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Proceedings of the 1992 Western Groundfish Conference

June 1992

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PROCEEDINGS OF THE 1992 WESTERN GROUNDFISH CONFERENCE

Alderbrook Inn Resort
Union, Washington
27-30 January 1992

Compiled by
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June 1992

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ACKNOWLEDGMENTS

We were pleased with the near overwhelming response to our call for papers and commend the authors on their presentations. Special thanks go to those researchers who were able to change their presentations into posters in order to accommodate our scheduling needs. We appreciate the support given by the Alaska Fisheries Science Center (AFSC) and its Resource Assessment and Conservation Engineering Division, the Washington Department of Fisheries Marine Fish and Shellfish Program, and the University of Washington's School of Fisheries. In particular, we are grateful to the AFSC for publishing and distributing these proceedings. Several individuals, Antonio Comas-Perez, Susanne Finckh, Dewayne Fox, Jim Ianelli, Murdock McAllister, Dan Nichol, Martha Rickey, Frank Shaw, and John Wallace donated their time to help with transportation, registration, and visual aides and many of us for the first time consumed grenadier supplied by Mike Hosie. We would also like thank our moderators for their fine work in helping us keep to our schedule. Finally, all of you who attended but did not present...your presence was appreciated and contributed to the success of the conference.

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INTRODUCTION

The Western Groundfish Conference was established in 1981 to provide researchers with the opportunity to discuss and present recently published work as well as research in progress relating to groundfish biology, ecology, economy, management, and other general topics. Participants have primarily been affiliated with, but not limited to, universities or state, federal, and international agencies from the United States and Canada. These conferences are typically held biannually.

Following are the agenda, abstracts (submitted by author), and a list of attendees from the sixth Western Groundfish Conference held 27-30 January 1992 at Alderbrook Inn Resort, Union, Washington. In all, 152 attendees were present to hear a total of 69 presentations and see 16 posters. Presentations were limited to 15 minutes and in most cases, were given by the first author, but occassionally a second author (boldfaced) made the presentation. Authors' affiliations have been abbreviated in the 1992 agenda as follows:

ADFG	Alaska Department of Fish and Game
AFSC	Alaska Fisheries Science Center, National Marine Fisheries Service
MLML	Moss Landing Marine Lab
MBARI	Monterey Bay Aquarium Research Institute
NEFSC	Northeast Fisheries Science Center, National Marine Fisheries Service
NURC	National Undersea Research Center
ODFW	Oregon Department of Fish and Wildlife
OSU	Oregon State University
PBS	Pacific Biological Station, Department of Fisheries and Oceans, Canada
SEFSC	Southeast Fisheries Science Center, National Marine Fisheries Service
SIO	Scripps Institution of Oceanography
SWFSC	Southwest Fisheries Science Center, National Marine Fisheries Service
UA	University of Alaska
UW	University of Washington
WDF	Washington Department of Fisheries
WSG	Washington Sea Grant

In addition to the 1992 program, the agendas from previous conferences were included in an appendix for historical record.

A special session on a topic of particular interest in fisheries has often been scheduled. In 1992, presentations on submersibles and Remotely Operated Vehicles (ROV) entitled In Situ Technology in Fisheries Research was arranged for and chaired by Dr. Waldo Wakefield of NOAA's National Undersea Research Program (University of Alaska, Fairbanks).

The next Western Groundfish Conference has currently been scheduled for 17-20 January 1994 and will be held in Nanaimo, British Columbia. Persons interested in being placed on the Western Groundfish Conference mailing list or desiring more information regarding the 1994 Conference should write to

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1992 WESTERN GROUNDFISH CONFERENCE
ALDERBROOK INN RESORT
JANUARY 27-30

AGENDA

Registration - 3:00 - 6:00 p.m, Lobby

Welcoming - 6:15 p.m., Suite 220

Registration - 7:00 - 8:00 a.m, Eastwood

Opening Remarks - 8:00 a.m., Ken Weinberg (AFSC), Eastwood

MANAGEMENT AND STOCK ASSESSMENT
Tuesday 8:15 a.m. - 12:00 p.m.

Moderators: Bill Lenarz (SWFSC), Rick Methot (AFSC)

1. Schmitt, Cyreis (WDF). Puget Sound groundfish: A question of dollars and sense.
2. Cailliet, Gregor (MLML). The use of demographic analyses in managing two California shark fisheries.
3. Sampson, David B. (OSU). The assumption of constant fishing selectivity and the stock assessment for widow rockfish.
4. Honkalehto, Taina (AFSC). Diel movements of pollock on the Bering Sea shelf and implications for abundance assessment.
5. Stark, Jim (AFSC). The 1990 National Marine Fisheries Service Gulf of Alaska rockfish resource assessment survey results.
6. Overholtz, William J. (NEFSC). A comparison of harvesting strategies for the Northwest Atlantic mackerel stock under conditions of variable recruitment and density dependence.
7. Thompson, Grant G. (AFSC). The relative conservatism of alternative stock-recruitment relationships as used in the delay-difference model.
8. Ianelli, James N. and Daniel H. Ito (AFSC). Stock assessment of POP (*Sebastes alutus*) using an explicit age structured model.
9. Ralston, Steven and James R. Bence (SWFSC). Estimating the spawning biomass of *Sebastes jordani* from larval production.
10. Ito, Daniel H. (AFSC). Stock assessment working plan for rockfish stocks in waters off Alaska.
11. Lowe, Sandra A. (AFSC). The Atka mackerel resource of the Aleutian Islands.

GEAR RESEARCH / LIFE HISTORY: GROWTH, MORTALITY, REPRODUCTION
Tuesday 1:15 - 5:30 p.m.

Moderators: Rick Stanley (PBS), Bill Barss (ODFW)

1. Somerton, David (AFSC). Stock assessment using hook timers.
2. Sigler, Michael (AFSC). On the odds of catching fish with longline gear.

3. Pikitch, Ellen, K., **D. L. Erickson**, J. R. Wallace, J. A. Perez Comas, and J. R. Skalski (UW). Short-term effects of changes in codend mesh size and shape on the West coast groundfish trawl fishery.

4. Donnelly, Robert and Robert Burr (UW). The effect of velocity on the catch of small research trawls.

5. Nunnallee, Edmund P. (AFSC). An investigation of the avoidance reactions of Pacific whiting (*Merluccius productus*) to demersal and midwater trawl gear.

6. Melvin, Edward F. and Steven A. Osborn (WSG, MLML). Techniques and gear for the emerging Pacific hagfish fishery.

7. Barss, William H. (ODFW). Pacific and black hagfish: Fishery and sampling highlights from Oregon.

8. Hosie, Michael J. and David L. Stein (ODFW, OSU). The fishery and reproductive biology of Pacific grenadier, *Coryphaenoides acrolepis*, off southern Oregon and northern California.

9. Heifetz, Jonathan (AFSC). Growth and mortality of northern and dusky rockfish in the northeast Pacific.

10. Adams, Peter B. and **Daniel F. Howard** (SWFSC). Natural mortality of blue rockfish (*Sebastes mystinus*) during their first year in nearshore benthic habitats.

11. Norton, Elizabeth C. and R. Bruce MacFarlane (SWFSC). Tissue composition and energy content dynamics during the annual reproductive cycle in yellowtail rockfish (*Sebastes flavidus*).

12. Bowers, Michael and R. Bruce MacFarlane (SWFSC). Corpora atretica: A brief review of its significance and initial analysis of occurrence in yellowtail rockfish (*Sebastes flavidus*).

13. Norcross, Brenda L. (UA). Nearshore ecology of juvenile flatfish off Kodiak, Alaska.

14. Donohoe, Christopher J. (OSU). Distribution, abundance, food habits, age and growth of early juvenile white seabass (*Atractoscion nobilis*) off San Diego County, California.

Business meeting - 5:40 p.m., Eastwood

Banquet - 7:00 p.m., Waterwheel

TAGGING and STOCK IDENTIFICATION / FISHERIES CATCH ANALYSIS
Wednesday, 8:00 a.m. - 12:00 p.m.

Moderators: Victoria O'Connell (ADFG), Don Gunderson (UW)

1. Yamanaka, Kae Lynn (PBS). Lingcod transplant experiment.

2. McGauley, Kathleen and Timothy J. Mulligan (Humboldt State U). An application of polymerase chain reaction: Examination of yellowtail rockfish (*Sebastes flavidus*) mitochondrial DNA.

3. Stanley, Richard D., Jack V. Tagart, Bruce M. Leaman, Lew Haldorson, and Victoria M. O'Connell (PBS, WDF, UA, ADFG). Stock delineation of adult yellowtail rockfish (*Sebastes flavidus*) as indicated from tagging, parasite, and genetic studies.

4. Lenarz, William H. and Franklin R. Shaw (SWFSC, AFSC). Some factors that influence the recapture rate of tagged sablefish.

5. Rogers, Jean B. (SWFSC). Numerical definition of assemblages of groundfish caught off the coasts of Oregon and Washington and the commercial fishing strategies used to catch them.

6. Wallace, John R., Ellen K. Pikitch, and John R. Skalski (UW). Insights into analysis of codend mesh size and type data from the Pacific groundfish fishery.

7. Oddsson, Geir (UW). Icelandic groundfish surveys - integrating the input of commercial fishermen on tow locations: Improving the accuracy of stock assessment.

8. Crone, Paul R. (OSU). Sampling design and statistical considerations for the commercial groundfish fishery of Oregon.

9. Starr, Richard (ODFW). Spatial and statistical analyses of fishery catch data.

10. Fox, David (ODFW). Do commercial logbook data represent the distribution and abundance of fish?

11. Merems, Arlene (ODFW). The seasonal distribution and important habitat areas of English sole (*Parophrys vetulus*).

12. Nelson, Dale (ODFW). Use of logbook information to describe targeting: A preliminary analysis.

LIFE HISTORY: AGEING, FOOD HABITS
Wednesday 1:15 - 3:00 p.m.

Moderator: Ric Brodeur (AFSC)

1. Woodbury, David and Anne McBride (SWFSC). Comparing back-calculated birthdate distributions of juvenile chilipepper rockfish with their parturition seasons.

2. Jay, Shelly R. and Daniel H. Ito (AFSC). Age determination and growth of rougheye rockfish (*Sebastes aleutianus*) by the surface and break-and-burn methods of otolith reading.

3. Kastelle, Craig R. (AFSC). Pb-210/Ra-226 disequilibrium used for age validation with an application to sablefish (*Anoplopoma fimbria*).

4. Laidig, Thomas (SWFSC). Comparison of diets between *Sebastolobus alascanus* and *S. altivelis*.

5. Murie, Debra J. (U Victoria, BC). Comparative feeding ecology of sympatric copper and quillback rockfish in Saanich Inlet, British Columbia.

6. Pacunski, Robert E. (UW). Food habits of flathead sole, *Hippoglossoides elassodon*, in the eastern Bering Sea.

7. Livingston, Patricia (AFSC). Trends in groundfish predation on walleye pollock and Pacific herring in the eastern Bering Sea, 1985-88.

SPECIAL SESSION I: IN SITU TECHNOLOGY IN FISHERIES RESEARCH
Wednesday 3:30 - 5:15 p.m.

Chairman: Waldo Wakefield (NURC-UA)
Moderator: Mark Wilkins (AFSC)

1. Auster, Peter and Richard Malatesta (NURC-U Conn., Sea Educ. Assoc.). Groundfish - Microhabitat associations in low topography areas: Applications of remote operated vehicle (ROV) and manned submersible systems.

2. Grimes, Churchill B. (SEFSC). Some applications of undersea technology in marine fisheries and ecological research.

3. Lee, Welton and D. Elvin (Welton Lee Associates, Vermont Information Systems). Application of a visual catalog and identification system to enhance ROV studies of bottom fishes.

4. Barry, James P., C. H. Baxter, and C. K. Bretz (MBARI, MLML). Sampling benthic populations using ROV's: How can accuracy and statistical power be maximized?

5. Wakefield, W. Waldo (NURC-UA). The use of visual systems in quantifying the distribution and abundance of commercially important demersal fishes off central California.

6. Hixon, Mark, A., B. N. Tissot, D. L. Stein, and W. H. Barss (OSU, ODFW). Fish assemblages of deepwater reefs on the outer continental shelf of Oregon.

POSTER SESSION
Wednesday 5:30 p.m., Hamma Hamma

Barss, William, M. Hixon, D. Stein, W. Pearcy, and B. Tissot (ODFW, OSU). Coquille Bank as viewed from a submersible.

Brown, Annette L. and Kevin M. Bailey (AFSC). Age and growth of juvenile walleye pollock (*Theragra chalcogramma*).

Butler, John L., K. Rubin and L. Jacobson (SWFSC, SIO). Age determination of shortspine thornyhead, *Sebastolobus alascanus*, using otolith sections and 210Pb:226Ra rations.

Dawson, Pierre (AFSC). A geometry-based morphometric technique applied to walleye pollock.

Erickson, Daniel and Ellen Pikitch (UW). A histological description of shortspine thornyhead (*Sebastolobus alascanus*) ovaries: Structures associated with the production of gelatinous egg masses.

Finckh, Susanne and Daniel H. Ito (AFSC). Rockfish fleet dynamics in the Gulf of Alaska and Bering Sea: when they fish, where they fish, and what they fish for.

Kelley, Kevin M. (NURC-U Hawaii). Plans for the Hurl Deep Ocean RCV-150 Remotely Operated Vehicle Research Program in the central Pacific.

Laidig, Tom (SWFSC). Species identification from ROV video images.

Nichol, Daniel (AFSC). Reproductive demography of darkblotched rockfish (*Sebastes crameri*) off the Oregon coast.

Pikitch, Ellen K. and **José A. Perez Comas** and John R. Skalski (UW). Assessment of size selectivity parameters for groundfish species caught in the West coast trawl fishery.

Rickey, Martha (WDF). Population characteristics of arrowtooth flounder, *Atheresthes stomias*, off the Washington coast.

Roberts, Dale and Jim Bence (SWFSC). Testing for differences in fish abundances between finite geographic subsections of a large study area.

Sigler, Michael (AFSC). An electronic measuring board using bar codes.

Spring, Stella and Kevin Bailey (AFSC). Distribution and abundance of juvenile pollock from historical shrimp trawl surveys in the Western Gulf of Alaska.

Stein, D., M. Hixon, W. Pearcy, B. Tissot, and **W. Barss** (OSU, ODFW). Fish Assemblages of Deep Rocky Reefs off Oregon.

Wakefield, W. Waldo (NURC-UA). Reproduction and benthic settlement of *Sebastolobus altivelis* (Scorpaenidae) inhabiting the upper continental slope off central California.

EARLY LIFE HISTORY / ENVIRONMENTAL FACTORS
Thursday 8:00 a.m. - 10:15 a.m.

Moderator: Bruce Miller (UW)

1. Markle, Douglas F., **Christopher L. Toole**, and Phillip M. Harris (OSU). Metamorphosis and settlement of Dover sole (*Microstomus pacificus*) off Oregon.

2. Adams, Peter B., Stephen Ralston, and Thomas E. Laidig (SWFSC). Distribution, patchiness, growth, and hatch date of pelagic juvenile lingcod (*Ophiodon elongatus*) off Central California.

3. Gillespie, Graham E., R. D. Stanley, and B. M. Leaman (PBS). Early life history of rockfishes in British Columbia: Preliminary results of the first year investigation.

4. Buckley, Ray and Bruce Miller (WDF, UW). Recruitment of juvenile rockfishes (Sebastodes) to artifical reefs in Puget Sound.

5. Doyle, Miriam J. (AFSC). Larval fish assemblages off Washington, Oregon and northern California: An overview.

6. Castillo, Gonzalo C. (OSU). Environmentally induced recruitment variations in petrale sole (*Eopsetta jordani*) off Oregon and Washington.

7. Hollowed, Anne Babcock and Warren S. Wooster (AFSC, UW). Decadal scale variations in winter ocean conditions and recruitment of northeast Pacific groundfish.

8. Ingraham, Jim (AFSC). Simulations of year to year patterns of spring and summer surface currents in the Gulf of Alaska 1946-1991.

SPECIAL SESSION II: IN SITU TECHNOLOGY IN FISHERIES RESEARCH
Thursday 10:30 a.m. - 2:30 p.m.

Moderator: Waldo Wakefield (NURC-UA)

1. Harrold, Christopher, K. Light, and S. Lisin (Monterey Bay Aquarium). ROV based studies of macrophyte drift and associated megafauna in a submarine canyon.

2. Butler, John L., Peter B. Adams, W. Waldo Wakefield, Charles Baxter, Bruce Robison, Kathy A. Dahlin, and Tom Laidig (SWFSC, NURC-UA, Stanford U, MBARI). Comparisons of estimates of the abundance of slope ground fishes using ROVs and trawls.

3. Krieger, Kenneth J. (AFSC). Submersible observations of offshore rockfish in the eastern Gulf of Alaska.

4. O'Connell, Victoria M. and David W. Carlile (ADFG). Investigations of demersal shelf rockfish in the eastern Gulf of Alaska using a manned submersible.

5. Palsson, Wayne A. (WDF). Lingcod and rockfish assessments in Puget Sound.

6. Rose, Craig (AFSC). Behavior of North Pacific groundfish species in bottom trawls.

7. Stevens, Bradley G. and William E. Donaldson (AFSC, ADFG). Problems and solutions in the use of submersibles for studying epibenthic macro-fauna: Crab aggregations and pollution effects.

8. Cailliet, Gregor M., Mike McNulty, and Lynn Lewis (MLML, MBARI). Habitat analysis of Pacific hagfish (*Eptatretus stoutii*) in Monterey Bay, using the ROV Ventana.

9. Starr, Richard, Mark Hixon, Dave Fox, and Gary Johnson (ODFW, OSU, Biosonics). Paired submersible and acoustic surveys of a rocky reef.

10. Cailliet, Gregor M., Guillermo Moreno, and Waldo Wakefield (MLML, NURC-UA). Deep sea fishes of the Farallons: A comparison of beam trawl and camera sled samples.

