NPAFC
Doc. 362
Rev. ___

U.S. RESEARCH RESULTS, 1997-1998:
ABSTRACTS FOR THE NPAFC SCIENCE PLAN REVIEW

Compiled by

Katherine W. Myers and Saang-Yoon Hyun
Fisheries Research Institute
University of Washington
Box 357980
Seattle, Washington 98195-7980

submitted to the

NORTH PACIFIC ANADROMOUS FISH COMMISSION

by the

UNITED STATES OF AMERICA

October 1998

THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER:
Myers, K.W., and Hyun, S. 1998. U.S. research results, 1997-1998: abstracts for the NPAFC science plan review. (NPAFC Doc. 322.) Fisheries Research Institute, University of Washington, Seattle, WA. 16 p.

TABLE OF CONTENTS

1. Life History of Salmonids

1.1 Spatial Distribution

1.1.1

TI: NerkaSim: A research and educational tool to emulate the marine life history of Pacific salmon in a dynamic environment
AU: Rand,-P.S.; Scandol,-J.P.; Walter,-E.E.
AF: Dep. Zool., North Carolina State Univ., Raleigh, NC 27695-7617, USA
SO: FISHERIES 1997 vol. 22, no. 10, pp. 6-13
IS: ISSN 0363-2415
PY: 1997
LA: English
LS: English
PT: J (Journal-Article)
ER: M (Marine); F (Freshwater)
AB: This paper introduces NerkaSim, a computer program used to simulate and visualize the life history of Pacific salmon in a dynamic ocean environment. The computer program enables users to (1) archive and visualize biophysical oceanographic data; (2) execute a spatially explicit, individually based Pacific salmon model that can include migration, growth, and mortality processes; and (3) produce images of simulated migration trajectories and bioenergetic variables in both space and time. We anticipate a demand for the model for basic and applied research applications, where it can serve as a platform to explore hypotheses concerning migration, growth, and mortality processes for salmon in coastal and high-seas environments. Although designed to address issues related to British Columbia's Fraser River sockeye salmon (*Oncorhynchus nerka*), the model can easily be customized to accommodate different salmon species across the eastern Pacific Rim. Distributed as freeware, we hope that NerkaSim will become an effective educational tool for advanced undergraduates and graduate students interested in fisheries ecology and oceanography. Here, we provide examples of how the program has been used to advance understanding of migration behavior and habitat quality for salmon in the northeast Pacific Ocean. We also detail of how to obtain more information about NerkaSim and an executable version of the program.

1.2 Growth and Maturity

1.2.1

TI: Postembryonic changes in the structure of the olfactory bulb of the chinook salmon (*Oncorhynchus tshawytscha*) across its life history
AU: Jarrard,-H.E.
AF: Inst. Neurosci., Univ. Oregon, Eugene, OR 97403, USA
SO: BRAIN,-BEHAV.-EVOL. 1997 vol. 49, no. 5, pp. 249-260
IS: ISSN 0006-8977
PY: 1997
LA: English
LS: English

PT: J (Journal-Article)
ER: M (Marine); F (Freshwater)
AB: Juvenile chinook salmon (*Oncorhynchus tshawytscha*) memorize odors characteristic of their natal stream, then use these imprinted olfactory cues to return to that same stream years later as sexually mature adults. In a preliminary effort to identify neuroanatomical changes in the salmon olfactory system that may underlie these behavioral capabilities, the structure of the olfactory bulb (OB) was studied at three developmental periods across the life history: in early juvenile development (0.1-4 months of age), in late juvenile development (11-16 months), and as spawning adults (48 months). Using antibodies that selectively label primary olfactory afferents (anti-keyhole limpet hemocyanin), combined with a thionin counterstain, the telencephalon (TEL), OB, and two of the bulb's laminar components, the olfactory nerve -glomerular layer (ONL-GL) and inner cell layer (ICL), could be easily identified. Laminar organization and relative volume (i.e. percent of OB comprised by ONL-GL or ICL) were then compared across groups, and absolute volumes of the OB, ONL-GL, and ICL were compared to that of the TEL at each stage. Three age-related processes were observed across the life history. First, a rapid increase in organizational and structural maturity of the OB was found to be confined to early juvenile life. Second, an increase in OB, ONL-GL, and ICL volume, relative to TEL volume, was found to occur across the entire life history. Lastly, the composition of the OB itself changed, in that an increase in the relative volume of the ONL -GL, and a decrease in that of the ICL, were observed across the life history. Taken together, these results indicate that the OB of young salmon matures dramatically while the fish is still in the freshwater phase of its life history. Then, during migration to the ocean and growth to the adult stage, the volume of the OB, relative to that of the telencephalon, and the relative volume of the input layer of the bulb, both undergo a marked, continuous increase. These changes in the structure, and presumably the function, of the olfactory bulb of salmon may be important in the behavioral phenomena of olfactory imprinting as juveniles and homing as adults.

