	Not Warranted
Pacific Coast	Not Warranted

CHUM LISTING STATUS MAP

Click on an ESU or legend name below, or on the ESU name in the table provided to view a detailed map in Adobe Acrobat PDF Format. ** An Evolutionarily Significant Unit or "ESU" is a distinctive group of Pacific salmon, steelhead, or sea-run cutthroat trout.*



ESU Name	File Size (PDF)
Columbia River	460 K
Hood Canal Summer-run	264 K
Pacific Coast	698 K
Puget Sound/Strait of Georgia	588 K

- *An Evolutionarily Significant Unit or "ESU" is a distinctive group of Pacific salmon, steelhead, or sea-run cutthroat trout.*
- **********

COHO SALMON

Oncorhynchus kisutch

LISTING STATUS: COHO

Select an ESU name below to view detailed information about each ESU* - including further links to ESU maps, Federal Register Notices, and Status Reviews.

** An Evolutionarily Significant Unit or "ESU" is a distinctive group of Pacific salmon or steelhead.*

ESU Name	Status[1]
Central California	Threatened
Southern Oregon/Northern California Coasts	Threatened
Oregon Coast	Proposed Threatened
Puget Sound/Strait of Georgia	Species of Concern
Lower Columbia River/Southwest Washington	Proposed Threatened
Olympic Peninsula	Not Warranted