11. Melvin, Edward F. and Steven A. Osborn (WSG, MLML). Hagfish trap design based on ROV observations.

Closing Remarks - 12:30 p.m., Dan Erickson (UW)

Management and Stock Assessment

Puget Sound Groundfish: A Question of Dollars and Sense

by
Cyreis Schmitt

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Although the Washington Department of Fisheries is responsible for the protection and management of nearly 100 groundfish species in Puget Sound, current funds and staff allow for the active management of only lingcod and rockfishes. The significant developments of the past decade paint a colorful story of how we arrived at this point. Abundance of most species declined to low levels and fisheries were substantially restricted or closed. The impacts of marine mammals on groundfish grew. The state legislature mandated fishery closures and pollution studies. The Governor declared his intent to make Washington "The sport fishing capital of the nation." Meanwhile, fishers and the general public became increasingly involved in management decision-making and as volunteers in collecting data. I present the lessons I learned and speculate on the future of Puget Sound groundfish and fisheries.

The Use of Demographic Analyses in Managing Two California Shark Fisheries

by
Gregor M. Cailliet

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Demographic analyses can be useful for effectively managing elasmobranch fisheries. However, they require valid estimates of age-specific mortality and natality rates, in addition to information on the distribution, abundance, habits, and reproduction of the population, if reliable estimates of population growth are to be attained. Because such detailed ecological information is usually unavailable, complete demographic analyses have been completed for only four shark species: the spiny dogfish *Squalus acanthias*, the school or soupfin shark, *Galeorhinus australis*, the lemon shark, *Negaprion brevirostris*, and most recently the sandbar shark, *Carcharhinus plumbeus*.

In California, reliable estimates of age, growth, mortality, age at maturity, and fecundity are available only for the leopard shark, *Triakis semifasciata*. Demographic analysis of this species yielded a net reproductive rate (R_o) of 4.47 G^{-1}, a generation time (G) of 22.35 yrs, and an estimate of the instantaneous population growth coefficient (r) of 0.067 yr^{-1}. If the mean fishing pressure over 10 years ($F = 0.084\ yr^{-1}$) is included in the survivorship function, R_o and r are reduced considerably, especially if leopard sharks first enter the fishery at early ages. A size limit of 120 cm TL (estimated age of 13 yrs), especially on female sharks, is proposed for the California leopard shark fishery.

All age determination techniques attempted for the Pacific angel shark (*Squatina californica*) have met with difficulties. Recently, however, we have accumulated data on 69 tag recaptures and have used the size and time-at-large data to model a von Bertalanffy growth function (VBGF) for this species. Coupled with existing reproductive information, subsequent demographic analysis yielded an R_o of 2.25 G^{-1}, a G of 14.5 yrs, and an estimate of r of 0.056 yr^{-1}, all with only natural mortality (M) estimated at 0.2 yr^{-1}. When a reasonable estimate of fishing pressure (F) is included in the survivorship function, R_o. and r are reduced considerably. Until accurate estimates of K and F are available, it would be prudent to set a size limit several cm TL past the size at first reproduction to protect the Pacific angel shark in California.

The Assumption of Constant Fishing Selectivity and the Stock Assessment for Widow Rockfish

by
David B. Sampson

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Modern methods for fish stock assessment are often based on age-structured models that assume that fishing mortality at age is separable into a time-specific factor, the rate of fishing mortality on the fully exploited age-classes, and an age-specific factor, a selectivity coefficient that is constant through time and that measures the relative vulnerability of the particular age-class. Although the assumption of constant selectivity greatly simplifies the task of assessing the status of a fish stock, if the assumption is incorrect it can result in catch quotas that are inconsistent with the objectives of rational management of the resource and it can lead to incorrect assessments of the stock's status.

The most recent assessments for the stock of Pacific widow rockfish (*Sebastes entomelas*) are based on the untested assumption of constant selectivity. The research described here examined the sensitivity of the widow rockfish assessment to the assumption of constant selectivity and tested the validity of the assumption by analyzing information on the length and age of widow rockfish collected from commercial landings in Oregon. Monte Carlo experiments with the Stock Synthesis program (Methot, R. D. 1990. Synthesis model: An adaptable framework for analysis of diverse stock assessment data. Int. N. Pac. Fish. Comm. Bull. 50:259-277.) found that the assessment for widow rockfish can be highly sensitive to modest changes in selectivity. Analyses of the commercial length and age data support the notion that selectivity for widow rockfish has changed through the years because of changes in fishing gear and fishing patterns.

Diel Movements of Pollock on the Bering Sea Shelf and Implications for Abundance Assessment

by
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In the Bering Sea, walleye pollock population size is estimated by combining results of echo integration-midwater trawl surveys and bottom trawl surveys. Echo integration-midwater trawl surveys are usually conducted during day and night while bottom trawl surveys are conducted only in daylight. Combining results from the two types of surveys assumes that day/night differences in pollock behavior and distribution do not bias the survey results. The technique also assumes that the two survey methods assess pollock in adjacent, non-overlapping parts of the water column. These assumptions were partially examined during the summer 1991 Bering Sea shelf pollock survey. Ten transect sections, ranging from 7-30 miles long, were each surveyed three times, consecutively, during a 24-hour period. Results illustrate large changes in pollock abundance and distribution in the same location over 24 hours. Pollock appear to move off the bottom at night, and closer to the bottom during the day, thus overlapping midwater and near-bottom habitat. Results also suggest that for this survey, operating only during the daylight hours could result in higher biomass estimates than operating only at night or during a 24-hour period. So much behavioral variability occurred that statistical distinction between observations during day and night was difficult. These observations emphasize the relative importance of behavioral variability on fish population assessment and should be examined in more detail in future experiments.

Rockfish (Scorpaenidae) Distribution Abundance and Species Association in the Gulf of Alaska, Aleutian Islands and Southern Bering Sea

by
James W. Stark

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Rockfish stocks were assessed by National Marine Fisheries Service, Alaska Fisheries Science Center (AFSC) summer multispecies demersal trawl surveys conducted during 1990 in the Gulf of Alaska and during 1991 in the Aleutian Islands and southern Bering Sea in depths shallower than 500 m. Pacific ocean perch, northern rockfish, rougheye rockfish, shortraker rockfish, and shortspine thornyhead were dominant throughout both areas. The biomass of Pacific ocean perch (500,000 t) exceeded all other rockfish combined with 75% of the total occurring in the western Aleutian Islands in 100-300 m depths. Northern rockfish was twice as abundant in the Aleutian Islands (AI) as in the Gulf of Alaska (GOA) with a combined biomass of 300,000 t generally distributed in depths shallower than 200 m. Rougheye rockfish was found in all areas and depths (60,000 t) with the juveniles occurring in the shallow (depths < 100 m) inner shelf and the adults in gullies (200-300 m) and upper slope (300-500 m). Juvenile shortraker rockfish were rarely encountered and 90% of the overall biomass (33,000 t) occurred on the slope in depths of 300-500 m. Shortspine thornyhead abundance probably exceeded that of shortraker rockfish but sampling did not occurr in depths below 500 m, which had a large proportion of the shortspine thornyhead stocks during previous AFSC surveys.

Five rockfish species had 99% of their total biomass in the GOA including sharpchin (33,000 t), dusky (25,000 t), redbanded (3,000 t), and yelloweye rockfish (1,000 t). Fifteen rockfish species occurred only in the GOA: principally redstripe (23,000 t), silvergray (13,000 t), yellowmouth and black rockfish (2,000 t each). The remaining eleven species were restricted to areas east of Cook Inlet and each had under 600 t in total biomass.

Results of numerical (cluster) analysis indicated general rockfish assemblages. A deepwater (301-500 m) rockfish complex of shortraker and rougheye rockfish and shortspine thornyhead inhabited the continental slope and deepest gullies of the AI and GOA. Pacific ocean perch associated with the deepwater complex in the GOA east of Cook Inlet and associated with a more shallow water (101-200 m) outer shelf and banks complex comprised of northern and dusky rockfish west of Cook Inlet. Two additional outer shelf complexes occurred in areas east of Cook Inlet: the first included the silvergray, redstripe and sharpchin rockfish and the second included the northern, harlequin and dusky rockfish.

A Comparison of Harvesting Strategies for the Northwest Atlantic Mackerel Stock Under Conditions of Variable Recruitment and Density Dependence

by
William J. Overholtz

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Previous research indicated that density dependence in population level responses such as growth and predation mortality rate may play a major role in regulating the dynamics of the Northwest Atlantic stock of Atlantic mackerel. Simulation studies, utilizing this compensatory model of the mackerel stock, suggest that expected yields and spawning stock sizes under conditions of constant harvest rate or constant catch would be quite disparate. Yields and spawning stock size would be less variable and slightly larger under a constant catch strategy for catches of mackerel up to approximately 200,000 t. However, a constant harvest rate strategy would provide higher long-term yields and a more stable spawning stock at catches greater than 200,000 t. A comparison of a constant catch policy with $F_{0.1}$ and F_{max} fishing strategies (constant F) suggests that an F_{max} strategy would cause a long-term decline in the spawning stock below the current minimum spawning stock target and provide highly variable yields. A constant catch strategy could produce nearly the same level of yield with considerably less variability and maintain a larger mean spawning stock biomass than the $F_{0.1}$ strategy.

The Relative Conservatism of Alternative Stock-Recruitment Relationships As Used in the Delay-Difference Model

by
Grant G. Thompson

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This study examines the question of whether particular forms of the stock-recruitment curve are inherently more conservative than others, using Deriso's delay-difference equation as the basic model of stock dynamics. The answer turns out to be conditional on how conservatism is measured. When the inverse of the fishing mortality rate corresponding to extinction is used as the measure of conservatism, it appears that conservatism in the Deriso-Schnute stock-recruitment equation increases directly with the shape parameter γ, while the Cushing equation represents an inherently low level of conservatism. However, when the inverse of the fishing mortality rate corresponding to maximum sustainable yield (F_{MSY}) is used as the measure of conservatism, the results are less straightforward; in fact, it appears to be impossible to show that a particular stock-recruitment equation is inherently more conservative than any other. Nevertheless, a case can be made that certain forms are less capable of generating extreme behavior than others. Specifically, it is important to note that when the stock-recruitment relationship follows the Cushing equation or the Deriso-Schnute equation with $\gamma=-1$ (i.e., the Beverton-Holt equation) F_{MSY} is bounded above by the fishing mortality rate corresponding to maximum yield per recruit (F_{max}), whereas F_{MSY} can exceed F_{max} under the Deriso-Schnute equation with $\gamma>-1$ (e.g., the Ricker equation).

Stock Assessment of Pacific Ocean Perch (*Sebastes alutus*) Using an Explicit Age Structured Model

by
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We explore the utility of a relatively new analytic model for assessing the status of the Pacific ocean perch resource in the Aleutian Islands region – the stock synthesis model. Previous assessments of Pacific ocean perch have relied on the stock reduction analysis (SRA) model as its primary analytical tool. While SRA and stock synthesis are fundamentally aged based models, the main difference between the two is that SRA does not explicitly keep track of abundance of fish at age. By employing the delay difference equations of Deriso and Schnute, SRA shortcuts the accounting of numbers at age while reproducing estimated biomasses and catch as if this accounting had been done. Stock synthesis, on the other hand, explicitly tracks the numbers at age in the catch. This allows information on the relative numbers at age to be used in the estimation process, allowing the use of more detailed information than would otherwise be possible using SRA.

For the stock synthesis analysis, we freed up several important assumptions that were needed in the stock reduction analysis. First, we no longer assumed knife-edged selectivity; and secondly, the relationship between stock and recruitment was relaxed. Our preliminary results indicate that assessments of Pacific ocean perch based on SRA are not sensitive to the knife-edge recruitment assumption. And by relaxing the stock recruitment relationship, we found that strong year classes apparently supported much of the early fishery. This contrasts sharply with the hypothesis that the large catches early in the fishery were due to removals of accumulated old fish, as would be predicted by equilibrium type models. It must be stressed, however, that these results are preliminary. Further refinements of our modelling approach should allow a comprehensive treatment of all the available data, resulting in improved Pacific ocean perch stock assessments.

Estimating the Spawning Biomass of *Sebastes jordani* from Larval Production

by
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Shortbelly rockfish (*Sebastes jordani*) is a very abundant and underutilized species found along the central California coast. Hydroacoustic surveys provide rough estimates of 150,000-300,000 t in the shelf-slope region between Ascension Canyon and the Farallon Islands, a distance of only 100 km.

To more accurately assess the magnitude of this resource a larval production estimate of spawning biomass is being developed based on a research cruise conducted in February 1991. During this ichthyoplankton survey 160 bongo net stations were occupied in a 6-day period. Although laboratory work and analysis are still in progress, several definitive patterns have now emerged.

The distribution of shortbelly rockfish larvae was strongly centered in water depths of 100-500 m in the vicinity of Pioneer Canyon. This result differs from a pilot survey conducted in 1990, which showed the larvae were more abundant around Ascension Canyon. Even so, the spatial extent of larvae was circumscribed during the survey; abundance ranged 0-10,000 larvae$\cdot$10 m^{-2}.

Geostatistical analysis of the data revealed anisotropic structure in the semivariogram. Kriging and integration of the abundance data produced an estimate of $5\cdot10^{11}$ larvae in the survey region at the time of the survey, of which $\sim 1\cdot10^{11}$ were produced each day. A preliminary calculation of the rate of spawning biomass ($mt\cdot d^{-1}$), using weight specific fecundity, is presented.

Stock Assessment Working Plan for Rockfish Stocks in Waters off Alaska

by
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Management of rockfish (*Sebastes* and *Sebastolobus* spp.) stocks in waters off Alaska is hampered by limited information and considerable uncertainty as to current stock abundance and long-term productivity. With the exception of Pacific ocean perch (*S. alutus*), relatively little is known about the biology, distribution, and population dynamics of commercially important rockfish species. Moreover, concern has been expressed by the industry regarding the apparent inability of trawl surveys to adequately assess rockfish biomass, especially for the deeper water species such as shortraker rockfish (*S. borealis*) and rougheye rockfish (*S. aleutianus*). This lack of information, combined with the uncertainty in the biomass estimates, has prompted the Alaska Fisheries Science Center (AFSC) to develop a comprehensive working plan to improve rockfish stock assessments and management recommendations. The AFSC's rockfish working group (RWG) was charged with this task.

The overall focus of the working plan was to identify, develop, and prioritize specific research activities that would lead to improved rockfish stock assessments. More specifically, the primary goal was to develop better estimates of allowable biological catch (ABC), the starting point used by fishery management in the setting of annual harvest levels. The RWG concluded that better estimates of ABC would be obtained by explicitly acknowledging and evaluating the potential sources of bias and uncertainty in our estimates and by incorporating a better understanding of the biology, distribution, behavior, and population dynamics of the rockfish stocks. Explicitly acknowledging bias and uncertainty would allow resources to be optimally allocated towards estimating or eliminating bias, or finding alternative assessment methods that can knowingly use biased data.

My talk will focus on the development of the working plan, research activities now under way, and planned research endeavors for the future.

The Atka Mackerel Resource of the Aleutian Islands

by
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The center of abundance of Atka mackerel (*Pleurogrammus monopterygius*) has been in the Aleutian Islands. Atka mackerel is a unique species which has been very difficult to assess for the following reasons: 1) The stock tends to occur in large localized concentrations; 2) Two of the four resource surveys conducted in the Aleutian Islands were unable to sample critical Atka mackerel habitat; 3) The surveys have been far apart in time. A population of fast-growing fish with a high natural mortality rate can show rapid changes in abundance. Surveys three or more years apart, as in the past, may miss important events in stock dynamics; and 4) The fishery and surveys appear to select different components of the population.

The most recent surveys conducted in 1986 and 1991 indicated Atka mackerel biomass levels of 544,800 t and 657,900 t, respectively. The resource has previously been exploited at very low levels based on assessments that did not utilize the high biomass estimates from the latest surveys. The current stock assessment for Atka mackerel utilized the stock synthesis model for the first time. This model allowed the simultaneous analysis of catch biomass and age composition, and abundance and age composition from the surveys. The model was tuned to the the estimates of biomass from the surveys, which provided a very different picture of the resource than in the past. The most interesting result of the analysis is the prediction of a strong 1988 year class in order to support the high levels of biomass as indicated by recent surveys.

The various data components and their associated biases are discussed. The results of the stock assessment are presented and discussed in the context of the various assumptions used in the model.

Gear Research

Stock Assessment Using Hook Timers

by
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Estimates of longline CPUE can be biased by gear saturation and interspecific competition for hooks. Such bias can be eliminated, however, if CPUE is redefined in terms of the times to capture every fish. Times to capture were estimated for pelagic armorhead (*Pseudopentaceros wheeleri*), on SE Hancock seamount on four consecutive annual stock assessment cruises. Although densities were low and hook competitors were few over this period, relative abundance estimators based on times to capture are shown to be superior to the traditional estimates of CPUE.

On the Odds of Catching Fish with Longline Gear

by
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A stochastic model is developed which provides estimates of fish abundance from longline surveys. The model accounts for hook competition and is based on a binomial-Poisson mixture distribution. This model generalizes previous models of hook competition which is derivable as an exponential decay model. Fish are assumed to arrive randomly at the gear at some rate λ, which is proportional to abundance (Poisson process). The probability of successive captures p_j is assumed to be related to the number of fish already caught (binomial process). The parameters λ and p_j are estimated from hook timer (time to capture) data collected during August 1991 for sablefish, halibut, and Pacific cod in the Gulf of Alaska.

Short-Term Effects of Changes in Codend Mesh Size and Shape on the West Coast Groundfish Trawl Fishery

by
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An alternate haul technique, following a randomized block design, was used to estimate short-term biological and economic effects of different codend mesh sizes and shapes on the west coast bottom trawl fishery. West coast trawl vessels, operating under production conditions, donated vessel time during the 1987-1990 field work; 102 experimental trips were conducted from the Canadian border to Point Conception, California. Short-term effects (e.g. dollars per trawling hour, total catch, catch sorting time, discards, and fish length selectivity) on the deep water Dover (DWD) trawl fishery are discussed.

The Effect of Velocity on the Catch of Small Research Trawls

by
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Experiments directed at understanding the effects of velocity on the catch from small research trawls were conducted in Puget Sound, Washington at several locations and times of the year. Two trawls, one a 3-m beam trawl, the other a 7.6-m otter trawl, were used. Velocities ranged from 1.0 to 3.2 nautical miles per hour. In each experiment the different velocities were replicated and the entire experimental design was randomized. Tow distance, bottom type, and bottom depth were held constant; other variables were held constant to the extent possible working under field conditions. Changes in velocity of the 7.6-m otter trawl showed only minor changes in catches of either abundance or size of fish caught. In contrast, the 3-m beam trawl results showed statistically significant changes in catches. The average size of English sole, slender sole, and Pacific sanddab all increased with velocity, while plainfin midshipman sizes decreased; generally the number of fish in the catch also increased with velocity. The basic design of each trawl and resulting behavioral responses of the fish were thought to be the reasons for the observed results.