1.2.2
TI: The sea-run and the sea
AU: Pearcy,-W.G.
AF: Coll. Oceanic and Atmos. Sci., Oregon State Univ., Corvallis, OR 97331, USA
CO: Symp. on Sea-Run Cutthroat Trout: Biology, Management, and Future Conservation, Reedsport, Oregon (USA), 12-14 Oct 1995
SO: SEA-RUN-CUTTHROAT-TROUT:-BIOLOGY,-MANAGEMENT,-AND-FUTURE -CONSERVATION. Hall,-J.D.;Bisson,-P.A.;Gresswell,-R.E.-eds. CORVALLIS,-OREGON -USA AMERICAN-FISHERIES-SOCIETY,-OREGON-CHAPTER 1997 pp. 29-36
IS: ISBN 0-913235-99-7
RN: LOC: 97-065411 (97065411)
PY: 1997
LA: English
LS: English
PT: B (Book); K (Conference)
ER: M (Marine); B (Brackish)
AB: Our knowledge of the marine life of anadromous coastal cutthroat trout is limited. Smolts and kelts usually migrate to the ocean in the spring and return to fresh water during summer/fall

after only a few months, rarely overwintering at sea. Where the coastline is indented with inlets, such as in Alaska and Puget Sound, sea-run cutthroat trout apparently remain close to shore and do not venture into deep waters. Off the Oregon and Washington coasts, however, fish were caught in purse seines mainly from 10-50 km offshore, from May through August, often in the vicinity of the Columbia River plume. Coastal movements of fish tagged in Oregon-Washington waters were usually to the south, the direction of prevailing currents during the summer. Most fish caught at sea were age 1 or 2, younger than reported in early studies. Marine growth rates off Oregon/Washington averaged about 1.0 mm/day, similar to those of juvenile steelhead. Fishes are the main prey and diets are often similar to those of coho and chinook salmon. Although the residence of coastal cutthroat trout in the ocean and estuaries is brief compared to other anadromous salmonids, it is an important phase in their life history. Unfavorable ocean conditions since 1976 may have resulted in poor ocean/estuarine growth and survival of sea-run cutthroat trout in the southern portion of their range.

1.2.3

TI: Early maturity in amago salmon (*Oncorhynchus masu ishikawai*): An association with energy storage

AU: Silverstein,-J.T.; Shimma,-H.; Ogata,-H.

AF: School Fisheries, University Washington, 355100, Seattle, WA 98195, USA

SO: CAN.-J.-FISH.-AQUAT.-SCI.-J.-CAN.-SCI.-HALIEUT.-AQUAT. 1997 vol. 54, no. 2, pp. 444-451

IS: ISSN 0706-652X

PY: 1997

LA: English

LS: English; French

PT: J (Journal-Article)

ER: M (Marine); F (Freshwater)

AB: Two groups of amago salmon (*Oncorhynchus masu ishikawai*) with large differences in incidence of early maturity were reared in similar environments and periodically sampled beginning 1 week after exogenous feeding commenced in January and ending in June when maturing individuals could be distinguished. Mean weight of fish in the 2 groups did not differ beyond the first month of feeding; the early-maturing group had significantly greater variation in weight, significantly higher triacylglycerol content in the first samples taken, and maintained higher triacylglycerol content throughout the experiment. Fat storage differences are described in early-maturing salmon and in salmon that do not mature early, at a far younger age than has been reported previously. Seasonal trends in energy storage show an overall reduction in fat storage in both groups and some differences in glycogen storage dynamics between the groups in late spring. Results support a previous hypothesis that a size or energy storage threshold must be surpassed for maturation to occur and furthermore suggest that the decision to mature could be made at a very early stage of development.

1.2.4
TI: Sea-run cutthroat trout: life history profile
AU: Trotter,-P.C.
AF: 4926 26th Ave. S., Seattle, WA 98108, USA
CO: Symp. on Sea-Run Cutthroat Trout: Biology, Management, and Future Conservation, Reedsport, Oregon (USA), 12-14 Oct 1995
SO: SEA-RUN-CUTTHROAT-TROUT:-BIOLOGY,-MANAGEMENT,-AND-FUTURE-CONSERVATION. Hall,-J.D.;Bisson,-P.A.;Gresswell,-R.E.-eds. CORVALLIS,-OREGON-USA AMERICAN-FISHERIES-SOCIETY,-OREGON-CHAPTER 1997 pp. 7-15
IS: ISBN 0-913235-99-7
RN: LOC: 97-065411 (97065411)
PY: 1997
LA: English
LS: English
PT: B (Book); K (Conference)
ER: M (Marine); B (Brackish); F (Freshwater)
AB: The coastal cutthroat trout occurs along the Pacific coast of North America from the lower Eel River, California to Prince William Sound, Alaska, in a zone that conforms remarkably closely with the Pacific coast rain forest belt. The sea-run cutthroat trout is the anadromous form of this subspecies. Adults show a preference for small streams, low gradient systems, and the lower-gradient downstream reaches of large river systems, although in some populations adults migrate considerable distances upstream. They spawn in small tributaries from late winter to late spring, depending on the locality. Juveniles rear in streams for two or more years, and, if there are no cohabiting species, are found predominately in pools and other slow-water habitats, especially those with root wads and large wood. Young-of-the-year sea-run cutthroat trout appear to be displaced from pools by young-of-the-year coho salmon and from riffle habitats by juvenile steelhead. Seaward migration of smolts peaks in May. Smolt age 2 is common in populations that migrate to sheltered saltwater areas, smolt age 3 or 4 in populations that migrate to the open ocean. Anadromy does not seem to be strongly developed in coastal cutthroat trout; fish generally remain close inshore or in areas of reduced salinity, as in river plumes, while in salt water. Also, they seldom if ever overwinter in saltwater, but return to streams in the late summer, fall, or winter of the year they go to sea. In some instances, these are overwintering migrations only, because females seldom spawn before age 4. There is evidence that homing to natal streams is precise in fish that will be ready to spawn, but individuals returning to fresh water just to overwinter may not necessarily return to their natal stream. Sea-run cutthroat trout survive spawning rather well and recover their condition quickly. Repeat spawning is not at all uncommon, with some fish returning to spawn three, four, and even five times. Sea-run cutthroat trout may live to an age of 7 or 8 years and reach maximum fork lengths of around 50 cm.