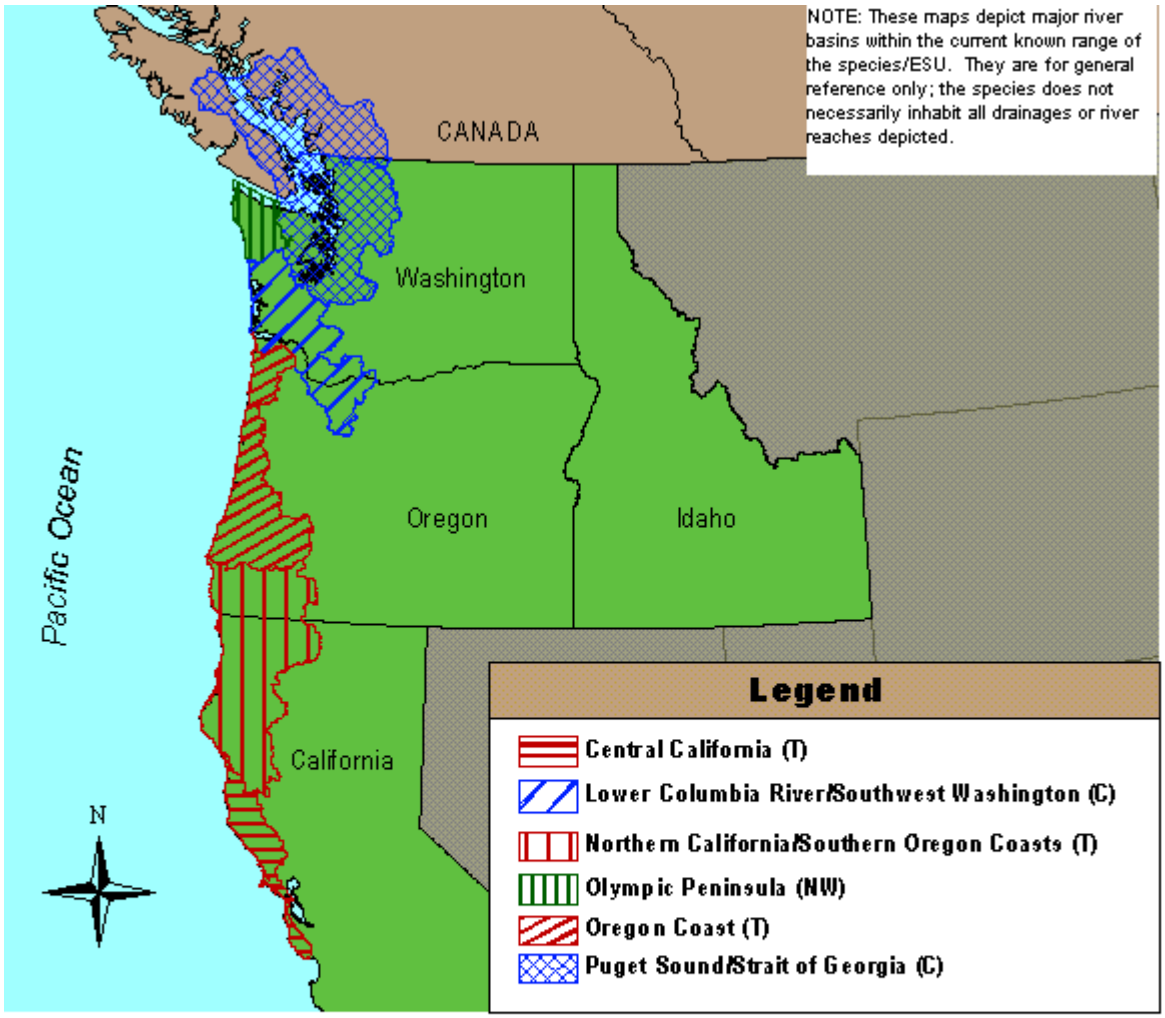
COHO SALMON

Oncorhynchus kisutch

COHO LISTING STATUS MAP

Click on an ESU or legend name below, or on the ESU name in the table provided to view a detailed map in Adobe Acrobat PDF Format.

** An Evolutionarily Significant Unit or "ESU" is a distinctive group of Pacific salmon, steelhead, or sea-run cutthroat trout.*



Status

T - Threatened
C - Candidate
NW - Not Warranted

ESU Name	File Size (PDF)§
Central California	267 K
Lower Columbia River/Southwest Washington	570 K
Northern California/Southern Oregon Coasts	588 K
Olympic Peninsula	367 K
Oregon Coast	514 K
Puget Sound/Strait of Georgia	515 K

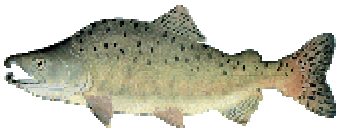
PINK SALMON

Oncorhynchus gorbuscha

LISTING STATUS: PINK

Select a link below to view detailed information about each ESU* (Evolutionarily Significant Unit), including further links to ESU maps, Federal Register Notices, and Status Reviews.