An Investigation of the Avoidance Reactions of Pacific Whiting (*Merluccius productus*) to Demersal and Midwater Trawl Gear

by
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An experiment was conducted to demonstrate the avoidance behavior of Pacific whiting (*Merluccius productus*) when confronted by trawl gear. Echograms are presented to show the fish's reaction during the day and night to demersal and midwater trawls, and limited echo integrator data are presented which suggest that the fish also respond to vessel noise. Trawl hauls made during the day and at night cause significant disruption of depth layering and the fish consistently avoid trawl warps, doors and the mouth of the trawl by diving and by moving to the sides of the gear path. This behavior may result in trawl catch per unit effort (CPUE) rates and biological sample compositions that are quite different from what would be obtained from undisturbed fish layers. There are discussions of problems and sources of bias associated with assessment of the near bottom portion of pelagic fish abundance using demersal trawl and echo integration methods, the comparability of demersal trawl and acoustic survey data, and the combination of concurrent survey results obtained by use of the two methods.

Techniques and Gear for the Emerging Pacific Hagfish Fishery

by
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Experiments were completed comparing the size and number of Pacific hagfish (*Eptatretus stoutii*) captured using a variety of fishing techniques (soak time, bait type and concentration, and impact of derelict traps) and trap design features (trap size, size and placement of escapement holes, and number of entrance funnels) in order to identify methods that select for larger hagfish ($\geq$ 12 in) required for sustainable management and by tanners, without compromising production. Results of a series of experiments on soak time, escapement hole size, and the impacts of derelict traps are discussed.

Plastic five gallon buckets fitted with entrance funnels from commercially available Korean hagfish traps were fished with treatments sequentially randomized along multiple groundlines at 50 fathoms in Monterey Bay. Mean number per trap and mean total length varied significantly with three soak times and five escapement hole sizes in a two-way ANOVA design; number and length increased with longer soak intervals and number decreased but length increased with increasing hole size. Traps with 0.48 in escapement holes fished for 24 hours consistently captured larger (90-97% $\geq$ 12 in) hagfish with no significant loss in overall production. A comparison of the length and number of hagfish caught in 12 hour daytime and nighttime soaks and 24 hour soaks were not significant suggesting that increased catch rates observed in longer soaks are probably a function of longer soak time and not increased nocturnal activity. Two trials where traps were baited with hagfish and fished for 24 hours produced a single hagfish, suggesting that lost hagfish traps pose little threat to the hagfish resource. Results suggest that escapement hole size and soak time are likely management tools for a sustainable hagfish fishery.

Life History: Growth, Mortality, Reproduction

Pacific and Black Hagfish: Fishery and Sampling Highlights from Oregon

by
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In 1988, the Oregon Department of Fish and Wildlife began sampling and monitoring the development of a new fishery off the coast of Oregon for Pacific hagfish *Eptatretus stouti* and black hagfish *E. deani*. Hagfish landings by Oregon trap vessels have been modest ranging from a low of 26,000 pounds in 1988 to about 344,000 pounds. Through November 1991, samples have been taken on 1,648 Pacific hagfish and 942 black hagfish. Mean length of fish sampled from 1988-89 commercial landings was 39.6 cm for Pacific hagfish and 34.5 cm for black hagfish. Fifty percent maturity for male and female Pacific hagfish was 35 cm and 42 cm, respectively. Fifty percent maturity for male and female black hagfish was 34 cm and 38 cm, respectively. Both species either spawned throughout the year or have a protracted spawning period. Mature females of both species had one to three distinct sizes of eggs, but they usually contained only one size group of eggs over 5 mm in length. Mature Pacific hagfish females averaged 28 eggs over 5 mm in length, and black hagfish females averaged 14 eggs over 5 mm in length. Hermaphroditism was found in 2% (three fish) of the Pacific hagfish examined.

The Fishery and Reproductive Biology of Pacific Grenadier, *Coryphaenoides acrolepis*, off Southern Oregon and Northern California

by
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Pacific grenadier, *Coryphaenoides acrolepis*, is slowly becoming an important commercial trawl fish species on the continental slope off southern Oregon and northern California. Presently, this species is being landed incidentally in a target fishery for longspine thornyhead, *Sebastolobus altivelis*, in 900-1360 m. Landings of Pacific grenadier show promise of increasing significantly as trawlers fish deeper on the continental slope. To study this species' reproductive biology, 3,566 individuals were sampled from commercial catches between 1988 and 1991. Most were obtained between December 1989 and November 1990. Males predominated in the commercial catches, always forming more than 60 percent and often more than 80 percent of the landings. Males first ripen at about 450 mm TL or 100 mm head length; females first ripen at about 480 mm TL or 110 mm head length. Mean instantaneous fecundity was about 53,000 2-mm eggs. Preliminary results show that grenadier spawned throughout the year; ripe and spent males and females were collected in every month, although a prolonged spawning peak appeared to exist in the summer. These results have distinct implications for successful management of this species.

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Growth and Mortality of Northern and Dusky Rockfish in the Northeast Pacific

by
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Biomass estimates indicate that northern rockfish (*Sebastes polyspinis*) is the second most abundant and dusky rockfish (*S. ciliatus*) the third most abundant species of *Sebastes* in the Gulf of Alaska. Ages obtained by the "break and burn" method of reading otoliths are used to determine von Bertalanffy growth curve parameters and natural mortality. Maximum ages were 57 years for northern rockfish and 49 years for dusky rockfish. For both species, males grew more slowly and reached a smaller maximum size than females. Estimates of instantaneous annual rates of natural mortality were 0.06 for northern rockfish and 0.09 for dusky rockfish.

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Natural Mortality of Blue Rockfish (*Sebastes mystinus*) During Their First Year in Nearshore Benthic Habitats

by
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Natural mortality rates for benthic first-year juvenile blue rockfish (*Sebastes mystinus*) were estimated from underwater counts at two Mendocino County sites (Dark Gulch, 1985-1988; and Salmon Point, 1987-1988), and at one Sonoma County site (Horseshoe Point, 1988) in northern California. Seven independent mortality estimates ranged from 0.001 to 0.008 day^{-1}. Analysis of a balanced subset of the data from Dark Gulch and Salmon Point during 1987 and 1988 failed to detect significant differences in mortality between sites or years. The patchy distribution of juveniles makes it difficult to detect statistically significant differences, but during the four years of the study, mortality estimates were higher during years with stronger recruitment. This suggests a density-related component of mortality, which we propose comes from increased predation by fishes that eat juvenile blue rockfish only when they are abundant. This density-related mortality during the first year reduces extreme inter-annual variation between subsequent adult year-classes.

Tissue Composition and Energy Content Dynamics during the Annual Reproductive Cycle in Yellowtail Rockfish (*Sebastes flavidus*)

by
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Nutritional dynamics of adult yellowtail rockfish were analyzed from the perspective of temporal changes in tissue composition and energy content of liver, muscle, mesentery and gonad tissues over one annual reproductive cycle. Monthly tissue composition data were obtained for rockfish collected from Cordell Bank, a sea mount 20 nautical miles west of Point Reyes, California. Females accumulated somatic tissue energy reserves mainly in the form of lipids during the spring and summer months when food is abundant. Maternal lipid and protein reserves are depleted in a reciprocal relationship with ovarian growth during the winter when feeding is much reduced. The greatest declines of lipids and protein occurred in mesenteries and muscle, respectively. Data from females adjusted for size revealed that approximately 30% of somatic tissue loss during the time interval from oocyte development to parturition was for female-specific purposes. Lipids contributed 74% of the energy lost from somatic tissues. The ratio of lipid gained in ovaries to lipid lost from female stores during development (0.43) suggests that 57% of the lipids was utilized for energy-requiring reproductive processes. Protein showed a 220% net gain in ovaries relative to somatic tissue protein loss, indicating net synthesis of ovarian tissue.

Corpora Atretica: A Brief Review of Its Significance and Initial Analysis of Occurrence in Yellowtail Rockfish (*Sebastes flavidus*)

by
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Atretic oocytes constitute an energy consumptive process without reproductive output. Depending on the degree, an intensive and widespread occurrence of resorbing oocytes results in recruitment inhibition or failure. Histological observations of female yellowtail rockfish (*Sebastes flavidus*) ovaries showed variations in the frequency of atretic oocyctes seasonally and by stage of oocyte maturation. While the incidence of atretic oocytes has been widely reported among teleosts, the consequences are poorly understood and appear to differ among species. A brief review of corpora atretica, its significance and possible consequences is presented.

Nearshore Ecology of Juvenile Flatfish off Kodiak, Alaska

by
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Although at least twelve species of flatfish are commercially fished from Kodiak, Alaska, juvenile habitats are unknown. Intertidal zones, estuaries, and shallow protected bays are nursery areas for flatfish in the lower 48, Europe and Japan. Therefore, I hypothesized that similar habitats should shelter juveniles in Alaska. Preliminary sampling was conducted in shallow waters (<9 m) of Kalsin and Middle Bays on Kodiak Island in August, 1990. Seven species of flatfish were collected: Pacific halibut (*Hippoglossus stenolepis*), rock sole (*Pleuronectes bilineata*), yellowfin sole (*Pleuronectes aspera*), English sole (*Pleuronectes vetulus*), Alaska plaice (*Pleuronectes quadrituberculatus*), starry flounder (*Platichthys stellatus*), and sand sole (*Psettichthys melanostictus*). Six of these species included individuals that were age-0 or age-1. All flatfish were captured on sand substrate. There was little variation in diet among the seven species. All ate Crustecea. The primary difference was that Mysidae comprised the principal component of the diet of halibut and sand sole, but were not consumed by the other species. This study was expanded in August and September 1991 in an effort to characterize ecological parameters of juvenile flatfish habitat around Kodiak. In 1991, four additional species were collected: arrowtooth flounder (*Atheresthes stomias*), flathead sole (*Hippoglossoides elassodon*), Dover sole (*Microstomus pacificus*), and butter sole (*Pleuronectes isolepis*). Gear comparisons were conducted between a 2.5 m try net used in 1990 and a 3 m plumb staff beam trawl used in 1991.

Distribution, Abundance, Food Habits, Age and Growth of Early Juvenile White Seabass (*Atractoscion nobilis*) off San Diego County, California

by
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Two bays and the coast of San Diego County were sampled for two years at three depth strata to determine the distribution, food habits, and growth rates of newly settled white seabass (*Atractoscion nobilis*). Age was estimated from daily increments in otoliths, and validated using fish of known age reared in the laboratory. Spawning occurs from March to September, with a peak in June. Larvae settle at about 7 mm (1 month) and inhabit shallow water (5-8 m) along the coast, although a few were taken in the bays in 0.5-1 m. Overall abundance is low, with the highest densities (July) not exceeding 25 ha^{-1}. They remain in this habitat for 2-3 months, feeding primarily on mysid crustaceans, and associate with drifting plant material. Growth is rapid, about 1. 3 mm d^{-1}. As they grow, fish become more important in the diet. At about 100 mm SL (~100 d), the juveniles move out of the area, most likely into deeper water. The coastal shallows may be preferred because the abundant food and warmer water promote rapid growth and increase survival.

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Tagging and Stock Identification

Lingcod Transplant Experiment

by
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Lingcod (*Ophiodon elongatus*) stocks in the Strait of Georgia are presently depressed. An ultrasonic tagging and radio tracking experiment was conducted to assess the potential of rebuilding stocks through transplanting small lingcod from other areas. Lingcod were captured, displaced approximately 250 km, tagged and released into a Strait of Georgia study area. Thirteen displaced lingcod and five resident (caught in the study area) lingcod were tagged with VEMCO ultrasonic pingers and tracked within a study area. Both day and night observations were made and individuals were followed for periods as long as 32 days. The lingcod used in the study were all between 2+ and 3+ in age and suspected to be immature fish. Seven of the 13 displaced lingcod left the study area within 20 days of release. Six displaced lingcod and all resident fish remained within the study area. The displaced lingcod that stayed in the study area tended to be smaller than the fish that left. This study suggests that small, immature lingcod displaced over large distances are likely to establish themselves within a new area.

An Application of Polymerase Chain Reaction: Examination of Yellowtail Rockfish (*Sebastes flavidus*) Mitochondrial DNA

by
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The management of U.S. Pacific coast yellowtail rockfish (*Sebastes flavidus*) is of concern due to declining northern stocks, coastwide reductions in mean lengths, and changes in fishing patterns. Sound management of a fishery requires that the population structure be understood and that subpopulations, or stocks, if they exist, be identified and managed separately. The objective of this study was to use polymerase chain reaction (PCR) and mitochondrial DNA (mtDNA) analysis to examine the genetic structure of three Pacific coast yellowtail rockfish populations.

The polymerase chain reaction was used to amplify a 1,600 base pair region of the mitochondrial ribosomal RNA genes from 74 yellowtail rockfish collected from three Pacific coast localities: Nootka Sound, Vancouver Island, British Columbia; Westport, Washington; and Cordell Bank, California. Intraspecific genetic variability was assayed by subjecting the amplified region to a restriction fragment length polymorphism (RFLP) analysis. The segment was digested with ten type II restriction endonucleases, and the resulting fragment patterns were examined for polymorphisms. A total of 33 restriction sites allowed examination of 133 base pairs of the mtDNA molecule. Except for a single variant observed in the Westport Hha I digests, no variation was detected within or among the three yellowtail rockfish populations.

Results support an earlier allozyme study which concluded that Pacific coast yellowtail rockfish should be regarded as one genetically homogeneous group. Although tagging results suggest yellowtail assemblages may be wholly or partially isolated as adults, coastwide dispersal of pelagic larvae and juveniles may play a significant role in gene flow among populations.

Stock Delineation of Adult Yellowtail Rockfish (*Sebastes flavidus*) as Indicated from Tagging, Parasite, and Genetics Studies

by
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Potential stock boundaries of yellowtail rockfish were examined using the results of tagging, parasite and genetics studies. While the tagging indicates that individual adult rockfish can travel long distances (>400 km), the three studies together indicate that, for management and assessment purposes, the population of yellowtail rockfish in the areas of the traditional trawl fisheries can be treated as five or six stocks. One of the stocks straddles the international boundary between Washington and Canada and therefore requires joint management. The report summarizes the information of movement of yellowtail rockfish from the three studies.

Some Factors That Influence the Recapture Rate of Tagged Sablefish

by
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Between 1971 and 1989, 55,732 sablefish were tagged and released off the coasts of California, Oregon, and Washington. We have temporal, spatial, and biological data on 3,926 of these fish that were recaptured and reported by the end of 1990. The primary objectives of the tagging study were to gain knowledge on the movements and growth of sablefish. While the study was not designed to estimate population size or survival rates, it seemed useful to determine if the data are appropriate for such estimates and to develop guidelines for the design of future sablefish tagging studies.

Standard methods for estimating population size or survival rates assume that each tagged member of a group has an equal probability of recapture. We examine two factors, fish length and capture depth when tagged, that we expected to influence recapture rate.

Our results show that recapture rate is positively correlated with size and usually negatively correlated with bottom depth of first capture. Thus the design of future tagging studies that require equal probability of recapture should include consideration of stratification by size and bottom depth of first capture.

Fisheries Catch Analysis

Numerical Definition of Assemblages of Groundfish Caught off the Coasts of Oregon and Washington and the Commercial Fishing Strategies Used to Catch Them

by
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Numerical definition of species caught together by the groundfish trawl fishery operating off the Oregon and Washington coasts during 1985-1987 indicated six major assemblages of species. Assemblages were selected based on consistencies in three types of analysis of the species weights caught per tow: detrended correspondence ordination, two-way-indicator species clustering, and Bray-Curtis group average clustering. Two of the assemblages were dominated by a single species, one consisting largely of pink shrimp (*Pandalus borealis*) (SHR) and the other primarily comprised of widow rockfish (*Sebastes entomelas*) (WID). The other assemblages identified were a deepwater rockfish assemblage (DWR), a deepwater Dover assemblage (DWD), a nearshore mixed-species assemblage (NSM); and a bottom rockfish assemblage (BRF). Discriminant function analysis was used to define fishing strategies which accurately predicted the catch of the defined assemblages, as well as being simple and easy to use and describe. Assuming that the probability of catching the assemblages was equal for all gears combined, the selected function predicted that mud gear utilized in less than 89 fm would catch NSM, while mud gear at greater depths would catch DWD. Roller gear used in less than 134 fm was determined to catch BRF; in 134-283 fm, DWR; and in greater than 283 fm, DWD. Shrimp gear was predicted to catch SHR, midwater gear to catch WID, and combination gear DWD.

Insights into Analysis of Codend Mesh Size and Type Data from the Pacific Groundfish Fishery

by
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Several different net configurations were used in a randomized block design. Two of the nets remained the same in each configuration while the other nets were changed to increase the number of direct comparisons. If parallelism can be found between the two nets which remained the same, what can be indirectly implied about the other nets which were not directly compared?

Icelandic Groundfish Surveys: Integrating the Input of Commercial Fishermen on Tow Locations: Improving the Accuracy of Stock Assessment

by
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Groundfish research in Icelandic waters began around the turn of the century and has been continuous since 1930. Standardized groundfish surveys have been carried out since the mid-1950s, but they have changed substantially over the years. Initial surveys consisted of 20 tows conducted mainly in inshore areas; surveys gradually expanded to 200 tow locations in the Icelandic continental shelf waters. A completely new survey design was initiated in 1985. Principal objectives were to improve the accuracy of stock assessment of demersal fish (particularly cod) and to increase cooperation with fishermen and other sections of the fisheries community through a joint research project. Approximately 600 stations are towed during a period of 2-3 weeks in early March. Five commercial stern trawlers of comparable size, engine power and overall design use gear specially designed for this survey. Captains of the research trawlers and several commercial fishermen from all over Iceland, in cooperation with the union of fisheries officers, were involved in planning of the project from the beginning. The most important input of the fishermen concerns selection of the tow locations. Stations are semirandomly distributed in the survey area within rectangles of 30 x 30 nautical miles, while stratifying for estimated cod abundance. The towing locations of half the stations in each rectangle were selected by the commercial fishermen, whereas the remaining tow locations were randomly selected. Commercial fishermen initially exhibited overwhelming approval for this survey design; however, they now display mixed feelings about the survey results.