1.3 Feeding Ecology (Diet)

1.3.1
TI: Feeding habits of juvenile Pacific salmon in marine waters of southeastern Alaska and northern British Columbia
AU: Landingham,-J. H.; Sturdevant,-M.V., -Brodeur,-R.D.

AF: Auke Bay Lab., Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., 11305 Glacier Hwy., Juneau, AK 99801, USA
SO: Fishery Bulletin 1998 vol. 96, pp. 285-302
PY: 1998
LA: English
LS: English
PT: J (Journal-Article)
ER: M (Marine)
AB: First ocean-year feeding habits were determined for juvenile salmon (*Oncorhynchus* spp.) collected with purse seines in marine waters of southeastern Alaska in 1983 and 1984 and northern British Columbia in 1984. Associated prey assemblages were sampled with neuston and plankton nets in 1984. Salmon diets included at least 30 taxa of prey. Crustaceans (principally hyperiid amphipods), fish, and tunicates were the most important prey of pink (*O. gorbuscha*), chum (*O. keta*), and sockeye (*O. nerka*) salmon. Fish were the most important prey of coho (*O. kisutch*) and chinook (*O. tshawytscha*) salmon and made up the highest percentage of stomach content weight for all salmon species. Diet shifted from crustaceans in 1983 to fish in 1984 for juvenile pink, sockeye, and chum salmon. Diet overlapped significantly (C>0.60) between pink and sockeye salmon, pink and chum salmon, and chum and sockeye salmon. Coho salmon diet overlap was <0.60 in all pared comparisons. Nearly all (98.6%) of the 2,210 stomachs examined were at least half full. Although, in general, prey consumed were not very similar to prey observed in the environment, the composition of salmon diets was more similar to neuston collections than to zooplankton collections.

2. Population Dynamics

2.1 Abundance, Monitoring, and Forecasting

2.1.1

TI: Time series outlier analysis: Evidence for management and environmental influences on sockeye salmon catches in Alaska and northern British Columbia
AU: Farley,-E.V.,Jr.; Murphy,-J.M.
AF: TAG-Data Flow/Alaska Inc., for Ocean Carrying Capacity Prog. at Auke Bay Lab., Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., 11305 Glacier Hwy., Juneau, AK 99801, USA
SO: ALASKA-FISH.-RES.-BULL. 1997 vol. 4, no. 1, pp. 36-53
PY: 1997
LA: English
LS: English
PT: J (Journal-Article)
ER: M (Marine)
AB: Autoregressive, moving average models were fit and outliers were identified for commercial catches of 9 major sockeye salmon Oncorhyncus nerka stocks in Alaska and northern British Columbia. Distinct patterns in the sample autocorrelation and partial autocorrelation functions indicated stock-specific dynamics. Three types of outliers were considered: level-shift, temporary-change, and additive outliers. Most additive outliers were unexplainable and may represent multiplicative survival at several different life history stages. Additive outliers that could be explained resulted from changes in fishing effort. Temporary-change outliers

commonly reflected cold winter temperatures in western Alaska during the early 1970s. Four of nine river systems in our analysis had level-shift outliers, and only one of these had a positive shift in the late 1970s. The level-shift outliers, which indicate a long-term shift in catch levels, appeared to be the result of changes in escapement policy rather than an abrupt change in the production dynamics of the North Pacific.

2.1.2

TI: Bayesian averaging of generalized linear models for passive integrated transponder tag recoveries from salmonids in the Snake River
AU: Newman,-K.
AF: Div. Stat., Univ. Idaho, Moscow, ID 83844-1104, USA
SO: N.-AM.-J.-FISH.-MANAGE. 1997 vol. 17, no. 2, pp. 362-377
IS: ISSN 0275-5947
PY: 1997
LA: English
LS: English
PT: J (Journal-Article)
ER: M (Marine); F (Freshwater)
AB: Bayesian methods provide a means of explicitly accounting for uncertainty in the choice of model used to interpret fisheries data. The probability of a given model being the correct model conditional on the data, the posterior probability, is a measure of the degree of belief and strength of evidence for the model. Bayesian model averaging uses these posterior probabilities to make weighted inferences, thus providing a solution to the problem of selecting a single model from a group of models that seem nearly equivalent by conventional statistical criteria. The approach is applied to a generalized linear model analysis of survival for juvenile and mature adult spring chinook salmon *Oncorhynchus tshawytscha* and steelhead *Oncorhynchus mykiss* from the Snake River. The fish, tagged as juveniles with passive integrated transponders (PIT), outmigrated from freshwater habitat to the ocean during 1989 -1991, and include some of the first PIT tag recoveries of adult fish. Covariates used to model survival were year of outmigration, rearing type (hatchery or wild), and distance upstream at time of release. The Bayesian approach sometimes yielded simpler models than those selected with Akaike's information criterion, and averaging models by their posterior probabilities smoothed out differences between models in estimated survival rates. All three covariates were important in modeling juvenile survival of spring chinook salmon and steelhead, but not in modeling adult survival (for fish detected as juveniles). For spring chinook salmon, the adult survival rates were a function of rearing type alone, and wild fish had survival rates over seven times higher than hatchery fish. In contrast, juvenile survival rates, as measured from time of tagging to time of detection at a downstream dam, for spring chinook salmon were higher for the hatchery fish than the wild fish, but this is largely because wild fish were tagged in the fall preceeding the spring of emigration and hatchery fish were tagged during that spring. For steelhead, none of the factors had a significant effect on adult survival rates. The failure to identify factors affecting adult survival rates may be because too few fish were tagged and adult recovery rates were low. It will be necessary to increase the number of fish tagged and released if managers want to more precisely measure and compare the relative strengths of effects of such factors on survival to the adult stage. Many outmigrating juvenile salmonids are captured at upstream dams and barged beyond downstream dams. Assuming that most of the