** An Evolutionarily Significant Unit or "ESU" is a distinctive group of Pacific salmon or steelhead.*



ESU Name	Listing Status
Even-Year	Not Warranted
Odd-Year	Not Warranted

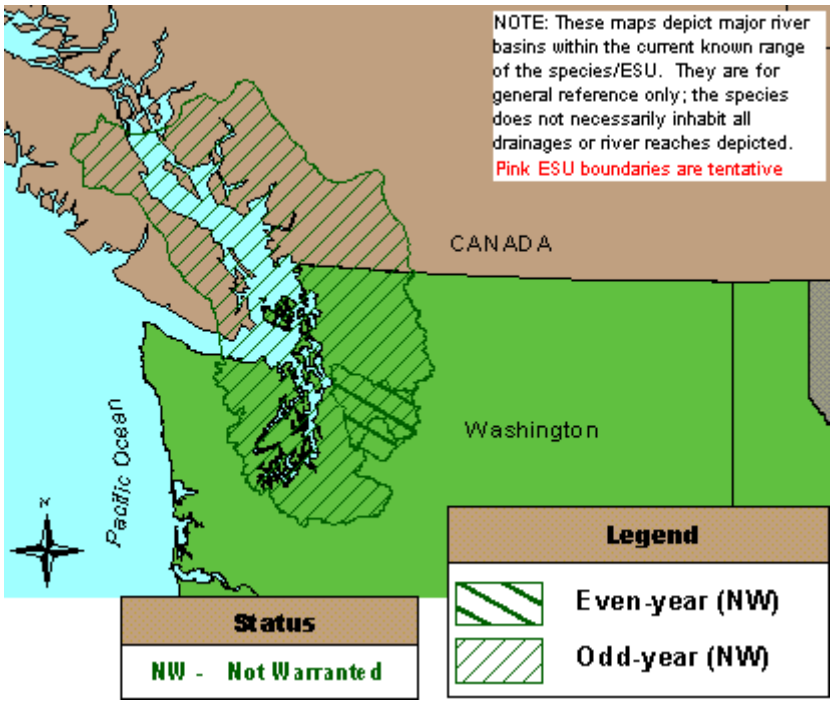
PINK SALMON

Oncorhynchus gorbuscha

PINK LISTING STATUS MAP

Click on an ESU or legend name below, or on the ESU name in the table provided to view a detailed map in Adobe Acrobat PDF Format.

** An Evolutionarily Significant Unit or "ESU" is a distinctive group of Pacific salmon, steelhead, or sea-run cutthroat trout.*



ESU Name	File Size (PDF)
Odd-Year	517 K
Even-Year	284 K

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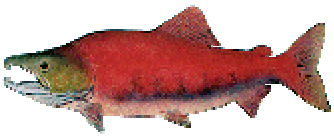
SOCKEYE SALMON