Sampling Design and Statistical Considerations for the Commercial Groundfish Fishery of Oregon

by
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Since 1989, to estimate the species composition of rockfish landings (*Sebastes* spp. and *Sebastolobus* spp.) Oregon has adopted a two-stage stratified sample survey design with port-month group as a stratum and boat trips within a stratum as primary (first-stage) sampling units. The harvested fish are sorted into market categories prior to unloading at the shore-based processing facilities. To accommodate logistical sampling constraints the primary sampling units are poststratified into these market categories. At least one cluster unit of a predetermined weight (25 or 50 lb) is subsampled within each market category of a primary sampling unit. The estimator is based on poststratification of a stratum into market categories (subpopulations or domains of study), rather than on a simple random sampling scheme where a cluster unit is randomly selected from all possible clusters in a sampled boat trip, i.e., market category variation is disregarded entirely. The recommended sampling strategy requires that boat trip landing poundage for market categories be available after the fishing season to serve as weights in the estimation procedures, e.g., the state of Oregon requires processors (landing sites) to provide fish tickets, summarizing individual boat trip catches, and these documents usually contain the needed landing information used in the empirical analyses.

For 1989 and 1990 sampling data, precise coefficients of variation (CV) of mean catch per cluster and total catch for principal species of the widow rockfish (*Sebastes entomelas*), yellowtail rockfish (*Sebastes flavidus*), Pacific ocean perch (*Sebastes alutus*), and thornyhead (*Sebastolobus* spp.) market categories were observed (CVs $\leq 15\%$). These fish species contributed over 70% to the total weight of rockfishes harvested during this time period. However, the species compositions of two other market categories, "large" and "small" rockfish complexes, were found to be more variable which resulted in imprecise catch estimates for many of the species incorporated into these sort groups (CVs = 15-130%).

The paper evaluates the present rockfish species composition monitoring program, including field sampling protocol and statistical analysis of collected data. The problems that have hampered this sampling approach, as well as future design considerations are also discussed.

Spatial and Statistical Analyses of Fishery Catch Data

by
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The Oregon Department of Fish and Wildlife has developed methods to spatially and statistically analyze commercial fishery logbooks on a tow by tow basis. We are using a database consisting of 1980 through 1989 Oregon commercial trawl fishery logbook records to evaluate spatial and temporal patterns in fisheries. A plot of the location of commercial fishery activity shows that the commercial fleet fishes most of the continental shelf. By assuming the commercial fleet samples most of the shelf, the commercial catch provides an indication of species distribution and relative abundance. Although analysis of fishery catch data should not be considered a replacement for oceanic research, fishery catch data can provide information on fish distribution and abundance. A description of uses of the data set is presented as an introduction to three subsequent presentations.

Do Commercial Logbook Data Represent the Distribution and Abundance of Fish?

by
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The Oregon Department of Fish and Wildlife has developed a database of 1980 through 1989 Oregon commercial trawl fishery logbook records. These data should prove useful in analyzing fish abundance and distribution patterns, provided they are not overly biased by fishery-related factors such as market conditions and regulations. We compared logbook catch data with National Marine Fishery Service (NMFS) research cruise trawl data to test the hypothesis that logbook catch patterns do not significantly differ from research trawl catch patterns. Our comparison of data types employed three different methods:

1. comparison of the geographic distribution of logbook and NMFS trawls,
2. linear correlation analysis of NMFS and logbook CPUE values, and
3. comparison of species biomass estimates from the NMFS and logbook data.

The comparisons demonstrated that the logbook data representation of fish abundance and distribution is very similar to research trawl data. The comparisons also shed light on important information gaps in the research data that can be filled by logbook data, and how logbook data can be used to help design research cruises. In addition, our analysis suggested several methods for handling and averaging logbook CPUE data to optimize data analysis.

The Seasonal Distribution and Important Habitat Areas of English sole (*Parophrys vetulus*)

by
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Geographic and statistical analyses were performed on 10 years of groundfish logbook data for selected groundfish species. Our work has demonstrated that commercial logbook data adequately reflect the distribution patterns of fish species. The purpose of this study was to:

1) Determine the general distribution of English sole during upwelling, prespawning and spawning periods, and

2) Identify areas where English sole is most abundant within these time periods.

Previous studies show that English sole aggregate and move slightly offshore and south in the fall, immediately prior to spawning. In the spring and summer months, English sole disperse and move inshore and to the north. A GIS program was used to spatially analyze tow location information, and statistically analyze areas with high concentrations of tows. Geographic display of English sole tows indicates that fishing patterns are reflective of English sole movement. The analysis also identifies specific areas that are heavily fished, indicating areas most heavily used by English sole during prespawning, spawning and upwelling periods. Statistical analyses describe the relative abundance of English sole in these areas.

Use of Logbook Information to Describe Targeting: A Preliminary Analysis

by
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Targeting of fishing effort on a particular species can influence the results of management decisions. We analyzed 10 years (1980-89) of logbook information for yellowtail rockfish (*Sebastes flavidus*) and sablefish (*Anoplopoma fimbria*) to determine if logbooks can be used to describe targeting patterns. The objective of this study was to identify areas where targeting may be occurring by application of various criteria to the database.

We determined the percentage of yellowtail rockfish or sablefish in each tow. A threshold level was selected and applied to the data to sort for those tows meeting the criteria. Maps were produced showing the locations of the tows meeting the criteria. The resulting distribution of tows from application of the various criteria were compared with each other and with the overall tow distribution for the species.

Life History: Ageing and Food Habits

Comparing Back-Calculated Birthdate Distributions of Juvenile Chilipepper Rockfish with Their Parturition Seasons

by
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Chilipepper rockfish (*Sebastes goodei*) are ovoviviparous. Parturition (larval extrusion) occurs over a several month period during the winter months. Juveniles obtained in the spring from surveys designed to assess year-class strength of juvenile rockfish along the central California coast showed a narrow birthdate distribution of several weeks. To determine whether parturition shifts interannually or if the larvae/juveniles survive from a period of optimal conditions, we examined the incidence of "eyed" embryos in the ovaries of gestating females collected during port sampling of California commercial landings. Data collected in 1985 and 1986 suggested a similar parturition season, although surviving juveniles came from more restricted time periods with centers varying between years.

In 1989, a program was implemented to improve the determination of the date of larval extrusion. Adult fish were obtained from the ports of Fort Bragg and Bodega Bay, California. The developing ovaries were classified to seven stages (i.e., early vitellogenesis to spent condition). Samples of eyed embryos were brought back to the laboratory and examined to estimate the date of parturition. Juvenile fish were obtained from juvenile rockfish surveys. The distribution of estimated dates of winter parturition for 1989-90 and 1990-91 was then compared with the back-calculated birthdate distributions of juveniles that survived until the following spring.

Age Determination and Growth of Rougheye Rockfish (*Sebastes aleutianus*) by the Surface and Break-And-Burn Methods of Otolith Reading

by
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In this study, we estimate the age of 241 rougheye rockfish (*Sebastes aleutianus*) collected during the 1990 NMFS trawl survey of the Gulf of Alaska. The surface and break-and-burn methods of otolith reading are employed to estimate the age of these specimens. A comparison is made of the resulting ages derived by the two ageing techniques. The results of this comparison indicate that the surface and break-and-burn methods yield essentially the same ages up through age 11 yr. After age 11 yr, however, the break-and-burn ages tended to be much older for a given surface age. Growth parameters for the length-weight relationship and the von Bertalanffy growth model are also estimated and presented.

Pb-210/Ra-226 Disequilibrium Used for Age Validation with an Application to Sablefish (*Anoplopoma fimbria*)

by
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The application of radiometric dating to validate groundfish ageing is new. Only four studies have been published to date. I present a review of the theory and necessary assumptions when using the ratio of naturally occurring Pb-210/Ra-226. The method is sensitive to the failure of the assumptions. Sablefish is a good candidate for radiometric age validation because of the difficulty in using the burnt cross-section of their otoliths and because of their potentially long life span. The Pb-210/Ra-226 disequilibria found in sablefish otoliths generally confirmed the ageing criteria used to interpret the otolith's cross-section.

Comparison of diets between *Sebastolobus alascanus* and *S. altivelis*

by
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In recent years, the fishery for *Sebastolobus* spp. has expanded dramatically. As part of an effort to gain basic biological knowledge about these species, we compared the diets of the two *Sebastolobus* species. We examined 1,534 *Sebastolobus alascanus* and 1,366 *S. altivelis* collected during seven cruises from 1988 to 1991. *Sebastolobus alascanus* fed mainly on fish, natantia, and reptantia, while *S. altivelis* was found to consume primarily polychaetes and small crustaceans. We examined the regional and temporal differences both between and among species. The degree of cannibalism was examined for both species along with its implications.

Comparative Feeding Ecology of Sympatric Copper and Quillback Rockfish in Saanich Inlet, British Columbia

by
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Comparative feeding ecology was examined for two sympatric rockfish congeners, copper rockfish (*Sebastes caurinus*) (n=602) and quillback rockfish (*S. maliger*) (n=285), in Saanich Inlet, B.C., Canada, from 1986 to 1990. Rockfish were collected between 15 and 40 m and their food habits determined from stomach content analyses. Both species consumed demersal crustaceans throughout the year. Copper rockfish consumed a greater proportion of pelagic fishes than quillback rockfish, whereas quillback rockfish had a greater proportion of pelagic crustaceans in their diet. Niche breadth of the diet (by mass) for both species was low to moderate (0.19-0.51) in spring, summer and fall. Breadth of the diet was extremely narrow in winter (0.02), however, due to both copper and quillback rockfish feeding predominantly on one prey species, juvenile herring (*Clupea harengus*). Niche overlap based on the mass of food resources consumed by copper and quillback rockfish was relatively high (>0.55) throughout the year, and in particular during the winter (0.99). Narrow niche breadths and high niche overlap between the species in winter occurred when large schools of juvenile herring were available in the environment and were presumably not a limited resource for rockfish. Maximum niche overlap was therefore correlated with an abundance of a shared resource rather than indicative of competition for food resources between copper and quillback rockfish. Copper and quillback rockfish consumed the greatest quantity of food during the winter when feeding on juvenile herring, although quillback rockfish consumed less food mass than copper rockfish in the winter. A greater proportion of quillback rockfish were collected with food in their stomachs during the spring and summer, when the numerically dominant food items were pelagic crustaceans. The importance of fish prey in the diets of both copper and quillback rockfish increased with size.

Food Habits of Flathead Sole, (*Hippoglossoides elassodon*), in the Eastern Bering Sea

by
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Flathead sole (*Hippoglossoides elassodon*) is an important member of the eastern Bering Sea ecosystem; however, little is known of the species food habits within the region. Stomachs were collected from 6,167 flathead sole in the eastern Bering Sea from June 1984 to September 1988. Results of stomach content analysis showed that flathead sole feed primarily on epibenthic and benthopelagic organisms. Overall, ophiuroids were the dominant prey item both by weight (47%) and frequency of occurrence (42%). Fish, mainly walleye pollock (*Theragra chalcogramma*), made up a large portion of the diet by weight (29%) but were of little importance by frequency of occurrence (<10%). Decapods were common prey items and comprised 13% of the overall diet by weight. Analysis of the diet by size group indicated a shift in food habits from a crustacean based diet to an ophiuroid based diet with increasing predator size. Diet composition varied with changes in bottom depth. At bottom depths 150 m, the diet was composed almost exclusively of fish, shrimp, euphausiids and mysids. As bottom depth increased, ophiuroids became increasingly important as food, and comprised the bulk of the diet of fish collected from the continental slope area (>200 m bottom depth). Seasonal and annual variations in diet composition were limited, and no diel feeding patterns were identified. Shannon-Weaver diversity indices calculated for two predator size groups indicated that the diet of large flathead sole (>30 cm) was less diverse than that of smaller fish (<30 cm) in most seasons, years and depth zones, due to a larger proportion of ophiuroids in the diet. Competition among the dominant flatfish species in the eastern Bering Sea does not affect the food habits of flathead sole.

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Trends in Groundfish Predation on Walleye Pollock and Pacific Herring in the Eastern Bering Sea, 1985-88

by
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Groundfish food habits data from 1985 to 1988 were used to describe spatial and interannual trends in predation on walleye pollock, *Theragra chalcogramma*, and Pacific herring, *Clupea harengus pallasi*, in the eastern Bering Sea. The amount of predation was calculated using estimates of predator biomass, daily ration, and the proportion of walleye pollock or Pacific herring in the stomach contents. Groundfish predators included in the study were walleye pollock, Pacific cod *Gadus macrocephalus*, yellowfin sole *Limanda aspera*, Greenland turbot *Reinhardtius hippoglossoides*, arrowtooth flounder *Atheresthes stomias*, flathead sole *Hippoglossoides elassodon*, and rock sole *Lepidopsetta bilineata*.

Groundfish predation on walleye pollock during this time period was dominated by cannibalism on age-0 walleye pollock by adults. Highest predation rates during the 4 years occurred in 1985, which coincided with the higher 1985 pollock year-class size (relative to 1986 through 1988) as predicted by cohort analysis at age 3 and trawl survey estimates at age 1. Estimated numbers of a particular year class of pollock consumed at age 0 by groundfish predators were highly correlated ($r^2 \geq 0.94$) both with cohort analysis estimates of year class size at age 3 and trawl survey estimates of year class size at age 1.

Herring consumption by groundfish predators tended to be sporadic in time and space and may depend on encounter rates of herring schools rather than overall biomass. No particular age group of herring was consumed. Sizes eaten by groundfish mainly ranged from 10 to 30 cm. Pacific cod tended to be the most consistent predator on herring, consuming herring in all four years. Herring were consumed by cod in widely scattered locations on the eastern Bering Sea shelf from May to September. During winter, herring consumption by cod was observed only near the continental slope between 59 and 60°N latitude. Other groundfish predators were walleye pollock, arrowtooth flounder, and Greenland turbot. Consumption by these predators occurred in only 1 or 2 out of the 4 years sampled. There was no apparent relationship between biomass of herring consumed by groundfish predators and cohort analysis estimates of herring biomass in a given year.

Special Session I: In Situ Technology in Fisheries Research

Groundfish - Microhabitat Associations In Low Topography Areas: Applications of Remote Operated Vehicle (ROV) and Manned Submersible Systems

by
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Direct underwater observations using ROVs and manned submersibles were made of the small-scale distribution and microhabitat relationships of groundfish and related fauna at 55 m and 712 m sites off the northeast United States.

Video transects were recorded and treated either as a series of adjacent quadrats (i.e., non-overlapping video frames) or as strip transects. When treated as a series of quadrats, video recordings had the ability of "rolling" the image forward to identify taxa in the far field area of each selected frame. This is not possible using still photographic techniques. While there is a sacrifice in terms of resolution, current high resolution video systems (e.g., Hi-band 8, S-VHS, SP Beta) provide enough detail for taxonomic identifications. The use of "shuttle search" editing functions on the VCR facilitated single frame viewing and manipulation. Post cruise recording of SMPTE time code on each tape enabled individual frames to be identified and relocated.

Microhabitat heterogeneity at both sites occurred on the scale of meters. Microhabitat features included shells, biogenic depressions, depressions with adjacent burrows, excavated clay outcrops, glacial erratic boulders, and sand wave crests within a background of sand-silt or sand-silt-clay substrate. Significant species-specific microhabitat relationships were found for a majority of taxa.

The use of different ROVs and manned submersibles required various analytical procedures to create comparable data sets due to differences in configuration of the video camera (e.g., altitude, tilt angle, lens focal length) and operational constraints (e.g., horizontal excursion distance, bottom time limitations, altitude/velocity restrictions). In general, ROVs and manned submersibles with the capability of mounting the video camera close to the substrate (e.g., <0.5 m) were equivalent. To determine the survey area represented by each microhabitat type, it was possible to categorize video frames with small areas-of-coverage (~ 1 m^2) to a single microhabitat type while frames with large areas-of-coverage (~ 7 m^2) required the use of random dot techniques on randomly selected frames throughout the transect.

Some Applications of Undersea Technology in Marine Fisheries and Ecological Research

by
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From 1979 to 1986 manned submersibles were used to investigate various aspects of the fishery biology and ecology of tilefishes, Branchiostegidae, in the Atlantic Ocean from New England to Florida and in the southeastern Gulf of Mexico. Nekton Gamma was used to evaluate gear configuration, soak time, as well as bait and catch predation on longlines fished for the tilefish, *Lopholatilus chamaeleonticeps*, near Hudson Submarine Canyon. The Johnson Sea-Link system, along with a variety of sensors and sampling devices (e.g., video camera, still and time-lapse photography, CTD, grab and suction samplers, pursing ring and excluder nets, rotenone injector and acoustic transponder), was used to estimate the distribution and abundance of shelters and describe the habitat, behavior and community structure of *Lopholatilus chamaeleonticeps* and *Caulolatilus microps*. Coordinated submersible, sidescan sonar and seismic profiling operations were utilized to demonstrate the role of bioerosion by *Lopholatilus chamaeleonticeps* in creating an 800 km^2 area of rough bottom topography around Hudson Submarine Canyon, and pointed out the potential utility of sidescan sonar as a tool for detection of fish habitats.

In September 1990 we began a pilot project to evaluate the use of an ROV (Mini-Rover) and columnated light photographic system for collecting imagery that if processed on an optical pattern analysis system could yield data on larval fish behavior and predator/prey interactions.

Application of a Visual Cataloging and Identification System to Enhance ROV Studies of Bottom Fisheries

by
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There now exists an abundance of high quality film and video material which has been collected at great expense over the past two decades of marine explorations with submersibles, ROVs and SCUBA. This material could form the basis of an important research tool to be used as an aid in visual identification and training as well as for other research needs. However, to a great extent this valuable resource is essentially unavailable to most investigators due to its cumbersome physical format, dispersed archival sites, and poor quality or complete lack of catalog annotation. With the rapid increase in the use of ROVs and submersibles for fisheries research, this situation is being further exacerbated by the rapid accumulation of new visual material.