juvenile salmonids detected at upstream dams were barged and that those undetected were not barged, the effect of barging on adult survival rates was estimated as a function of juvenile detection rates. For example, if the juvenile detection rate is 60%, spring chinook salmon adult survival is estimated to be 2.7 times greater for barged fish and 22.1 times greater for steelhead.

2.1.3

TI: Status and trends of anadromous salmonids in the coastal zone with special reference to sea-run cutthroat trout

AU: Williams,-J.E.; Nehlsen,-W.

AF: Bureau Land Manage., 1387 S. Vinnell Way, Boise, ID 83709, USA

CO: Symp. on Sea-Run Cutthroat Trout: Biology, Management, and Future Conservation, Reedsport, Oregon (USA), 12-14 Oct 1995

SO: SEA-RUN-CUTTHROAT-TROUT:-BIOLOGY,-MANAGEMENT,-AND-FUTURE -CONSERVATION. Hall,-J.D.;Bisson,-P.A.;Gresswell,-R.E.-eds. CORVALLIS,-OREGON -USA AMERICAN-FISHERIES-SOCIETY,-OREGON-CHAPTER 1997 pp. 37-42

IS: ISBN 0-913235-99-7

RN: LOC: 97-065411 (97065411)

PY: 1997

LA: English

LS: English

PT: B (Book); K (Conference)

ER: M (Marine); B (Brackish)

AB: The status and trends of anadromous salmonid stocks are influenced by an array of natural and human-caused disturbances and ocean cycles. Declines of anadromous salmonids appear to be greater in the southern latitudes than in the northern portions of the range. In coastal zones of western North America, stocks of coho salmon, steelhead, and sea-run cutthroat trout exhibit widespread losses from the Columbia River basin southward, with lesser problems to the north. Many factors contribute to this trend. Degradation and simplification of freshwater habitats are more extensive from central British Columbia southward than in northern British Columbia and Alaska. Coastal morphology is more complex from Puget Sound northward because of numerous bays and islands, which favor salmonid survival in the ocean. Ocean productivity, which is cyclic north to south along the coast, has been more favorable during recent years off the coasts of British Columbia and Alaska than farther south. In fresh water and estuaries, overharvest and negative interactions with nonnative fishes introduced from hatcheries or other sources also contribute to the declines of anadromous salmonids. It is important to examine all of these factors in the context of dynamic and variable environments that characterize the coastal zones. Dams and hydropower operations, which are often cited as primary factors in the decline of salmon and steelhead, are more of a concern for stocks that use large river systems and are less of a problem for most coastal stocks. Although less well known than other anadromous salmonids, sea-run cutthroat trout are good indicators of the health of coastal watersheds and, as such, deserve more recognition from fishery, resource management, and conservation groups. Better information on the status and trends of sea-run cutthroat trout from throughout its range is essential for improved management of this valuable resource.

2.2 Mortality

2.2.1

TI: Frequency of pinniped-caused scars and wounds on adult spring-summer chinook and sockeye salmon returning to the Columbia River
AU: Fryer,- J.K.
AF: Columbia River Inter-Tribal Fish Commission, 729 Northeast Oregon Street, Portland, Oregon 97232, USA
SO: North American Journal of Fisheries Management 1998 vol. 18, pp. 46-51
PY: 1998
LA: English
LS: English
PT: J (Journal-Article)
ER: M (Marine); F (Freshwater)
AB: At Bonneville Dam (Columbia River, 235 km from the mouth), the percentage of anadromous adult Pacific salmon *Oncorhynchus* spp. with abrasions (scars or wounds) caused by pinnipeds has increased from 2.8% in 1991 to 25.9% in 1996 for sockeye salmon *O. nerka* and from 10.5% in 1991 to as much as 31.8% in 1994 for spring-summer chinook salmon *O. tshawytscha*. Although there was a large increase in the percentage of salmonids with pinniped-caused abrasions between 1991 and 1996, fewer than 3% of the fish were judged to have abrasions sufficiently severe to adversely affect their survival to spawning. Larger, earlier-migrating chinook salmon were more likely to have abrasions than smaller, later-migrating fish. Similar trends were not found for sockeye salmon. Although these results suggest that pinniped predation may be an increasingly serious problem for Columbia basin salmonids, a lack of data that relates abrasions to pinniped-caused mortality makes it impossible to accurately estimate the magnitude of pinniped-caused mortality.