Oncorhynchus nerka

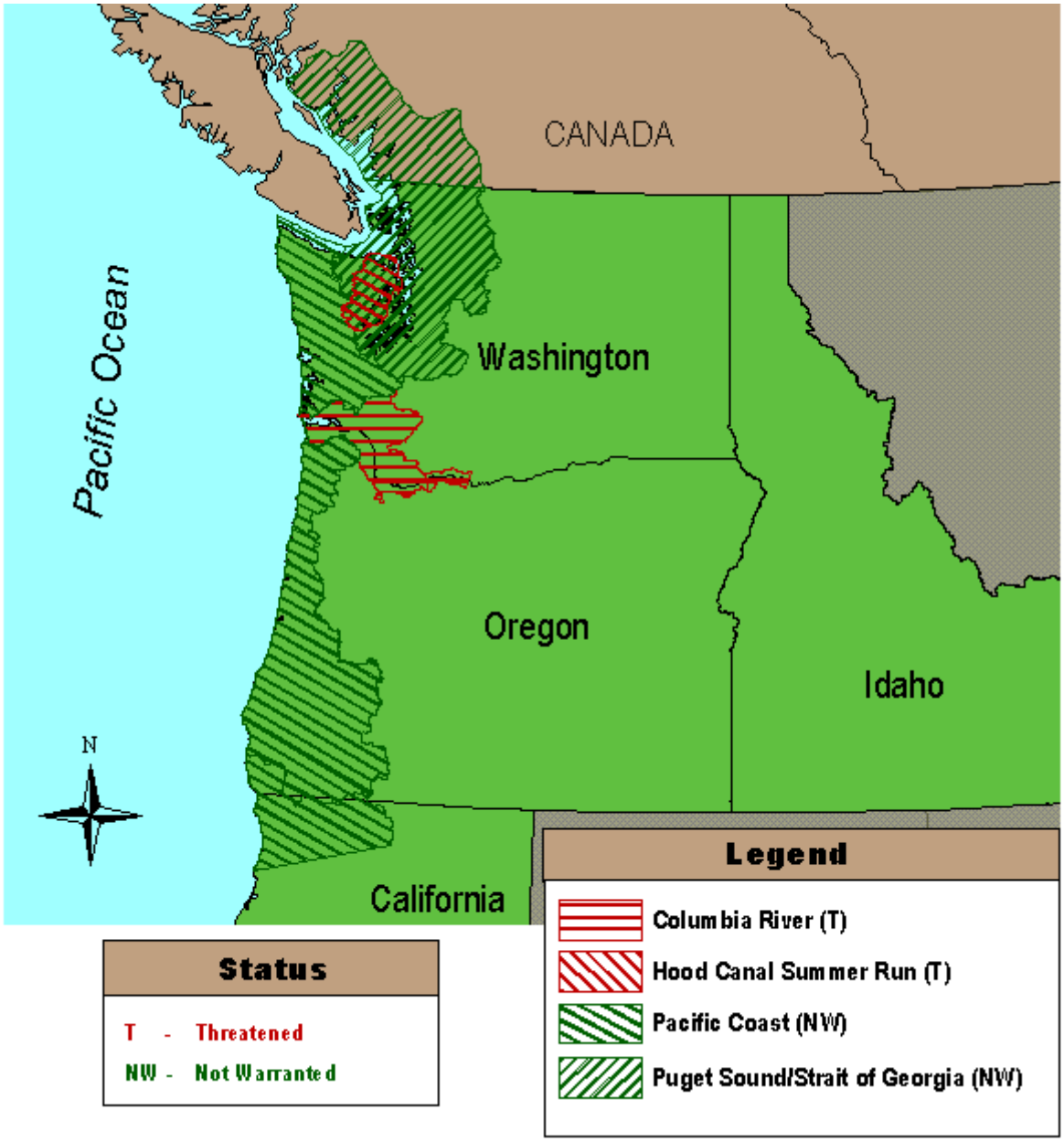
LISTING STATUS: SOCKEYE

Select a link below to view detailed information about each ESU* (Evolutionarily Significant Unit), including further links to ESU maps, Federal Register Notices, and Status Reviews.

** An Evolutionarily Significant Unit or "ESU" is a distinctive group of Pacific salmon or steelhead.*



ESU Name	Listing Status
Ozette Lake	Threatened
Snake River	**Endangered**
Baker River	Not Warranted
Okanogan River	Not Warranted
Lake Wenatchee	Not Warranted
Quinault Lake	Not Warranted
Lake Pleasant	Not Warranted



ESU Name	File Size (PDF)
Columbia River	460 K
Hood Canal Summer-run	264 K
Pacific Coast	698 K
Puget Sound/Strait of Georgia	588 K

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STEELHEAD

Oncorhynchus mykiss

LISTING STATUS: STEELHEAD

Select a link below to view detailed information about each ESU* (Evolutionarily Significant Unit), including further links to ESU maps, Federal Register Notices, and Status Reviews.