Current computing and imaging technologies offer a solution to these problems. Different kinds of images can be captured and converted to optical storage formats. A combination or analog video disc frames and digital image files on CD-ROM offers a system which can deal with both the large capacity needed for survey work and the resolution needed for quantitative studies. These stored, cataloged images can be retrieved quickly and combined with data and graphics to form a variety of useful research tools.

The authors have developed and tested a prototype Visual Cataloging and Identification System which permits collection and cataloging of images using a consistent annotation syntax. It combines database manipulation with image storage on a recordable videodisc and offers retrieval procedures through a graphic user interface. New visuals can be rapidly added as needed. This system allows visual and factual information collected at local research laboratories to be shared as a composite archive by other labs. Furthermore, the files associated with each image can be recalled in conjunction with mapping displays (GIS systems) and can be used to build an image library.

The system ultimately can be used to: (1) visually compare sets of habitat views differing by either geographic location or time of observation; (2) build an image library to assist in catalog annotation and in training workers to identify species using visual characters; (3) review research findings with the support of an interactive visual resource; and (4) enable any user to access large amounts of visual materials and data at any given time. Such features can be used to enhance current and future ROV/Submersible research of bottom fisheries.

Sampling Benthic Populations Using ROVs: How Can Accuracy and Statistical Power Be Maximized?

by
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Samples of benthic populations collected using ROVs, submersibles, or benthic sleds often consist of a few long transects within a site, owing to logistic constraints and long deployment and recovery times. Unfortunately, biologists' abilities to discriminate statistically changes in the abundance or distribution of benthic populations between sites or times are limited by such sampling designs. Because of the limited sample size of surveys using long benthic transects, the power of inferential statistics, used to compare abundance between sites or times, is low.

This presentation focuses on methods that can increase our ability to distinguish spatial and temporal patterns in benthic populations by modifying sampling designs or statistical analyses, or both. Sampling designs can be optimized by decreasing transect lengths and increasing replication, as well as incorporating random and repeated measures designs into benthic surveys. Analysis of autocorrelation along transect lines may allow division of single transects to increase replication within a site. Randomization techniques used to sample parts of single transects may also increase statistical power for comparisons between sites. The applicability of these techniques for benthic surveys will vary considerably.

The Use of Visual Systems in Quantifying the Distribution and Abundance of Commercially Important Demersal Fishes of Central California[1]

by
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Population estimates based on abundance estimates are constrained by limitations imposed by sampling. Trawls have been the standard sampling gear employed in the study of demersal fishes inhabiting areas of sea floor with sediment cover. Quantification of trawl sampling efficiency and bias has been a problem with conventional trawling surveys. For this study, two complementary survey techniques were used, a towed camera sled and bottom trawl.

From May 1984 through May 1985, seven cruises were conducted off Point Sur, California (36° 15-31'N, 122° 4-26'W) to investigate patterns in the distribution and abundance of demersal fishes inhabiting the upper continental slope. Sampling was conducted along bathymetric contours at 200-m intervals between 200 and 1,600 m. A total of 18,430 photographs from 30 camera-sled transects yielded photographs of 9,016 fish from 26 taxa. A total of 12,017 specimens representing at least 44 species of fish were collected in 36 bottom trawls. On the basis of camera transects, *Sebastolobus altivelis* was the numeric and gravimetric dominant. Other important taxa, either in terms of numbers or biomass, included *Eptatretus deani, Sebastolobus alascanus, Microstomus pacificus, Coryphaenoides acrolepis, Albatrossia pectoralis, Anoplopoma fimbria, Antimora microlepis, and Lycenchelys* spp. An unexpected concentration of the hagfish *Eptatretus deani* was discovered between ca. 600 and 800 m where densities averaged 325,000 per km^2.

Trawling was superior to photographic transects in providing a more complete description of the assemblages of benthic fishes within each depth stratum. Trawl-caught specimens were critical for interpreting bottom photographs. Specimens captured in the trawl provided material for a wide variety of laboratory studies including taxonomy, physiology, biochemistry, reproduction and growth. In this study, length-mass relationships and length-frequency data obtained from the trawl samples were used to convert abundance estimates from the camera-sled transects into biomass. Biomass estimates for fishes based on camera transects were higher by at least a factor of three than those based on swept area trawl sampling.

Photographic transects of the sea floor provide a continuous record of pattern in the distribution of fishes along a track on the sea floor. In this study, most species were quasi-randomly distributed on spatial scales ranging from meters to kilometers. An exception to this general pattern was observed for the hagfish *Eptatretus deani* when it was occupying burrows. Visual survey techniques also provide information on habitat associations for many species.

[1] This work was completed while the author was working in Ken Smith's lab at the Scripps Institution of Oceanography and in the Coastal Division of the Southwest Fisheries Science Center, La Jolla.

Fish Assemblages of Deepwater Reefs on the Outer Continental Shelf of Oregon

by
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From 1988 to 1990, we were contracted by the Minerals Management Service to describe fish assemblages on rocky reefs of the Oregon outer continental shelf, to examine interannual variation within the largest of these reefs, and to compare assemblages between reefs. We used the manned submersible Delta to run 2-3 replicate one-hour transects at 3-8 fixed stations on each reef, ranging from 60 to 450 m in depth. On each transect, we quantified demersal fish densities by species and size class, macroinvertebrate densities, and bottom type. We defined each transect segment of uniform bottom type as a "habitat patch" and used Canonical Correlation Analysis (CCA) to measure associations of fish and invertebrate densities within patches.

We detected, first, substantial interannual variability in fish densities at Heceta Bank from 1988 to 1990, and second, substantial differences in fish assemblages among Heceta, Coquille, and Daisy Banks in 1990. Whereas the first pattern remains unexplained, the second pattern was clearly related to habitat differences among banks.

CCA defined three predominant fish-habitat assemblages among banks. (1) *Shallow rock ridges with boulders* (<100 m depth): This reef-top habitat was dominated by three fish taxa. Yellowtail rockfish schooled at pinnacles and underwent foraging forays to midwater euphausid aggregations. Juvenile rockfishes dominated pure boulder bottoms, which provided numerous refuges. The largest piscivore we encountered, lingcod, co-occurred with the juvenile rockfishes, on which they preyed. (2) *Mid-depth boulder-cobblefields*: This extensive reef-slope habitat was dominated by four species of rockfish (sharpchin, pygmy, greenstriped, and rosethorn), which sometimes reached nearly uncountable densities in mixed-species aggregations. There was little evidence of microhabitat partitioning among these species. (3) *Deep mud* (>150 m depth): This reef-base habitat was inhabited by a sparsely distributed but diverse assemblage of fishes specialized for soft bottoms, including flatfishes, poachers, eelpouts, and sablefish. Also present were occasional hagfishes, ratfishes, and snailfishes.

Despite overall constancy in bottom types and invertebrate assemblages sampled at Heceta Bank from 1988 to 1990, the densities of eight abundant scorpaeniform fish taxa (pygmy, sharpchin, rosethorn, yellowtail, and juvenile rockfishes, shortspine thornyhead, lingcod, and sablefish) varied substantially between years. Variation in these fishes was largely concordant, suggesting general causation, although we detected no major interannual variation in oceanographic parameters.

Among banks, Coquille was located closest to shore. It lacked the rock-ridge habitat and was covered by a thin layer of silt, probably as a result of its proximity to coastal runoff. Perhaps as a consequence, Coquille Bank supported no yellowtail rockfish and few of the other rock-ridge fishes. However, soft-bottom species were more abundant at Coquille than at the other two banks, perhaps because of the silty bottom. Daisy Bank was comprised of mostly boulder-dominated bottoms, where juvenile rockfish, lingcod, and other boulder-associated species reached their greatest densities among banks.

Early Life History

Metamorphosis and Settlement of Dover Sole (*Microstomus pacificus*) off Oregon

by
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We examined pelagic larvae and recently-settled larvae and juveniles to describe metamorphosis and settlement of Dover sole. This species has a greatly prolonged pelagic larval period, which lasts approximately one year (based on unvalidated otolith increment counts) or two years (based on length frequency analysis). Eye migration begins shortly after hatching and is uncoupled from metamorphosis and the habitat change from plankton to benthos. Initiation of metamorphosis is associated with a change in six morphological characters, including the completion of eye migration. The earliest metamorphic larvae are collected in midwater trawls from June to January, and are most common September to December of the calendar year prior to settlement. Metamorphic larvae that are competent to settle are found on the bottom and in the water column from January to April or May. Recently-settled larvae (identified by body and otolith morphology) are found over a broad depth range, 55-377 m, while larvae that have been on the bottom longer are restricted to a narrow nursery area centered at 118 m. After settlement, metamorphosis continues as body depth shrinks and a long intestinal loop develops and extends into the secondary body cavity. Sr/Ca ratios in the otolith reach a mininum at about this time. Metamorphosis ends when adult proportions are attained, usually by July. Based on laboratory observations, validated otolith increments, and seasonal collection of staged larvae, the metamorphic process appears to take about one year.

Distribution, Patchiness, Growth, and Hatch Date of Pelagic Juvenile Lingcod (*Ophiodon elongatus*) off Central California

by
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The spatial distribution, growth, and hatch dates of pelagic juvenile lingcod (*Ophiodon elongatus*) off central California are examined in relation to patchiness. Results of 678 midwater trawls from annual research surveys conducted between 1983 and 1990 show that pelagic juvenile lingcod occur in shallow nearshore waters. Moreover, one large catch taken in 1990 off Point Reyes accounted for 27% of all the lingcod sampled. These fish were used to estimate the parameters of a Gompertz growth model from daily increments, from which hatch dates were calculated. The distribution of hatch dates confirmed that these fish were hatched over a 40 d period and came from more than one egg mass.

Oceanographic data indicate that the water mass at the Point Reyes catch site was coastally trapped. We suggest that the fish comprising the large catch were advected south by prevailing currents and accumulated in an area of coastally trapped water between Tomales Point and Point Reyes. These findings indicate that it may be possible to reduce variances from trawl surveys by stratifying over measures of recurrent local oceanography. It is possible that locally retained individuals, which may represent but a small portion of all pelagic juvenile lingcod, are more important to adult population recruitment than fish that are more widely dispersed.

Early Life History of Rockfishes in British Columbia: Preliminary Results of the First Year of Investigation

by
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The Department of Fisheries and Oceans, Canada has recently emphasized stock assessment and habitat as the priority issues for fisheries research and has identified early life history studies as being relevant to both these issues. To address these research priorities, the Marine Fish Population Dynamics Section at the Pacific Biological Station has initiated two programs on the early life history of rockfishes. Long-term goals of the investigation are: a) to examine the distribution and abundance of larval and juvenile stages of commercial rockfish species; b) to examine environmental effects on recruitment in hopes of developing predictive capability; c) to examine stock identification based on larval distribution patterns; d) to identify juvenile habitat requirements for commercial rockfishes; and e) to explore ecological linkages between rockfishes and other marine fishes.

Preliminary results of the first year of the investigation are presented. These results include a qualitative summary of the results of a Pacific ocean perch (*Sebastes alutus*) larval sampling cruise to Queen Charlotte Sound, and two cruises to study juvenile rockfish off the central west coast of Vancouver Island.

Examination of larvae taken from adults showed a wide range of developmental stages, which confirmed earlier observations that the period of parturition could be prolonged in this area. Although early in the period of parturition, larvae were captured at all depths up to over 300 m and were widely dispersed throughout Queen Charlotte Sound. Larval distribution was not inconsistent with our starting hypothesis that wind-driven surface currents would determine larval distribution.

Two survey cruises concentrating on juvenile shelf rockfishes off the west coast of Vancouver Island were completed in May and June 1991. The cruises collected juvenile rockfish and potential rockfish predators by midwater and bottom trawls in trawlable areas, and by midwater trawls and sunken gillnets over untrawlable substrates. Preliminary results documenting length at depth relations are presented for juvenile yellowtail rockfish, *S. flavidus*, and canary rockfish, *S. pinniger*. Bottom trawls provided samples of pygmy rockfish, *S. wilsoni*, and Puget Sound rockfish, *S. emphaeus*, which will be used to examine growth and maturity for these miniature rockfish species.

Recruitment of Juvenile Rockfish (*Sebastes*) to Artificial Reefs in Puget Sound

by
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At settlement from the plankton, juvenile rockfish (*Sebastes*) become strongly substrate-associated, apparently seeking shelter-habitat. Early post-planktonic rockfish recruit to the surface kelp-frond habitat in some beds of *Nereocystis luetkeana* and *Macrocystis pyrifera* in Washington. The biological processes occurring during the important substrate-associated recruitment period, which may significantly influence sub-adult and adult numbers, has been neglected in studies of cohort strength. The importance of shelter availability to recruitment and post-recruitment survival of juvenile rockfish has not been studied.

Artificial reefs in Puget Sound have high densities of sub-adult and adult rockfish; juvenile recruitment on these reefs is minimal and appropriate juvenile habitat appears limited due to construction techniques and depths. Specifically constructed benthic recruitment habitats were added to four artificial reefs in a replicated adjacent-"On-Reef" and isolated-"Off-Reef" design. These recruitment habitats are used to study the biological and abiotic parameters affecting juvenile rockfish recruitment, and the importance of shelter-habitat to recruit survival, growth, and distributions. Cohorts of juvenile rockfish are assessed through recovery of recruits marked (at >30mm TL) with bio-compatible internal micro-tags; the binary-coded wire tag (CWT), the alpha-numeric-coded Visible Implant (VI) tag, and the fluorescent polymer (FP) tag. Shelter-habitat selection and related trophic studies are used to assess benthic habitat function. Recovery of FP tagged juvenile rockfish, using ultra-violet underwater lights during visual strip transects of the benthic recruitment habitat at 11 d, 49 d, and 53 d, indicates early fidelity to the initial recruitment habitat. Differences in adult and juvenile rockfish densities on the On-Reef and Off-Reef habitats indicates (1) possible specific habitat selection by recruiting juveniles, or (2) predation by adults may be a major source of juvenile recruit mortality.

Larval Fish Assemblages off Washington, Oregon, and Northern California: An Overview

by
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Plankton and hydrographic data were collected off the coasts of Washington, Oregon and northern California from 1980 to 1987. Ten research cruises were undertaken for the purpose of investigating patterns in occurrence, distribution and abundance of species of fish eggs and larvae; these were the first large-scale ichthyoplankton surveys to be carried out in this region. Both the neuston and water column, to a depth of 200 m, were sampled at a grid of stations extending from 3 to 200 miles from shore, using neuston and bongo samplers, respectively.

Multispecies distributional patterns among the fish eggs and larvae have been investigated using the multivariate technique of numerical classification. The existence of geographically distinct ichthyoplankton assemblages are inferred from the results. For fish larvae in the water column, four species assemblages have been identified. This presentation will focus on these larval fish assemblages in terms of their distribution, species composition and abundance, and seasonal variation in occurrence and distribution. The origin and maintenance of these assemblages will also be considered with reference to the spawning strategies of the adult fish and the prevailing oceanographic conditions in the survey area.

Environmental Factors

Environmentally Induced Recruitment Variations in Petrale Sole (*Eopsetta jordani*) off Oregon and Washington

by
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Relations between year-class strength (YCS) of petrale sole (*Eopsetta jordani*) with parental stock size and environmental factors were investigated in two coastal areas off Oregon-Washington, (area 2B: 42°50'N - 44°18'N and area 3A: 45°46'N - 47°2O'N). Although spawner-recruit relations were not evident, a regression model based on winter indices of offshore and alongshore transport anomalies accounted for nearly 55% of the YCS variations in area 2B from 1958 to 1977. For the same period in area 3A, winter offshore and alongshore transport and sea surface temperature anomalies explained about 65% of the YCS variation. Nearshore salinity variations caused by the Columbia River also appeared to be related to YCS in area 3A. This study suggests that oceanographic factors control recruitment during winter, the season in which egg and early larval stages of petrale sole appear to be most abundant in coastal surface mixed layers.

Decadal Scale Variations in Winter Ocean Conditions and Recruitment of Northeast Pacific Groundfish

by
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This paper compares winter environmental conditions and year-class strength for a set of northeast Pacific fish stocks. Since 1932, environmental variability has been characterized by alternating warm and cool eras of 6 to 12 years duration. There appear to be two environmental states: one associated with weak circulation in the Alaska gyre and enhanced upwelling along the American west coast, the other with strong circulation in the Gulf of Alaska and weak upwelling farther south. The latter situation characterizes the warm eras, which are commonly initiated by an El Nino-Southern Oscillation event. Evaluation of time series of year-class strength of several fish stocks indicated warm and cool eras influenced groundfish stocks preferentially. The influence of this process on community structure in the northeast Pacific is discussed.

OSCURS Model of Lagrangian Surface Current Patterns in the Gulf of Alaska, Spring and Summer 1946-1990

by
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Results from the Ocean Surface Current Simulations (OSCURS) model provide new information about interannual variability of surface currents in the northeast Pacific Ocean. The model uses a superposition of daily wind drift currents on long-term mean geostrophic currents to explore the potential of obtaining indices of variability that could be applied to fisheries research. The model, previously tuned to reproduce the 1978 trajectories of satellite-tracked drifters (drogued at 20 m), showed successful hindcasted results of a 1962 drift bottle experiment. Drift was then duplicated for the years 1946 to 1990 by calculating daily wind and wind currents using empirical functions and the daily sea level pressure data. Model trajectories calculated from 25 March to 1 October show both convergence and divergence in the Subarctic Current as well as considerable year-to-year variability in flow. Descriptive and numerical analyses performed on this 45-year time series yields long-term mean and anomalous trajectory patterns. Years in which the divergence feature was wide or narrow, shifted north or south, and associated flows were identified. The nature and variability of this feature, which affects fisheries and climate, now can be assessed historically and in near real time.

A 6-minute video tape of results is presented.

Special Session II: In Situ Technology in Fisheries Research

ROV-Based Studies of Macrophyte Drift and Associated Megafauna in a Submarine Canyon

by
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The abundance of macroalgal detritus and associated megafauna were assessed over a three year period at two deep-sea study sites using video surveys performed by a remotely operated submersible vehicle. Density of macroalgal drift parcels was high and varied with time at our submarine canyon study site, perhaps reflecting seasonal fluctuation in export of nearshore macrophytes. Drift macrophytes were nearly absent at all times at an adjacent continental shelf site. The deep-sea echinoid *Allocentrotus fragilis* was a numerically important component of the megafaunal assemblage at both sites. Stomach content analysis of echinoids collected during the surveys showed a high percentage of kelp (*Macrocystis pyrifera*) in their diets. The absence of drift macrophytes at the shelf site may be due to consumption by echinoids rather than low macroalgal flux.