2.2.2

TI: Variability of family size and marine survival in pink salmon (*Oncorhynchus gorbuscha*) has implications for conservation biology and human use
AU: Geiger,-H.J.; Smoker,-W.W.; Zhivotovsky,-L.A.; Gharrett,-A.J.
AF: Division Fisheries, University Alaska-Fairbanks, 11120 Glacier Highway, Juneau, AK 99801, USA
SO: Can.-J.-Fish.-Aquat.-Sci.-J.-Can.-Sci.-Halieut.-Aquat. 1997 vol. 54, no. 11, pp. 2684-2690
IS: ISSN 0706-652X
PY: 1997
LA: English
LS: English; French
PT: J (Journal-Article)
ER: M (Marine)
AB: The short-term dynamics of salmonid populations are directly related to the mean sizes of individual families. The amount of genetic variation maintained in the population is directly related to the variance in sizes of individual families. Both the mean and variance of individual family sizes have important implications for conservation actions and sustainable levels of harvest of salmonid fishes. A context is developed for examining variation in family size,and estimates are provided of mean and variance of family size from five groups of marked pink

salmon (*Oncorhynchus gorbuscha*) released into the north Pacific Ocean. Two important results are presented: 1) a statistically detectable genetic component of marine survival exists in groups with high marine survival and 2) ratios of variance-to-mean family size are linearly related to mean family size over the interval that was observed. Results imply that short-term population increases come from a small fraction of the population's families, that salmon encounter a fluctuating marine environment, and that the most favored phenotype changes from generation to generation. Results also support the widely held view that protecting genetic variation in recovering or exploited salmon populations has important economic benefits.

2.2.3

TI: Salmon fry predation by seabirds near an Alaskan hatchery
AU: Scheel,-D.; Hough,-K.R.
AF: Prince William Sound Science Center, Box 705, Cordova, AK 99574, USA
SO: Mar.-Ecol.-Prog.-Ser. 1997 vol. 150, no. 1-3, pp. 35-48
IS: ISSN 0171-8630
NT: Incl. bibliogr.: 65 refs.
PY: 1997
LA: English
LS: English
PT: J (Journal-Article)
ER: M (Marine)
AB: We estimated the mortality of hatchery-raised pink *Oncorhynchus gorbuscha* and chum *O. keta* salmon fry from seabird predation near a salmon hatchery in Lake Bay, Prince William Sound, Alaska, USA. Field counts of seabirds and observations of feeding rates for plunge -diving seabirds were obtained during salmon fry releases between April and June 1995. Several hundred birds of 7 piscivorous species aggregated in front of the hatchery. Consumption rates were determined from focal-animal sampling and energetic models. For most species, per capita consumption rates based on behavioral data were lower than those calculated from energetic considerations. From energetic models and fry movement rates, we estimated that 2.7 to 5.9 million juvenile salmon (1.1 to 2.4% of released fry) were consumed during the study period. Differences between the energetics models accounted for 64% of this range; assumptions about fry movement rates accounted for the remainder. Gulls recorded during aerial surveys throughout Prince William Sound were significantly associated with spawning herring and hatchery sites, but not with miles of coast with herring spawn present. The correlation of bird aggregations with the presence of these small fish indicates that concentrations of prey fish have an important influence on the distribution of birds at sea during this time of the year. Bird numbers in both boat counts and aerial surveys declined from early May to early June. Taken together, these results indicate that salmon fry just entering the marine environment were not especially susceptible to avian predation. Their vulnerability to predation was apparently buffered by the presence of other attractive food patches within seabird foraging range early in our study period, and by declines in the numbers of seabirds foraging along the shoreline later in the study.

2.3 Stock Interaction

2.3.1

TI: Genetic effects of stock transfers of fish
AU: Waples,-R.S.
AF: National Marine Fisheries Service, Northwest Fisheries Science Center Coastal Zone and Estuarine Studies Division, Seattle, Washington, USA
CO: World Fisheries Congress, Theme 3: Protection of Aquatic Biodiversity, ,
SO: PROTECTION-OF-AQUATIC-BIODIVERSITY.-PROCEEDINGS-OF-THE-WORLD -FISHERIES-CONGRESS,-THEME-3. Philipp,-D.P.;Epifanio,-J.M.;Marsden,-J.E.;Claussen, -J.E.-eds. SCIENCE-PUBLISHERS,-INC. pp. 51-69
NT: AIC: QH75.A1W672.1992
LA: English
PT: B (Book); K (Conference)
AB: Genetic variation can be partitioned into differences between individuals within populations, differences between populations within species, and differences between species or higher taxa. Although species-level differences have received the most attention with respect to biodiversity, the hierarchical levels are not independent. For example, just as population viability depends on maintaining genetic variation among individuals, so too may the long -term viability of a species depend on conserving multiple, semi-independent populations (or stocks). In addition to contributing to the erosion of between-population genetic diversity, stock transfers may lead to reduced population fitness through outbreeding depression. These risks are discussed with examples involving freshwater and anadromous fishes in North America. Studies of largemouth bass *Micropterus salmoides* provide perhaps the clearest evidence of the negative effects of stock transfers on the fitness of local populations. Furthermore, genetic markers used in these studies demonstrate substantial introgression of foreign genes into local populations, indicating that the effects of stock transfers may be long lasting, if not permanent. In Pacific salmon (*Oncorhynchus* spp.), local populations exhibit considerable diversity in life history traits such as age structure; ocean migration patterns; and time of spawning, emergence, and outmigration. This diversity can be expected to buffer total productivity for the species against periodic or unpredictable changes in the environment. Extensive stock transfers, involving the exchange of eggs among hatcheries and intentional or unintentional release of hatchery fish into the wild, have contributed to a decline in between -population genetic diversity in these species.