** An Evolutionarily Significant Unit or "ESU" is a distinctive group of Pacific salmon or steelhead.*

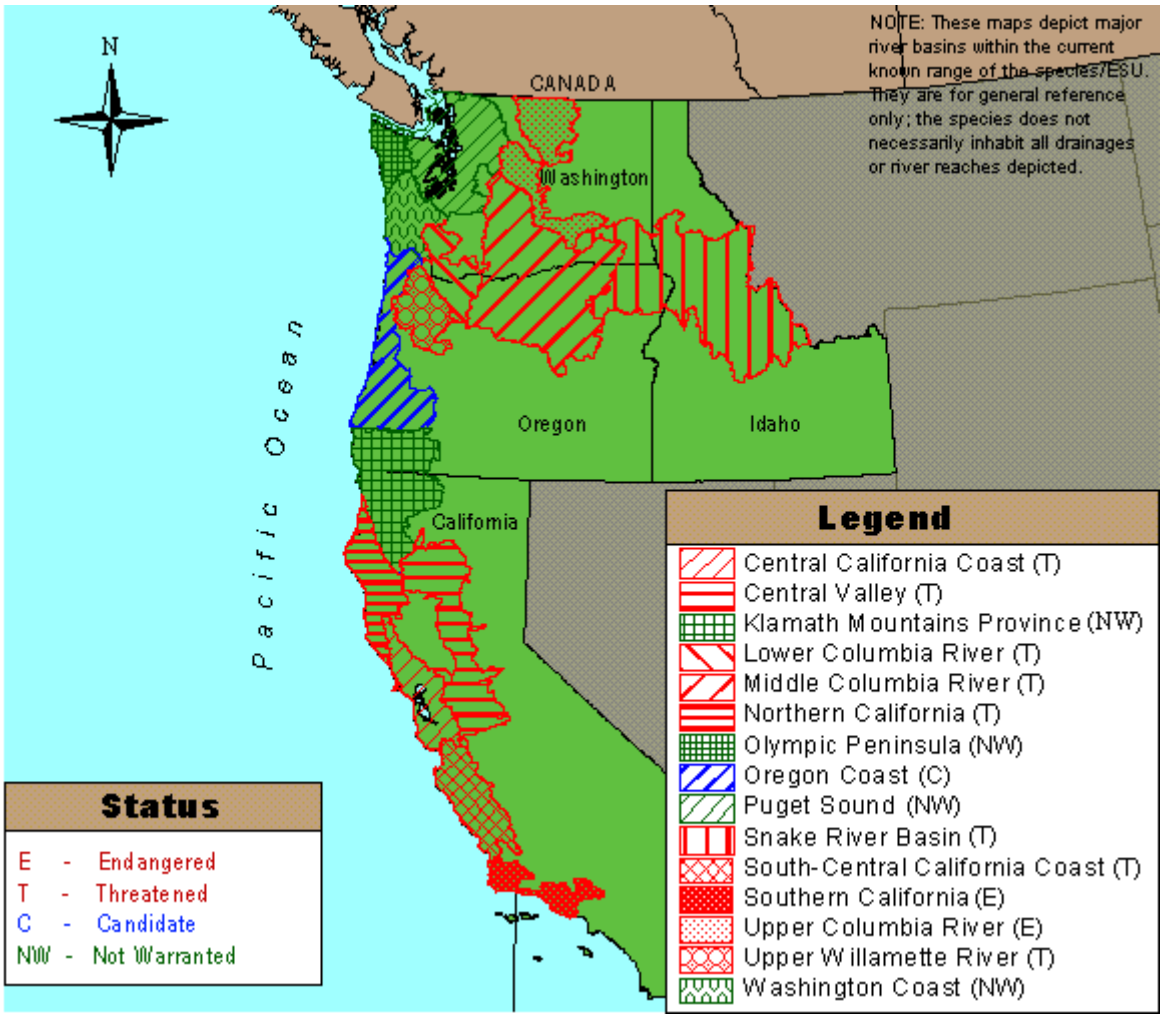
ESU Name	Listing Status[1]
Upper Willamette River	Threatened
Middle Columbia River	Threatened
Southern California	**Endangered**
South-Central California Coast	Threatened
Central California Coast	Threatened
Upper Columbia River	**Endangered**
Snake River Basin	Threatened
Lower Columbia River	Threatened
Central Valley, California	Threatened
Northern California	Threatened
Klamath Mountains Province	Not Warranted
Oregon Coast	Species of Concern
Southwest Washington	Not Warranted
Olympic Peninsula	Not Warranted
Puget Sound	Not Warranted

1 The status of some ESUs may change as a result of status review updates

STEELHEAD LISTING STATUS MAP

Click on an ESU or legend name below, or on the ESU name in the table provided to view a detailed map in Adobe Acrobat PDF Format.

** An Evolutionarily Significant Unit or "ESU" is a distinctive group of Pacific salmon, steelhead, or sea-run cutthroat trout.*



ESU Name	File Size (PDF)
Central California Coast	415 K
Central Valley, California	376 K
Klamath Mountains Province	586 K
Lower Columbia River	446 K
Middle Columbia River	889 K
Northern California	353 K
Olympic Peninsula	398 K
Oregon Coast	710 K
Puget Sound	727 K
Snake River Basin	834 K
South-Central California Coast	353 K
Southern California	260 K
Washington Coast	438 K
Upper Columbia River	575 K
Upper Willamette River	363 K