Comparisons of Estimates of the Abundance of Slope Ground Fishes Using ROVs and Trawls

by
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The abundance of slope ground fishes of Monterey, California was estimated using trawls and ROVs. Trawl estimates were made using the swept area method and ROV video tapes were analyzed using line transect methods. Detection functions were calculated for each species. These detection functions differed among species and from still camera transects.

Video transects indicated higher abundance of all organisms than found with the trawl. Abundance of sablefish were three times, Dover sole were four times, and thornyheads were nine times. The abundance of eelpouts, in particular the bigfinned eelpout, was 90 times higher in ROV video surveys than in the trawl samples. Trawl tracks at the 600 m site on the North Canyon wall indicate considerable effort by local fishermen in this area.

Analysis of the 200 m site indicate an extraordinary abundance of *Octopus californicus*. These octopi are observed to feed on euphausiids close to the bottom.

Submersible Observations of Offshore Rockfish in the Eastern Gulf of Alaska

by
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A submersible was used for in situ observations of the spatial distribution and habitat of offshore rockfish, and to visually count rockfish for comparison with bottom trawl catch rates. Fifty submersible dives were completed in the eastern Gulf of Alaska at depths between 188-290 m. Most Pacific ocean perch (*Sebastes alutus*) were in groups of 2-200 individuals located over flat, pebble substrate. Pacific ocean perch within a group were 1-4 m apart, usually oriented into the current, and distributed 0-7 m above the bottom. Shortraker rockfish (*Sebastes borealis*) were on 3-12^0 sloping terrain comprised of silt or pebbles interspersed with boulders. Shortrakers were on or near the bottom and not in groups. Other *Sebastes* spp. were associated with rugged habitat such as cobble, boulders, and coral.

Densities of rockfish estimated from bottom trawl catches were higher than densities observed from the submersible, indicating that the trawl gear herded rockfish into the opening of the trawl. This possible herding effect and their preference for trawlable bottom may result in overestimates of rockfish abundance from bottom trawl surveys.

Investigations of Demersal Shelf Rockfish in the Eastern Gulf of Alaska Using a Submersible

by
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For management purposes, eight species of rockfish (*Sebastes* spp.) are included in the demersal shelf rockfish (DSR) assemblage in the groundfish fisheries of the Gulf of Alaska. Yelloweye rockfish, *S. ruberrimus*, is the commercial target species within the group. Management of these eight species is hampered by the lack of biomass estimates. Trawl surveys, used to estimate biomass of many other groundfish species of Alaska, are precluded by the close association of DSR with untrawlable, rocky ocean bottom with high topographic relief. To obtain biomass estimates, the Alaska Department of Fish and Game is developing a habitat-based stock assessment method for DSR. As part of this development, we are conducting studies to define the relationships between habitat complexity and abundance of DSR. In 1989 we received support from the West Coast Center of the National Undersea Research Program to evaluate the use of a minirover ROV versus the submersible Delta for in situ assessment of DSR. This type of ROV was not a useful tool for prosecuting transects in the high relief areas inhabited by DSR. Using a two-person submersible, strip transects were initially utilized in 1990. However, estimation of transect width is difficult in this type of rugged terrain. After some modifications we were able to use hand-held sonar guns to estimate perpendicular distance to sighted objects, allowing us to employ line transect methods. Line transect methods applied from a 2-person submersible are being used to estimate the abundance of DSR over a range of habitats. Habitat data are collected simultaneously with counts of rockfish. The density of adult yelloweye rockfish was estimated at 2,170 fish per km^2, or 8.7963 t/km^2, on the Fairweather Ground, a rocky bank 35 nautical miles offshore of SE Alaska. Preliminary analysis suggests a definable, positive relationship between DSR abundance and habitat complexity. When refined, the modelled relationships between DSR abundance and habitat will be used with existing NOAA bathymetry data to estimate the probable current biomass of DSR in the eastern Gulf of Alaska.

Lingcod and Rockfish Assessments in Puget Sound

by
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Lingcod (*Ophiodon elongatus*) and four species of rockfishes (*Sebastes* spp.) provide significant recreational opportunities in Puget Sound. Catch rates are used to infer population levels, and these indicators have shown decreasing trends over the last decade, especially in the northern region of the inland marine waters. Yield analysis suggests that rockfish may be overexploited in some areas. Uncertainties about catchability changes and catch estimation procedures have prompted WDF to develop a new method for assessing fishes living on rocky reefs.

A direct method of assessing reef fish populations is being developed that will use some remote technique of estimating fish density. Observations of fish densities are being made with underwater television and high resolution acoustic devices. These remote techniques are being evaluated by simultaneous observations of density made by scuba divers. Once a valid technique is developed, a reef survey will be concluded to estimate the average density of fish in a region. This estimate will then be multiplied by the area of reef habitat, resulting in an estimate of lingcod and rockfish abundance. Abundance estimates can then be incorporated with catch and population parameters into a useful management model.

Preliminary comparisons of camera and scuba counts show close agreements between fish counts and a good ability to identify fish. Estimating areas during underwater television counts is still difficult but may be overcome by sonar technology. Behavioral aspects that affect remote assessment are being studied and include defining the conditions when reef fishes would be visible to video and acoustic gear and whether fish are attracted or repelled by the remote equipment.

Behavior of North Pacific Groundfish Species in Bottom Trawls

by
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Prompted by a need to reduce Pacific halibut (*Hippoglossus stenolepis*) bycatch in trawl fisheries, a cooperative project between the International Pacific Halibut Commission, industry representatives, and the National Marine Fisheries Service was established to aid the development of selective trawls. The initial focus of this project has been to observe and describe the behavior of selected species encountering bottom trawls. A trawl mounted, remotely aimed video system was developed to make those observations.

The observation system consists of an ultra low-light camera mounted on a pan/tilt unit in a protective cage. The cage is mounted on the trawl and the camera is remotely viewed and aimed using a "third wire" cable to the towing vessel.

The behaviors of different species in several areas of a trawl and the influence of trawl modifications on these behaviors have been observed. These behaviors include:

1. Height crossing over the footrope.
2. Location while passing through the intermediate.
3. Reactions to sorting grids placed in the intermediate and codend.
4. Tendency to lead up or dive through lines rising slowly from the bottom.
5. Comparison of reactions to cookie and bobbin gear.

Usefulness of the current observations and future plans of the project will be discussed.

Problems and Solutions in the Use of Submersibles for Studying Epibenthic Macro-Fauna: Crab Aggregations and Pollution Effects

by
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The 2-person submersible Delta was used in 1991 to study the mating of tanner crabs, (*Chionoecetes bairdi*), and to examine the effect of dumping fish processing wastes on the epifaunal community of Chiniak Bay, Kodiak, AK. A number of technical and logistic problems occurred, not all of which were solved. Successes included the development of tools to capture crabs, and methods for enumerating macrofauna. Problems included lack of a device for collecting multiple water samples, recovery of data from external hydrographic monitors, and imprecision of seafloor navigation and positioning. Most of these could be overcome if generic systems were made available to all NURP grantees.

A short video was also presented at the poster session.

Habitat Analysis of Pacific hagfish (*Eptatretus stoutii*) in Monterey Bay, Using the ROV Ventana

by
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Hagfish have been the subject of several Japanese and Korean fisheries; however, their populations have declined. Other sources of hagfish have been investigated, including those along the U.S. west coast, where the Pacific hagfish, *Eptatretus stoutii*, and black hagfish, *E. deani*, are common myxinids, occurring from southeast Alaska to Baja California, Mexico. The Pacific hagfish lives shallower (18-944 m), while the black hagfish is deeper (155-1158 m).

Under Sea Grant support, we have been studying aspects of the life history of these two hagfishes in Monterey Bay for the past two years. Because detailed information on their basic biology is lacking, we used baited traps to collect numerous specimens of Pacific and black hagfishes for studies of their sex ratios, size at maturity, fecundity, reproductive seasonality, and feeding habits. Still unknown are details about their fertilization mechanism, gestation period, and mode of development.

We also concentrated on the distribution, abundance, habitat utilization patterns, and ecological associations of the Pacific hagfish within the Monterey submarine canyon. In situ studies on these fish indicate that they prefer soft mud bottom, in which they burrow, but details about their habitats are few and incomplete. We used videotapes from surveys made by the Monterey Bay Aquarium Research Institute (MBARI) Remote Operated Vehicle (ROV) Ventana to depths of 450 m. The videos were used as a data base for describing the abundance and distribution of the Pacific hagfish at four sites within the bay. A total of 24 dives from April 1989 to June 1990 was included. Frames were used as photo quadrats if they were well lit, clearly focused, not a close-up, and did not overlap with a previously accepted frame. We classified the topography according to geologic formation, general terrain, slope, substrate type, substrate features, and presence of other fishes, invertebrates, and drift algae. The analysis of the MBARI ROV dive tapes indicated a wider use of habitats than previously understood. All four sites examined showed that the majority of animals were seen in sand or mud areas, but a high percentage (30%) were seen in mixed substrate sections, and a surprising number (21 out of 142 total) were seen in areas consisting only of massive substrate. A considerable amount of previously unavailable ecological information can be attained on natural or fished populations of marine organisms using ROVs in the deep-sea habitats, especially when used in conjunction with a traditional sampling study.

Paired Submersible and Acoustic Surveys of a Rocky Reef

by
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Visual belt transects using submersibles have been shown to effectively estimate species composition and relative abundance of bottom dwelling fish. In September 1991, we used hydroacoustic sampling techniques in addition to submersible observations to estimate species composition and relative abundance of fishes on a shallow rocky reef. The combination of hydroacoustic and submersible estimates of fish density provides a more accurate description of fish usage of nearshore rocky reefs.

We used two types of hydroacoustic surveys to estimate fish density and abundance over reefs. The first type of survey included acoustic transects conducted before, during, and after submersible operations. "Before sub" transects were conducted along a preset trackline that the submersible was expected to follow. "During sub" surveys occurred while the submarine was running visual transects on the preset trackline. "After sub" acoustic transects followed as closely as possible the exact route the submersible travelled.

The "Before", "During", and "After" submersible transects enabled us to estimate the numbers of fish too far off the bottom to be quantified by the submersible, and to estimate the numbers of reef fish that were nearer the bottom, but may have avoided the submersible. The submersible, in turn, provided groundtruth for the acoustic system. In several locations, we acoustically located fish schools over submersible stations and conducted "bounce dives" with the submersible to identify midwater species.

The second type of survey we employed included a series of "extensive" acoustic transects over the dive stations in a stratified grid sampling pattern when the submersible was not in use. These "extensive" transects provided a more thorough coverage of the reef system being surveyed and were intended to provide estimates of fish densities over a larger area. Stratified acoustic sampling of the entire study area provided density estimates that enabled us to characterize patchy distribution of reef fish.

Posters

Coquille Bank As Viewed from a Submersible

by
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In 1990, Oregon State University with cooperation from Oregon Department of Fish and Wildlife used the submersible Delta to conduct visual belt transects on Coquille Bank. Coquille Bank is located 17 nmi northwest of Cape Blanco off the central Oregon coast. Dives were conducted on eight stations. Our shallowest dive was to about 105 m while our deepest dive was 361 m. The shallow areas were characterized by boulder-cobble with some mud, and the deep areas were characterized by mud. Visibility was usually only 5 to 15 feet. The dominant fish in the boulder-cobble areas were sharpchin, and pygmy rockfish and to a lesser extent rosethorn rockfish. The prevalent fish in the deeper areas were sole, eelpout, poacher, sablefish, hagfish, and greenstriped rockfish. All fish observed over mud tended to be evenly and sparsely distributed except for greenstriped rockfish which were usually associated with small patches of rock surrounded by mud and sablefish which occurred in schools.

Age and Growth of Juvenile Walleye Pollock (*Theragra chalcogramma*)

by
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Growth rate and hatch date distributions were estimated for juvenile walleye pollock (*Theragra chalcogramma*) collected from the western Gulf of Alaska in autumn of 1987. Slower growth around Unimak Pass and the Shumagin Islands and faster growth upstream in the Alaska Coastal Current towards Kodiak Island was noted. Hatch date distributions were compared to identify regional differences that might reflect stock structure. For the main aggregation of pollock in the Shumagin Island region, hatch date distributions were not significantly different among the early larval cohort sampled in late May, the late larvae sampled in mid-June to early July, and the juveniles sampled in autumn. Lengths-at-age during larval life were back-calculated from juvenile otoliths and compared with lengths-at-age of the population sampled as larvae in May and June. Pollock surviving as juveniles in autumn were not larger as larvae than the general larval population.

Age Determination of Shortspine Thornyhead, *Sebastolobus alascanus*, Using Otolith Sections and ^{210}Pb:^{226}Ra Ratios

by
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Annuli in thin sections of otoliths were counted to determine the age of the shortspine thornyhead, *Sebastolobus alascanus*. Ages were validated by ^{210}Pb:^{226}Ra ratios in the cores of otoliths. Thin section ages indicated longevity of 147 y. Otolith length, width, and weight were examined and weight was the best predictor of thin section age. A von Bertalanffy growth curve was fitted to age and length data with Brodie growth coeeficient K = 0.023 and L_∞ = 72.8 cm. Age of 50 percent maturity was estimated at 13 y. Shortspine thornyhead is a very slow growing, long-lived fish. These results have important implications for the expanding fishery for thornyheads, *S. alascanus and S. altivelis*.

A Geometry-Based Morphometric Technique Applied to Walleye Pollock

by
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In order to help elucidate the stock structure of Bering Sea walleye pollock a new morphometric technique has been applied to samples of pollock from throughout the Bering Sea.

From photographs of pollock, landmark points are digitized and the resulting set of points are converted into shape coordinates by assigning two landmarks as endpoints along a 0-1 baseline with the coordinates of the remaining points scaled accordingly. This eliminates the effect of size on each specimen and preserves the two-dimensional position of all the landmarks.

Multivariate analysis of these collections of coordinates is then possible. Any variation in shape can be broken down into a linear and nonlinear component. The analysis of within and between group variation in shape is carried out by a principal components analysis of both the linear and nonlinear parts. Details of the technique and the results of the analysis on pollock will be presented.

A Histological Description of Shortspine Thornyhead Ovaries: Structures Associated with the Production of Gelatinous Egg Masses

by
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The ovarian structure of the shortspine thornyhead (*Sebastolobus alascanus*, Scorpaeniformes), which is similar to the ovarian structure previously described only for the pigmy lion fish (*Dendrochirus brachypterus*, Scorpaeniformes), is specialized for the production and expulsion of pelagic gelatinous egg masses. The germinative tissue and oocytes of *S. alascanus* encircle a mass of spongy ovarian stroma that is located within the center of the ovary. The stroma is attached to the ovarian wall only at the anterior end of each ovarian lobe; hence, the ovarian lumen surrounds the stroma, germinative tissue, and oocytes. Oocyte development takes place on the ends of vascularized ovarian peduncles that are protrusions of the ovarian stroma. Eggs are ovulated into an ovarian lumen that contains a gelatinous material. The gelatinous material is secreted into the ovarian lumen by a single row of specialized cells that line the ovarian wall.

Ovarian structures of *S. alascanus* and *D. brachypterus* are compared to descriptions provided for *Sebastes* species. Similarities in the ovarian wall epithelia between genera suggest a possible secretory function for *Sebastes*. The ovuliparous gelatinous spawns of *S. alascanus* and *D. brachypterus* may represent an intermediate step in the evolution of *Sebastes* viviparity.

Rockfish Fleet Dynamics in the Gulf of Alaska and Bering Sea: When They Fish, Where They Fish, and What They Fish For

by
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Understanding the dynamic behavior of fishing fleets is an area of fisheries research that needs greater attention. A better understanding of why, when, where, and how fishermen fish the way they do, can only lead to improved management of our fishery resources. The goal of our poster session is to provide preliminary information on the rockfish fleet in waters off Alaska. We examine catch, effort, and species composition information collected by U.S. observers aboard rockfish vessels in 1990 and 1991. Information on seasonality, distribution (temporal and spatial), specific targeting, species composition, and other fleet dynamics parameters are presented.

Plans for the HURL Deep-Ocean Remotely Operated Vehicle Research Program In the Western Pacific

by
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The Hawaii Undersea Research Lab (HURL) is one of the five National Undersea Research Centers in NOAA's National Undersea Research Program. HURL owns and operates the 2000 m manned submersible Pisces V, the 1000 m RCV-150 remotely operated vehicle (ROV) and the full ocean depth rated ALX-L deep-tow camera system. A unique aspect of our deep submergence expertise is the ability to complement manned submersible work with a suite of remote technologies. This allows scientists to more effectively utilize their manned bottom time. In the fall of this year we will take delivery of our new submersible support ship, the Kaimikai 0 Kanoloa. With this suite of technology and hardware, we will be able to establish a complete manned presence to 2000 m anywhere in the Pacific.

The working depth of the RCV-150 remotely operated vehicle system is currently being doubled to 2000 m. The extended depth capability will allow the ROV to reoccupy and sample sites marked by the submersible, survey areas of interest for use in planning future submersible dives, and to deploy and recover instrument packages to and from the seafloor. HURL has designed a multi-use, electro-opto-mechanical cable. This new cable will be used to deploy the ROV, the deep-tow camera, and other instruments such as television grab samplers. The ROV and cable will also provide an independent submersible rescue capability.

The Western Pacific Program will begin in the 1993-94 time frame. This program will focus on the biology and geology of seamounts in the Commonwealth of the Northern Marianas and the nearby United States EEZ of Guam. Emphasis will be placed on integrative regional studies. Successful scientists will be expected to contribute to broadly defined research goals as well as produce referred results in their own fields of study. In 1995 the program may be expanded to include other areas such as the Okinawa Trough and the Ryukyus.

Species Identification from ROV Video Images

by
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One of the major problems facing the use of video analysis for fish population estimation is the accurate identification of the different species. The identification concerns from a video image are different than when a fish is in hand (it is hard to count gill rakers from a video image). We examined video images of fish species from 100 - 600 m and developed video identification methods. This includes the use of meristics, pigmentation, swimming and other behaviors, geographic and depth considerations, habitat, reflectivity, etc. Specific examples are shown in the poster and the display videotape.