2.4 Stock Identification

2.4.1

TI: Mitochondrial DNA restriction site variation within and among five populations of Alaskan coho salmon (*Oncorhynchus kisutch*)
AU: Carney,-B.L.; Gray,-A.K.; Gharrett,-A.J.
AF: Division Fisheries, University Alaska Fairbanks, Juneau, AK 99801, USA
SO: CAN.-J.-FISH.-AQUAT.-SCI.-J.-CAN.-SCI.-HALIEUT.-AQUAT. 1997 vol. 54, no. 4, pp. 940-949
IS: ISSN 0706-652X
PY: 1997
LA: English
LS: English; French

PT: J (Journal-Article)
ER: M (Marine)
AB: Mitochondrial DNA from 3 Gulf of Alaska and 2 Bering Sea populations of coho salmon (*Oncorhynchus kisutch*) was assayed with 221 restriction endonucleases. A restriction site map was constructed for 15 enzymes that recognized hexanucleotide sequences and aligned to the rainbow trout (*O.mykiss*) gene map using the restriction map and known coho salmon sequences. The restriction site map and gene order of the coho salmon mtDNA genome are consistent with those of rainbow trout. Variation was observed for 6 enzymes at 10 sites that resulted in eight haplotypes. Variability and divergence observed exceeded those previously observed for allozyme loci in coho salmon. When variability that occurred only in single individuals was eliminated, two haplotypes that differed by four restriction sites remained. Variation at these sites was confirmed from polymerase chain reactions(PCR) amplified fragments. Bering Sea populations exhibited more variation than Gulf of Alaska populations. Explanations for the differences include more recent colonization by or smaller sizes of Gulf of Alaska populations.

2.4.2
TI: Incidence of thermally marked pink and chum salmon in the coastal waters of the Gulf of Alaska
AU: Farley,-E.V.,Jr.; Munk,-K.
AF: Auke Bay Lab., Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., 11305 Glacier Hwy, Juneau, AK 99801, USA
SO: ALASKA-FISH.-RES.-BULL. 1997 vol. 4, no. 2, pp. 181-187
PY: 1997
LA: English
LS: English
PT: J (Journal-Article)
ER: M (Marine)
AB: A Gulf of Alaska research cruise during July and August 1996 provided ocean recoveries of 698 juvenile pink *Oncorhynchus gorbuscha* and 350 chum *O. keta* salmon thermally marked during incubation at Alaskan and Canadian hatcheries. We obtained the recoveries from 2,343 pink and 1,695 chum salmon examined for thermal marks. The marked salmon migrated westerly; those released from southeastern Alaska hatcheries were caught as far west as Cape Puget and Cape Hinchinbrook, whereas pink salmon released from Prince William Sound hatcheries were found as far west as Mitrofania Island. Our results indicate that a modest research sampling program can collect sufficient numbers of thermally marked salmon for detailed studies of the growth and development of individual salmon stocks.

2.4.3

TI: X-ray spectroscopic elemental analysis of sockeye salmon (*Oncorhynchus nerka*) otoliths at different life history stages as a potential stock identification tool

AU: Ianelli,-J.N.

CO: Int. Symp. on Skeletal Microanalysis of Marine Fish Stocks, Hobart, Tasmania (Australia), 2-6 Mar 1992

SO: PROCEEDINGS-OF-THE-INTERNATIONAL-SYMPOSIUM-ON-SKELETAL -MICROANALYSIS-OF-MARINE-FISH-STOCKS. Thresher,-R.E.;Mills,-D.J.;Proctor, -C.H.;Ianelli,-J.N.-eds. 1997 no. 230 pp. 74-77

IS: ISBN 0-643-06151-7, ISSN 0725-4598

ST: Report-CSIRO-Marine-Laboratories no. 230

PY: 1997

LA: English

PT: B (Book); K (Conference)

AB: Elemental analysis on different zones of cross sectioned otoliths was shown to aid in stock identification applications to sockeye salmon (*Oncorhynchus nerka*). Previous studies on stock identification using analysis of elemental concentrations have used whole otoliths or other hard part tissue such as vertebrae. For the elements investigated, strontium concentrations varied most across the surface of the otolith, particularly between zones corresponding to early (freshwater) and maturing (seawater) life history stages. Comparisons between using an electron microprobe with energy dispersive spectrometer (EDS) and wavelength dispersive spectrometer (WDS) showed that the EDS could detect changes in absolute elemental concentrations found in otoliths. Detection accuracy on the EDS system was highest for Sr and Na. In all cases, the WDS microprobe appeared to resolve the concentrations to a higher level of accuracy than the EDS system. The x-ray energy spectra generated by an EDS system, while not being ideal for resolving absolute elemental concentrations, may still provide useful information to evaluate a mixed stock fishery problem. To test this possibility, nominal element concentrations were used as surrogates for the energy spectra generated from each otolith sample. Some of the "nominal" elements used may have been present in concentrations less than the minimum detection limit of the EDS, consequently, their values may reflect matrix effects. This information, was evaluated as an added means to discriminate among stocks. Problems with spectral artefacts such as peak broadening, peak distortion, silicon escape peaks, and the silicon internal fluorescence peak were avoided by randomizing the samples within the electron probe stage for the populations analysed.