Reproductive Demography of Darkblotched Rockfish (*Sebastes crameri*) off the Oregon Coast

by
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The reproductive development, size and age at sexual maturity, and fecundity were described for darkblotched rockfish (*Sebastes crameri*) collected off the Oregon coast. A total of 1,060 fish were examined; specimens were caught by commercial groundfish and shrimp trawlers between July 1986 and July 1987.

Insemination of females occurred from September to December, fertilization from December to February, and parturition from December to March. Females attained 50% maturity (reference point at which 50% of fish are mature) at a greater size (36.7 cm total length) and age (8.3 years) than males (29.7 cm total length; 5.2 years). A high percentage of the females collected, predominantly 6, 7 and 8 year olds, possessed ovaries in an intermediate "maturing" condition. Histological analysis revealed that these females were immature (e.g., ovaries showed no evidence of previous spawning and oocytes were unyolked). Fecundities ranged from 19,815 to 489,064 oocytes/ovary pair and increased exponentially with increasing fish size.

The age at full recruitment of females (7 years) was less than their age at 50% maturity. In addition, the largest most fecund individuals appeared reduced in abundance. Hence, continued exploitation of this species at current levels may compromise future recruitment.

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Assessment of Size Selectivity Parameters for Groundfish Species Caught in the West Coast Trawl Fishery

by
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One objective of this study is the comparison of size selection of commercially important groundfish species by diamond and square mesh codends. Catch-at-length data and other relevant information were collected through controlled mesh size experiments performed from 1988 to 1990, with the voluntary participation of the west coast groundfish trawl fleet. Selection curves of logistic type were fitted for sablefish (*Anoplopoma fimbria*), Dover sole (*Microstomus pacificus*) and shortspine thornyhead rockfish (*Sebastolobus alascanus*). Three methods were employed in estimating the parameters of the selection curves: 1) least-squares fitting of logistic curves to catch-at-length ratios corrected for ratios greater than 1; 2) least-squares fitting of logistic curves to 3-point moving averages of catch-at-length ratios; and 3) maximizing the likelihood equation for the catch-at-length by the experimental net referred to the joint catch by both the experimental and control nets. The resulting curves for each species, mesh type, and fitting methods were compared.

Population Characteristics of Arrowtooth Flounder, (*Atheresthes stomias*), off the Washington Coast

by
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Arrowtooth flounder (*Atheresthes stomias*) are one of the most abundant flatfishes in the north Pacific Ocean. Pacific coast landings have increased dramatically to 5,824 tons in 1990 from a previous 5-year average of 2,648 tons per year. Typically, over 60% of landings are from PMFC area 3C, just south of the U.S.-Canada border west of Cape Flattery. The Washington Department of Fisheries has been collecting biological data from market samples since 1986. Females seen ranged from 25 cm to 87 cm in length and from 3 to 27 years old. Average length of males tended to be about 15 cm less than females for a given year and males occurred much less frequently in market samples. Males sampled ranged from 30 to 71 cm, and from 3 to 19 years of age. At present very little is known about arrowtooth flounder biology and life history. A one-year maturity study is currently under way to pinpoint time of spawning, estimate length and age at maturity, calculate the gonad-somatic index for females, and collect ovarian tissue samples for histological examination. Sampling began in July 1991. Through December the gonadsomatic index has increased, and the first spawning fish were seen in the 7 December 1991 sample. Evidence suggests an annual on-off shore spawning migration, with fish moving to deeper water in winter. Planning for an age validation tagging project is under way.

Testing for Differences in Fish Abundance Between Finite Geographic Subregions of a Large Study Area

by
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Subregions of our study area between San Francisco and Monterey, CA are candidates for the receipt of dredge materials from San Francisco Bay. While the Tiburon Laboratory (NMFS) possesses the best set of midwater trawl data in the area, sampling is sparse in the subregions of interest making direct comparisons difficult.

To directly compare fauna at the candidate disposal sites a multistep analytical scheme was employed. First, the data were log transformed to homogenize variance and promote additivity of spatial differences. The data were then standardized (using z scores) to control for temporal changes common to the entire study region. Estimates of density were made on a finely and evenly spaced grid throughout the study region by interpolation between observed data points using several different interpolation algorithms. Fish density estimates in the subregions of interest were simply the average of interpolated values within each subregion. A jackknife procedure was employed, treating surveys as replicates, to estimate the variance of subregion means or differences between means for pairs of subregions.

Our final product consists of contour plots and statistics which test for differences in fish abundance between the candidate dredge disposal sites.

An Electronic Measuring Board Using Bar Codes

by
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The National Marine Fisheries Service annually conducts a longline survey for sablefish in the Gulf of Alaska. One to three thousand fish are caught each day, including species other than sablefish. Fish lengths routinely are measured and recorded by punching pin holes in plasticized paper strips. This method is quick and efficient, but suffers from several faults: the pin holes occasionally overlap and are hard to read, these holes must be tallied, and the tallied length frequencies must be keypunched into an electronic database. Because of these faults, I devised an alternative method of recording lengths.

The length measuring board consists of a ruler labeled with bar codes designating length and sex. In use, the fish is laid down on the board, and the appropriate bar code is read by a bar code wand. The information is stored in an electronic data logger attached to the bar code wand. The species and depth strata also are recorded automatically when length and sex are recorded. Species and depth strata are reset on the electronic data logger only when they change. The advantage of this approach is that only a single stroke of the bar code wand is necessary to record information on species, depth strata, length, and sex for each fish. At the end of the day, the data in the electronic data logger is downloaded to a personal computer.

The length measuring board was tested during the 1991 longline survey. The board successfully survived twenty-one days at sea and recorded over 34,000 lengths. The reading of the bar codes by the bar code scanner was checked routinely; the reading was reliable. Battery power in the electronic data logger was sufficient for the eight to ten hour work day. The system is nearly entirely water proof. The measuring board is made of mylar and the bar code wand and electronic data logger are sealed. The only connection exposed, that between the bar code reader and the data logger, was sealed with plastic. The main disadvantage of electronic measuring board is that there is no hard copy of the data until the data are downloaded to the personal computer and the data are printed. Thus, up to one day of length data could be lost if the data logger failed. However the data logger worked reliably. The rate of recording lengths for the electronic measuring board was similar to that for the old paper and punch method. The electronic measuring board reduced the time necessary for taking care of the data by about half. Further the disadvantages of the paper punch recording method were avoided and the tedious chore for three people of tallying and keypunching length frequencies for one to two hours each day while at sea in a rolling ship was gone.

Distribution and Abundance of Juvenile Pollock from Historical Shrimp Trawl Surveys in the Western Gulf of Alaska

by
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Abundance indices were formulated from historical data on age-0 and age-1 juveniles, and age-2 recruits of walleye pollock *Theragra chalcogramma* in the western Gulf of Alaska. Indices were examined for linear and rank correlations to determine when year-class strength is established. Age-0 were significantly correlated with Age-2 recruits, and the rank ordering of year-class strength did not change significantly between these stages. This correlation has several implications. First, relative recruitment levels appear to be established within the first 5 months after spawning. Second, the variability of age-0 recruits is great and represents a strong signal in the dynamics of the population. Finally, prerecruit surveys can be conducted to provide a prediction of year-class strength.

Fish Assemblages of Deep Rocky Reefs off Oregon

by
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Oregon State University with cooperation from Oregon Department of Fish and Wildlife has conducted a sampling program using submersibles to describe and monitor the community structure of fishes inhabiting rocky banks on the outer continental shelf off Oregon. From 1987-1989, sampling was done on Heceta Bank which is located 55 km off the central Oregon coast and rises abruptly from depths over 1,000 m on its seaward side to depths of less than 60 m. Sampling consisted of replicated visual belt transects at six fixed stations. Project methods and results including diversity and abundance of species, habitat segregation among rockfish, fish habitat, associations, and annual variation are summarized in our poster.

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Reproduction and Benthic Settlement of *Sebastolobus altivelis* (Scorpaenidae) Inhabiting the Upper Continental Slope off Central California[1]

by
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Studies on reproduction in adult *Sebastolobus altivelis* (longspine thornyhead) and settlement of their juveniles were conducted on trawl caught specimens collected off Point Sur, California from May 1984 to May 1985. Spawning, as indicated by the presence of hydrated oocytes in the ovaries, occurred during February and March. The median size for achieving sexual maturity for females was estimated to be 150 mm SL. On the basis of preliminary size at age data, determined from sectioned otoliths (not validated), 50% of *S. altivelis* are mature at age 13. *Sebastolobus altivelis* is a multiple spawner with determinate fecundity. Prior to spawning a single group of maturing oocytes (adding yolk) become differentiated from the immature oocytes (unyolked) that are present year-round in the ovary. Total annual fecundity for a 200 g female (SL = ca. 200 mm) was estimated at ca. 27,000 eggs with two to four batches spawned per season. On the basis of a combination of trawl samples and camera-sled transects, it was determined that 93% of the spawning population of *S. aitivelis* inhabits a stratum bounded by the 500 and 1,100 m isobaths. This depth stratum coincides with the oxygen minimum zone off central California. The slope-wide abundance of the spawning stock is estimated as ca. 3.0 to 4.3 x 10^4 individuals per 100 m of coastline for a representative segment of the slope off Point Sur, California (water depth = 400 - 1,600 m; area = 3.5 x 10^6 m^2).

Sebastolobus altivelis settle as relatively large demersal juveniles. The smallest demersal juvenile captured was 48 mm long. Juveniles settle over a broad depth range from ca. 600 to 1,200 m. Evidence from the current study does not indicate episodic settlement in this bathyal species, synchronized spawning apparently does not lead to synchronized settlement perhaps because of the protracted pelagic developmental period.

[1] This work was completed while the author was working in Ken Smith's lab at the Scripps Institution of Oceanography and in the Coastal Division of the Southwest Fisheries Science Center, La Jolla.

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Appendix

Previous Conference Agendas

1981 WESTERN GROUNDFISH CONFERENCE
SALISHAN LODGE
November 18-20

AGENDA

SESSION I - SAMPLING and ASSESSMENT
Wednesday 8:15 a.m. - 12:00 p.m.

Moderator - M. Hayes (NWAFC)

1. S. Johnson (ODFW). Heceta Bank rockfish survey.

2. J. Tagart (WDF). Preliminary results on the stock assessment of yellowtail rockfish (*S. flavidus*) in the United States portion of the INPFC Vancouver area.

3. W. Lenarz (SWFC). Assessment of the widow rockfish fishery.

4. R. Demory (ODFW). Should we sample both sexes of groundfish?

5. C. Cooperidder and W. Lenarz (SWFC). Study of a biological sample design for commercial landings of widow rockfish.

6. M. Nelson (NWAFC). The acoustic survey and research program at NWAFC (Presented by J. Traynor).

7. R. Thorne and G. Thomas (UW). Acoustic assessment of fish near bottom.

8. R. Uchida and D. Tagami (SWFC). Status of groundfish research in the northeastern Hawaiian Islands.

9. J. June (NWAFC). Summer and winter distribution and abundance of demersal fish along the continental shelf edge of the southeastern Bering Sea.

SESSION II - LIFE HISTORY and RELATIONSHIPS with the ENVIRONMENT
Wednesday 1:30 - 5:30 p.m.
Moderator - G. Cailliet (MLML)

1. G. Boehlert (OSU). Methodology of age determination and verification of age in *Sebastes*.

2. G. Hirschhorn and G. Small (NWAFC). Estimating growth parameters from scale surface area measurements: Comparisons with synthetic cohort estimates.

3. T. Echeverria (SWFC). Maturity in six species of rockfish (*Pisces*; *Scorpaenidae*; *Sebastes*).

4. A. Tyler (OSU). A review of the Oregon State University Sea Grant project: The Pleuronectid production system and its fishery.

5. W. Pearcey (OSU). A review of the Oregon State University Sea Grant project: The Pleuronectid production system and its fishery.

6. R. Rosenthal, L. Haldorson, J. Field, M. LaRiviere, V. Moron and J. Underwood (Alaska Coastal Research). Investigations of shallow water bottomfish off the coast of southeast Alaska with an evaluation of the gear types employed in the commercial fishery.

7. G. Walters (NWAFC). Early life history aspects of Gadids in Port Townsend Bay, Washington.

8. M. Love (Occidental College). Aspects of the life history and fishery of the white croaker (*Genyonemus lineatus*).

9. S. Becker, N. Gerrish, and K. Chew (UW). Patterns of demersal fish distributions in relation to the sedimentary environment.

SESSION III - FOOD WEBS and TROPHIC DYNAMICS
Thursday 8:00 a.m. - 12:00 noon

Moderator - A. Tyler (OSU)

1. E. Hobson and J. Chess (SWFC). Seasonal patterns in trophic relationships of the blue rockfish (*Sebastes mystinus*).
2. K. Bailey and J. Yen (UW). Predation by *Eucheta elongata* and other invertebrates on eggs and larvae of Pacific hake.
3. E. Best and G. St-Pierre (IPHC). Pacific halibut: Predator or prey.
4. R. Brodeur (OSU). Food habits of several shelf rockfish species.
5. W. Wakefield (OSU). Feeding relationships within an assemblage of demersal fishes on the Oregon continental shelf.
6. J. Goering (UA). The role of oceanic fronts in S.E. Bering Sea shelf food webs.
7. R. Cooney (UA). Feeding preferences and the distribution of food for larval and post-larval walleye pollock (*Theragra chalcogramma*) in the southeastern Bering Sea (presented by R. Smith).
8. R. Smith (UA). Feeding in juvenile and adult pollock--influence of size, season, and geographical area.
9. T. Nishiyama (UA) Size, number, and weight of stomach contents of larval pollock.

SESSION IV - ECONOMICS, SOCIOLOGY, and MANAGEMENT
Thursday 1:30 - 5:30 p.m.

Moderator - I. Barrett (SWFC)

1. M. Lynde (UW). Predicted supply curve for domestic western Alaska groundfish harvest.
2. P. Adams and W. Lenarz (SWFC). Some estimates of the ability to target on species in the northeastern Pacific otter trawl fishery.
3. D. McCaughran (IPHC). Management of Pacific halibut.
4. C. Pautzke (NPFMC). Groundfish management decisions in the Alaska FCZ.
5. C. Carter and B. Rettig (ODFW, OSU). Multifishery activity in Oregon commercial fishing fleets.
6. G. Smith (SWR). Fisheries management considerations for allocating groundfish resources among competing user groups.
7. T. Johnson and M. Miller (UW). Smallboat fishing commitment and groundfish development.
8. P. Stevens (SIO). Pacific whiting: Multispecies interactions and management/policy approaches.
9. E. Ueber (SWFC). 1990 management of the California, Oregon, and Washington groundfish fishery.

SESSION V - MODELING, QUANTITATIVE ANALYSIS and SYSTEMS APPROACH to GROUNDFISH RESEARCH
Friday 8:00 a.m. - 12:00 noon.

Moderator - D. Hankin (HSU)

1. R. Mintel and G. Smith (NWAFC). A description of the resource survey data-base system of the Northwest and Alaska Fisheries Center, 1981.

2. D. Bernard (OSU). Simulation analysis of the offshore Pacific whiting stock.

3. C. Knechtel and L. Bledsoe (NWAFC). A numerical simutlation model of the population dynamics of walleye pollock in a simplified ecosystem.

4. R. McKelvey (UI). Modeling economic regulation of the groundfisheries.

5. W. Karp (UW). Mark-recapture estimates of exploitation and migration rates for Pacific cod in Port Townsend Bay, Washington.

6. R. Deriso (IPHC). Application of a delay-difference population model to Pacific halibut.

7. G. Kruse and A. Tyler (OSU). Influence of physical factors on the English sole (*Parophrys vetulus*) spawning season.

8. L. Low (NWAFC). Simulation model for evaluation of time-area closures for Bering Sea groundfish fisheries.

9. K. Bailey and R. Francis (NWAFC). Ongoing research on the resource biology and fisheries management of Pacific whiting and walleye pollock.

1983 WESTERN GROUNDFISH CONFERENCE
Asilomar Conference Center
Pacific Grove, California
January 10-12

Agenda

Opening Remarks - Monday 8:15 a.m.

SESSION I- ECONOMICS and MODELING
Monday 8:20 - 11:45 a.m. - Heather Room

Moderator: William Aron (NWAFC)

1. R. Francis (NWAFC). Management model for the Pacific whiting fishery.
2. T. Hayden (OSU). Environmental effects on yield in the English sole fisheries off Oregon and Washington.
3. R. Stanley (PBS). Correlative examination of environmental parameters and indices of Pacific ocean perch recruitment in Queen Charlotte Sound.
4. D. Knechtel (NWAFC). Some useful areas for further research as indicated by a sensitivity analysis of a model of walleye pollock.
5. S. Anderson and S. Hansen (UC-Davis). Marketing channels of west coast groundfish.
6. C. Korson (SWR). An economic overview of the past five years of the Pacific groundfish fishery.
7. E. Ueber (SWFC). Fishery yield curves.

SESSION II - REVIEW PAPERS on ROCKFISH BIOLOGY and MANAGEMENT
Monday 1:00 - 5:15 p.m. - Heather Room

Moderator: Jurgen Westrheim (PBS)

1. R. Lea (CDFG). Current approaches to and problems with rockfish systematics.
2. W. Lenarz and T. Echeverria (SWFC). Comparative biology of rockfishes.
3. R. Larson (SF State U). Ecology of nearshore rockfishes.
4. M. Love (Occidental College). Movements of rockfishes.
5. G. Boehlert (OSU). An overview of ageing of rockfish.
6. R. Mayo (NEFC). Redfish fisheries of the north Atlantic.
7. D. Gunderson (UW). Pacific ocean perch fisheries of the north Pacific.
8. T. Jow (CDFG). Review of west coast rockfish fisheries.

Monday 7:30 - 9:30 p.m. - Toyon Room
Meeting of the Technical Sub-Committee of the U.S. - Canada Groundfish Committee.