2.4.4

TI: Origins of chum salmon caught incidentally in the eastern Bering Sea walleye pollock trawl fishery as estimated from scale pattern analysis

AU: Patton,-W.S.,-K.W. Myers, -R.V. Walker

AF: University of Washington, School of Fisheries, Fisheries Research Institute, Box 357980, Seattle, Washington, 98195-7980 USA

SO: North American Journal of Fisheries Management. 1998 vol. 18 pp. 704-711
940-949

PY: 1998

LA: English

LS: English; French
PT: J (Journal-Article)
ER: M (Marine)
AB: Approximately 74,500 chum salmon *Oncorhynchus keta* were intercepted in the 1994 U.S. walleye pollock (*Theragra chalcogramma*) B-season fishery in the eastern Bering Sea and Aleutian Islands. Using scale pattern analysis, we estimated the stock composition of age-0.3 chum salmon (fish that had spent three winters in the ocean) from this incidental catch. A conditional maximum-likelihood discrimination model, assessed through a series of simulation runs using hypothetical stock mixtures, was 83.3-92.3% accurate. Our fleet-wide, unstratified proportion estimates closely resembled the results of a concurrent stock composition study based on allelic frequencies of the 1994 chum salmon bycatch. Interception estimates weighted by time, which depend on the accuracy of National Marine Fisheries Service week-stratified bycatch estimates, indicated that about 50% of the incidentally-caught chum salmon originated from Asia (Russia and Japan), 18% from western and central Alaska, and 32% from southeast Alaska, British Columbia, and Washington. The western and central Alaskan proportion increased over the course of the B-season fishery, although the numbers intercepted remained stable. A comparison of our regional interception estimates with estimated run sizes indicates that bycatch in the 1994 B-season walleye pollock fishery did not greatly affect returns to western Alaskan chum salmon fisheries.

2.4.5
TI: Genetic population structure of coastal cutthroat trout
AU: Williams,-T.H.; Currens,-K.P.; Ward,-N.E.,III; Reeves,-G.H.
AF: Dep. Fish. and Wildl., Oregon State Univ., Corvallis, OR 97331, USA
CO: Symp. on Sea-Run Cutthroat Trout: Biology, Management, and Future Conservation, Reedsport, Oregon (USA), 12-14 Oct 1995
SO: SEA-RUN-CUTTHROAT-TROUT:-BIOLOGY,-MANAGEMENT,-AND-FUTURE-CONSERVATION. Hall,-J.D.;Bisson,-P.A.;Gresswell,-R.E.-eds. CORVALLIS,-OREGON-USA AMERICAN-FISHERIES-SOCIETY,-OREGON-CHAPTER 1997 pp. 16-17
IS: ISBN 0-913235-99-7
RN: LOC: 97-065411 (97065411)
PY: 1997
AB: no abstract

3. Salmon Habitat and Ecosystem

3.1 Physical-biological Interaction and Productivity

3.1.1
TI: Effects of interdecadal climate variability on the oceanic ecosystems of the NE Pacific
AU: Francis,-R.C.; Hare,-S.R.; Hollowed,-A.B.; Wooster,-W.S.
AF: School of Fisheries, Box 357980, University of Washington, Seattle, WA 98195, USA
SO: Fish. Oceanogr. 1998 vol. 7, no. 1, pp. 1-21
PY: 1998
LA: English
LS: English
PT: J (Journal-Article)

ER: M (Marine)
AB: A major reorganization of the North-east Pacific biota transpired following a climatic 'regime shift' in the mid 1970s. In this paper, we characterize the effects of interdecadal climate forcing on the oceanic ecosystems of the NE Pacific Ocean. We consider the concept of scale in terms of both time and space within the north Pacific ecosystem and develop a conceptual model to illustrate how climate variability is linked to ecosystem change. Next we describe a number of recent studies relating climate to marine ecosystem dynamics in the NE Pacific Ocean. These studies have focused on most major components of marine ecosystems – primary and secondary producers, forage species, and several levels of predators. They have been undertaken at different time and space scales. However, taken together, they reveal a more coherent picture of how decadal-scale climate forcing may affect the large oceanic ecosystems of the NE Pacific. Finally, we synthesize the insight gained from interpreting these studies. Several general conclusions can be drawn. 1. There are large-scale, low-frequency, and sometimes very rapid changes in the distribution of atmospheric pressure over the North Pacific which are, in turn, reflected in ocean properties and circulation. 2. Oceanic ecosystems respond on similar time and space scales to variations in physical conditions. 3. Linkages between the atmosphere/ocean physics and biological responses are often different across time and space scales. 4. While the cases presented here demonstrate oceanic ecosystem response to climate forcing, they provide only hints of the mechanisms of interaction. 5. A model whereby ecosystem response to specified climate variation can be successfully predicted will be difficult to achieve because of scale mismatches and nonlinearities in the atmosphere-ocean-biosphere system.

3.2 Climate Change Effects

3.2.1

TI: Climate-ocean variability and ecosystem response in the northeast Pacific
AU: McGowan,-J.A.; Cayan,-D.R.; Dorman,-L.M.
AF: Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA 92093
SO: Science, 10 July 1998, Vol. 281
PY: 1998
LA: English
LS: English
PT: J (Journal-Article)
ER: M (Marine)
AB: The role of climatic variation in regulating marine populations and communities is not well understood. To improve our knowledge, the sign, amplitude, and frequency of climatic and biotic variations should be compared as a necessary first step. It is shown that there have been large interannual and interdecadal sea-surface temperature changes off the West Coast of North America during the past 80 years. Interannual anomalies appear and disappear rather suddenly and synchronously along the entire coastline. The frequency of warm events has increased since 1977. Although extensive, serial, biological observations are often incomplete, it is clear that climate-ocean variations have disturbed and changed our coastal ecosystems.

3.2.2

TI: Effects of climate change on inland waters of the Pacific coastal mountains and western Great Basin of North America

AU: Melack,-J.M.; Dozier,-J.; Goldman,-C.R.; Greenland,-D.; Milner,-A.M.; Naiman,-R.J.

AF: Dep. Ecol., Evolution and Mar. Biol., and Inst. for Computational Earth System Sci., Univ. California, Santa Barbara, CA 93106, USA

CO: Symp. on Regional Assessment of Freshwater Ecosystems and Climate Change in North America, Leesburg, VA (USA), 24-26 Oct 1994

SO: SPECIAL-ISSUE:-FRESHWATER-ECOSYSTEMS-AND-CLIMATE-CHANGE. Cushing, -C.E.-ed. JOHN-WILEY-and-SONS 1997 vol. 11, no. 8 pp. 971-992

IS: ISSN 0885-6087

ST: Hydrological-Processes vol. 11, no. 8

PY: 1997

LA: English

LS: English

PT: B (Book); K (Conference)

ER: F (Freshwater)

AB: The region designated as the Pacific Coastal Mountains and Western Great Basin extends from southern Alaska (64 degree N) to southern California (34 degree N) and ranges in altitude from sea level to 6200 m. Orographic effects combine with moisture-laden frontal systems originating in the Pacific Ocean to produce areas of very high precipitation on western slopes and dry basins of internal drainage on eastern flanks of the mountains. In the southern half of the region most of the runoff occurs during winter or spring, while in the northern part most occurs in summer, especially in glaciated basins. Analyses of long-term climatic and hydrological records, combined with palaeoclimatic reconstructions and simulations of future climates, are used as the basis for likely scenarios of climatic variations. The predicted hydrological response in northern California to a climate with doubled CO_2 and higher temperatures is a decrease in the amount of precipitation falling as snow, and substantially increased runoff during winter and less in late spring and summer. One consequence of the predicted earlier runoff is higher salinity in summer and autumn in San Francisco Bay. In saline lakes, the incidence of meromixis and the associated reduction in nutrient supply and algal abundance is expected to vary significantly as runoff fluctuates. In subalpine lakes, global warming will probably lead to increased productivity. Lacustrine productivity can also be altered by changes in wind regimes, drought-enhanced forest fires and maximal or minimal snowpacks associated with atmospheric anomalies such as El Nino-Southern Oscillation (ENSO) events. Reduced stream temperature from increased contributions of glacial meltwater and decreased channel stability from changed runoff patterns and altered sediment loads has the potential to reduce the diversity of zoobenthic communities in predominately glacier-fed rivers. Climatic warming is likely to result in reduced growth and survival of sockeye salmon in freshwater, which would, in turn, increase marine mortality. Further research activities should include expanded studies at high elevations and of glacier mass balances and glacial runoff, applications of remote sensing to monitor changes, further refinement of regional climatic models to improve forecasts of future conditions and continued analyses of long-term physical, chemical and biological data to help understand responses to future climates.

3.2.3
TI: Year-to-year variations in Bering Sea ice cover and some consequences for fish distributions
AU: Wyllie-Echeverria, -T., -W.S. Wooster
AF: Pacific Marine Environmental Laboratory, Seattle, Washington, USA 98115
SO: Fish. Oceanogr. 1998 vol. 7, no. 2, pp. 159-170
PY: 1998
LA: English
LS: English
PT: J (Journal-Article)
ER: M (Marine)
AB: The southernmost extension of winter ice cover varies interannually and on longer time scales, reflecting large-scale changes in driving forces, especially in the position and intensity of the winter Aleutian Low Pressure System. A conspicuous pattern is alternating warm and cool periods of several years' duration. These variations in sea ice cover are reflected in the character of a subsurface cold pool, formed as stratification isolates the deeper cold waters from surface exchanges. The cold pool is better developed and more extensive in summers that follow deep southward penetration of winter sea ice. Interannual and decadal-scale variations in the distributions of some fish stocks reflect those of ice and thermal conditions. In particular, the distribution of walleye pollock, *Theragra chalcogramma*, varies significantly with multiannual cool and warm years while Arctic cod, *Boreogadus saida*, is only present within the cold pool. The relation among climate variations, sea ice cover, subsurface thermal conditions, and fish distribution provides information on how climate affects marine ecosystems and may also have practical application in predicting fish distributions.

3.3 Regime Effects (Temporal and Spatial)

3.3.1
TI: A Pacific interdecadal climate oscillation with impacts on salmon production
AU: Mantua,-N.J.; Hare,-S.R.; Zhang,-Y.; Wallace,-J.M.; Francis,-R.C.
AF: Joint Inst. for Study Atmos. and Oceans, Univ. Washington, Box 354235, Seattle, WA 98195-4235, USA
SO: BULL.-AM.-METEOROL.-SOC. 1997 vol. 78, no. 6, pp. 1069-1080
PY: 1997
LA: English
LS: English
PT: J (Journal-Article)
ER: M (Marine)
AB: Evidence gleaned from the instrumental record of climate data identifies a robust, recurring pattern of ocean-atmosphere climate variability centered over the midlatitude North Pacific basin. Over the past century, the amplitude of this climate pattern has varied irregularly at interannual-to-interdecadal time scales. There is evidence of reversals in the prevailing polarity of the oscillation occurring around 1925, 1947, and 1977; the last two reversals correspond to dramatic shifts in salmon production regimes in the North Pacific Ocean. This climate pattern also affects coastal sea and continental surface air temperatures, as well as stream flow in major west coast river systems, from Alaska to California.