SESSION III - FISHERIES MONITORING: SAMPLE DESIGN, PROBLEMS and METHODOLOGY
Tuesday 8:15 - 11:45 a.m. - Toyon Room

Moderator: Norm Abramson (SWFC)

1. M. Mangel (UC-Davis). Theory of effort allocation for acoustic surveys.
2. C. Rose (NWAFC). An examination of methods for sampling research trawl catches.
3. C. Cooperrider (SWFC). Cost components of sampling rockfish landings - Where does all the money go?
4. J. Coe (NWAFC). Use of post-stratification techniques for data from the 1982 eastern Bering Sea groundfish survey.
5. M. Wilkins (NWAFC). Feasibility of applying hydroacoustic/line transect survey methodology to the estimation of groundfish populations.
6. R. Stanley and J. Fargo (PBS). Significance of discarded juveniles on overall yield and sequential population analysis of Hecate Strait English sole (*Parophrys vetulus*).
7. D. Gotshall (CDFG). A new method for acquiring CPUE data using divers.
8. G. Hirschhorn and G. Small (NWAFC). Age and growth patterns from scale surface measurements generated by digitizers with emphasis on within-fish variability of Pacific cod.

SESSION IV - DISTRIBUTION and COMMUNITY STRUCTURE
Tuesday 8:15 - 11:45 a.m. - Acacia Room

Moderator: Francis Henry (CDFG)

1. J. Allen (NWAFC). Organization and evolution of demersal fish communities of the southern California shelf.
2. L. Haldorson (UA). Community population structure of shallow-water reef fishes off southeast Alaska.
3. P. Raymore (NWAFC). Description of the fish fauna of the eastern Bering Sea continental slope province.
4. G. Walters (NWAFC). Geographic patterns of demersal fish and invertebrate communities in the eastern Bering Sea.
5. W. Westphal (Occidental College). Spatial and temporal distribution of soft-substrate fishes off southern California.
6. T. Nishiyama and Lih-Feng Chen (Inst. Marine Sciences, Fairbanks). Effect of water temperature upon the growth and distribution of walleye pollock in the eastern Bering Sea.
7. E. Brown (NWAFC). Assessment of diel variability in the distribution of groundfish in the vicinity of Cape Ommaney, Alaska.
8. J. Field (UW). Patterns of distribution and growth of dusky, black, and yellowtail rockfishes in the southeastern Gulf of Alaska.

SESSION V - FOOD HABITS
Tuesday 1:00 - 3:00 p.m. - Toyon Room

Moderator: Milton Love (Occidental College)

1. R. Smith (UA). Flatfish feeding in Alaskan waters.

2. D. Gadomski (OSU). Feeding ecology of pelagic larvae of English sole (*Parophrys vetulus*) and butter sole, (*Isopsetta isolepis*).

3. D. Howard (SWFC). Seasonal variability in feeding habits of the kelp greenling (*Hexagrammos decagrammus*).

4. T. Nishiyama (Inst. Marine Sciences, Fairbanks). Feeding aspects of larval walleye pollock.

5. C. Ryan (SWFC). Feeding of brown rockfish (*Sebastes auriculatus*) in San Francisco Bay.

6. J. Chess and S. Smith (SWFC). Diel and seasonal patterns in feeding relations of the shortbelly rockfish, (*Sebastes jordani*).

SESSION VI - FISHERIES MANAGEMENT
TUESDAY 3:30 - 5:15 p.m.

Moderator: Robert Demory (ODFW)

1. D. Thomas (CDFG). Effects of foreign fishing on the central California trawl fishery.

2. J. Hardwick (CDFG). Changes in California's sablefish fishery in the 1970's.

3. R. Porter (PMFC). Marine recreational fish statistics survey: Groundfish sport catch.

SESSION VII - ROCKFISH LIFE HISTORY and BIOLOGY
Tuesday 1:00 - 5:15 p.m. - Acacia Room

Moderator: Donald Gunderson (UW)

1. D. VenTresca, R. Lea and R. McAllister (CDFG). Movement of tagged rockfish along the central California coast.

2. B. Leaman (PBS). Rockfish ageing techniques and implications on estimates of growth and mortality rates.

3. M. Yoklavitch and G. Boehlert (OSU). Variability in age estimates in *Sebastes* as a function of methodology, different readers, and different laboratories.

4. R. Rosenthal (Alaska Coastal Research, Langley). Preliminary observations on the biology, distribution and abundance of the Puget Sound rockfish in southern Alaska.

5. L. Chen (SD State Univ). Meristic variation in *Sebastes*.

6. L. Wishard (UW). Electrophoretic investigations of the genus *Sebastes*.

7. R. Beckwitt and J. Petruska (Occidental College). Mitochondrial DNA analyses in the family Scorpaenidae: Possible applications in taxonomy and stock analysis.

8. T. Echeverria (SWFC). Comparison of microscopic and macroscopic determinations of sexual maturity in rockfish.

9. P. Guillemot (SF State U). Seasonal cycles of fat content and gonad volumes in rockfish species in California.

10. R. Brodeur (OSU). Gastric evacuation rates of black rockfish and their application to daily ration and food consumption estimates.

Business Meeting - Tuesday 7:30 p.m. - Acacia Room

SESSION VIII - ELASMOBRANCH BIOLOGY and MANAGEMENT
WEDNESDAY 8:15 - 11:45 a.m.

Moderator: Gregor Cailliet (MLML)

1. D. Miller (CDFG). White shark activity off the Pacific coast.

2. J. Richards (Sea Grant, UC-Santa Barbara). An overview of the California angel shark fishery in the Santa Barbara Channel.

3. G. Cailliet (MLML). Studies on the age and growth of the Pacific angel shark (*Squatina californica*) using vertebral bands.

4. D. Kusher and G. Cailliet (MLML). Age, growth, and reproduction of the leopard shark (*Triakis semifasciata*), gray smoothhound (*Mustelus californicus*), and the brown smoothhound (*Mustelus henlei*).

5. S. Smith (SWFC). Age verification and movements of field tagged leopard sharks (*Triakis semifasciata*) in San Francisco Bay.

6. D. Bedford (CDFG). Review of the California drift-net fishery for sharks.

1985 WESTERN GROUNDFISH CONFERENCE
THE ALDERBROOK INN
Union, Washington
February 10-13

AGENDA

Opening Remarks - Monday 8:00 - 8:15 a.m., R. Francis, E. Ueber, Eastwood

SESSION I - SURVEYS and FISHERIES ECOLOGY
MONDAY 8:15 a.m.-12 Noon, Eastwood

Moderator: T. Dark (NWAFC)

1. H. McElderry (Victoria B.C.). A survey of saltwater recreational anglers in British Columbia: The role of bottomfishing in a predominantly salmon oriented sportfishery.

2. T. Wyllie Echeverria (SWFC). Abundance and distribution of juvenile rockfish (*Pisces*; *Scorpaenidae*; *Sebastes*) from central California.

3. G. Walters (NWAFC). Studies of the distribution and abundance of juvenile groundfish in the northwestern Gulf of Alaska, 1980-82.

4. D. Knechtel (NWAFC). Predicted probabilities of detecting changes in annual abundance of juvenile groundfish in the Gulf of Alaska, as a function of annual population densities and number of fishery survey trawl hauls.

5. J. Traynor (NWAFC). Distribution and size composition of age 0 walleye pollock in the eastern Bering Sea based on acoustic midwater trawl survey in 1982 and 1984.

6. N. Williamson and J. Traynor (NWAFC). Research on the acoustic target strength of fish at the Northwest and Alaska Fisheries Center.

7. E. Nunnallee (NWAFC). Abundance of spawning walleye pollock in Shelikof Strait as determined from acoustic midwater trawl surveys in 1980-84.

8. R. Keiser, T. Mulligan, N. Williamson and M. Nelson (PBS, NWAFC). Intercalibration of two echo integration systems based on acoustic backscattering measurements.

9. B. Culver (WDF). Movement of black rockfish (*Sebastes melanops*) tagged off the Washington and Oregon coast.

10. R. Brodeur and W. Pearcy (OSU). A distribution analysis of some pelagic nekton off Oregon and Washington.

11. J. Allen (NWAFC). Functional structure of demersal fish communities of the eastern Bering Sea.

12. P. Murphy (NWAFC). Distribution and trophic relationships of nearshore bottomfish in coastal waters of southeast Alaska.

SESSION II - GROUNDFISH ECONOMICS and MANAGEMENT
Monday 1:00 - 5:00 p.m., Eastwood.

Moderator E. Ueber (SWFC)

1. K. Matthews (UW). Movement of nearshore, territorial rockfishes and implications to management.

2. W. Silverthorne and J. Golden (SWR, ODFW). Regulation of the *Sebastes* Complex in the INPFC Columbia area.

3. B. Bracken (ADFG). Rational management of the Gulf of Alaska rockfish fisheries.

4. J. Terry (NWAFC). Management options for joint-venture and foreign fisheries when there are fully utilized species.

5. P. Evans (NMFS Wash. D.C.). The Pacific Coast and Gulf of Alaska groundfish management plans: A view from Washington D.C.

6. D. Larson and J. Povolny (NPFMC). The political economy of fishery development in the North Pacific.

7. S. Hanna (OSU). Fleet structure and fishing effort in the Oregon groundfish fishery.

PANEL DISCUSSION: ALTERNATIVE TOOLS for MANAGING the GROUNDFISH FISHERY
Monday 8:00 -10:00 p.m., Eastwood

1. E. Ueber (SWFC). Introduction by moderator.

2. B. Rettig (OSU). Summary of limited entry programs in selected countries.

3. D. Huppert (SWFC). Westcoast groundfish management - issues and options.

4. A. Gorham (UA). Groundfish management policy in the North Pacific.

5. R. Mylchreest (Dept. Fish. Vancouver). An economic view of individual quota management in a multispecies fishery.

6. B. Rettig (OSU). Hazards and lotteries: Alternative management approaches at risk.

7. E. Ueber (SWFC). Questions and summation.

POSTERS
Tuesday 9:45 - 10:15 a.m., 2:45 - 3:15 p.m., 7:00 - 9:00 p.m., Eastwood

1. D. Ayers (WDF). WDF black rockfish studies, 1981-84.

2. K. Bailey and C. Stehr (NWAFC). Laboratory studies of Alaska pollock.

3. T. Wyllie Echeverria (SWFC). Months of larval extrusion for 31 species of *Sebastes* from central California.

4. A. Hollowed and K. Bailey (NWAFC). Patterns and coherence in year-class strengths of marine fishes along the west coast.

5. B. Megrey and M. Lynde (NWAFC). A display of microcomputer methods for performing several methods of cohort analysis.

SESSION III - BIOLOGICAL PROCESSES
Tuesday 8:00 a.m.-12 Noon, Eastwood.

Moderator: G. Walters (NWAFC)

1. R. Rosenthal (Kinnetic Labs). Range extensions of some common reef dwelling fishes in Alaskan waters.

2. M. E. Clarke (OSU). Feeding behavior of larval walleye pollock and food availability to larval pollock in the southeastern Bering Sea.

3. S. Lee and T. Nishiyama (UA). Feeding competition between larval walleye pollock and Pacific cod in the southeastern Bering Sea.

4. S. Lee and T. Nishiyama (UA). A comparison of number and interval of gill rakers between larval walleye pollock and Pacific cod.

5. D. Dwyer, K. Bailey and P. Livingston (NWAFC). Cannibalism among walleye pollock (*Theragra chalcogramma*) in the eastern Bering Sea: Mechanisms and potential impact.

6. G. Boehlert (SWFC). Reproduction and embryonic energetics in the genus *Sebastes* with a comparison of eastern and western Pacific species.

7. B. Leaman (PBS). Rockfish reproduction in relation to general life-history theory.

8. S. L. Moreland (SWFC). Identification of juvenile rockfish.

9. W. LaRoche (NWAFC). Taxonomy and distribution of larval and juvenile rockfish (*Sebastes*).

10. R. Straty (ABL-NWAFC). Observations of the distribution, habitat, and behavior of young juvenile rockfish off SE Alaska.

11. M. Eldridge (SWFC). Physiological research in groundfish management.

12. J. Chess (SWFC). Vertically migrating organisms entrapped on the sea floor as prey for groundfish.

13. E. Hobson, J. Chess and D. Howard (SWFC). Effects of the 1982-83 El Nino on habitats of nearshore groundfish in southern California.

SESSION IV - STATUS of STOCKS and POPULATION DYNAMICS
Tuesday 1:00 - 5:00 p.m., Eastwood

Moderator: J. Tagart (WDF)

1. G. Boehlert and J. Wetherall (NMFS Honolulu). Groundfish fisheries of the central North Pacific seamounts.

2. P. Adams (SWFC). The effects of harvesting sexually segregated populations of lingcod (*Ophiodon elongatus*).

3. R. Demory (ODFW). Life history of Dover sole and results of the 1972-76 flatfish survey.

4. J. Golden (ODFW). Use of stock assessment models to estimate current Dover sole biomass.

5. E. Pikitch and E. Rextad (ODFW). Stock assessment off Dover sole in a fishery demonstrating changes in effort and exploitation patterns.

6. B. Megrey and M. Lynde (NWAFC). A comparison of several cohort analysis methods.

7. V. O'Connell (ADFG). Status of the nearshore longline fishery for shallow water rockfish in the southeastern Gulf of Alaska.

8. G. Stauffer and S. McDevitt (NWAFC). Evaluation of the regional production of sablefish based on an index of catch per unit of habitat area.

9. L. Richards (PBS). Rockfish assemblages and habitat in the Strait of Georgia, British Columbia.

10. W. Overholtz, M. Sissenwine and S. Clark (NEFC). Recruitment variability and its implications for managing and rebuilding the Georges Bank haddock stock.

11. C. Rogers (UW). Population dynamics of juvenile flatfish in Grays Harbor estuary.

12. G. Thompson and D. Ito (NWAFC). A model of the population dynamics of Pacific cod in the eastern Bering Sea.

13. R. Mayo and S. Clark (NEFC). Assessment of pollock (*Pollachius virens l.*) stock in the Scotian Shelf, Gulf of Maine, and Georges Bank region, 1984.

Business Meeting - Tuesday 7:00 - 9:00 p.m. - Loft

Canadian/U.S. Groundfish Committee - Tuesday 7:00 -9:00 p.m. - Eastwood.

SESSION V - AGE and GROWTH
Wednesday 8:00 - 11:45 a.m., Eastwood

Moderator: K. Bailey (NWAFC)

1. M. Lynde, M. Van Houten, and R. Francis (NWAFC). Regional and temporal differences in growth of walleye pollock in the eastern Bering Sea and Aleutian Basin with implications for management.

2. K. Kuzis (UW). Age and growth of black rockfish.

3. P. Dygert (UW). Size dependent seasonal patterns of energy utilization for growth and reproduction in English sole.

4. G. Small and H. Lai (NWAFC). Traditional versus computer assisted ageing of Pacific cod (*Gadus macrocephalus*) scales.

5. H. Lai, L. Low, and D. Gunderson (NWAFC, UW). Evaluation and validation of age determination for Pacific cod.

6. R. Smith (UA). Growth and feeding in juvenile pollock.

7. J. Shenker, and B. Olla (OSU). Laboratory feeding and growth of juvenile sablefish.

8. W. Lenarz (SWFC). Annual variations in length-weight relationships of California rockfish and a description of a new technique to estimate length-weight relationships from aggregate data.

9. C. Wilson (OSU). The effects of different otolith ageing techniques on estimates of growth and mortality for two species of rockfishes, *Sebastes pinniger* and *S. diploproa*.

10. D. Somerton (NWAFC). Indirect ageing of pollock.

11. L. Haldorson and R. Rosenthal (UA). Mean length as a measure of fishing mortality in rockfish populations.

Closing Remarks - Wednesday 11:45 a.m.-12 Noon, R. Francis, E. Ueber, Eastwoodu

1987 WESTERN GROUNDFISH CONFERENCE
Salishan Lodge
Gleneden Beach, Oregon
March 25-27

Agenda

Opening Remarks - Wednesday - 8:00 a.m.

SESSION I - MISCELLANEOUS RESEARCH and MODELING
Wednesday 8:20 a.m. - 12:00 p.m.

Moderator - Bill Lenarz (SWFC)

1. B. Fagen (UA). Applying underwater video techniques in studying fish behavior.
2. D. Somerton (SWFC). Use of hook-timers on research longlines as an aid to stock assessment.
3. D. Wildermuth (WDF). Incidental catch of dungeness crab by otter trawlers off Washington.
4. J. Norris (UW). Analysis of four factors affecting the sablefish soft fish problem.
5. M. Leet and C. Reiley (SWFC). An annotated bibliography of references on the genus *Sebastes*.
6. J. Hightower (SWFC). A multi-species harvesting model for rockfish.
7. B. Stokes (UW). Multi-species bio-economic modeling.
8. B. Megrey and R. Baldwin (NWAFC). Bioeconomic simulation model of the walleye pollock fishery in the Gulf of Alaska.

SESSION II - ECOLOGICAL and BIOLOGICAL PROCESSES
Wednesday 1:00 - 5:30 p.m.

Moderator - Bruce Leaman (PBS)

1. E. Hobson, J. Chess and D. Howard (SWFC). Recovery of nearshore groundfish habitats from effects of the 1982-1983 El Nino.
2. D. Howard, E. Hobson and J. Chess (SWFC). Annual variability in juvenile rockfish (*Sebastes* spp) recruitment to nearshore habitats in northern California, 1983-1986.
3. T. Echeverria (SWFC). Oceanic characteristics of the California Current: Possible effects on juvenile rockfish distribution.
4. R. Methot, J. Hunter, and W. Flerx (SWFC). Sablefish and Dover sole investigations in central California: Preliminary results.
5. G. Davis (WDF). Lingcod tagging in the Gulf of Georgia, 1982-83.
6. S. McDevitt (NWAFC). Status of the west coast sablefish resource.
7. G. Thompson (NWAFC). A method for inter-annual application of an age length key.
8. J. Whipple and B. Jarvis (SWFC). An overview of factors affecting condition and reproduction in yellowtail rockfish (*Sebastes flavidus*).

9. M. Eldridge, B. Jarvis and J. Whipple (SWFC). Condition, reproduction and effective fecundity in yellowtail rockfish.

10. R. McFarlane (SWFC). Temporal relationships of blood nutrients and ions in female yellowtail rockfish.

11. M. Bowers (SWFC). Annual changes in the ovarian activity of adult yellowtail rockfish.

POSTER SESSION
Thursday 10:00 - 10:30 a.m.

1. A. Lamb (W. Vancouver). Film and display on the book Coastal Fishes of the Pacific Northwest.

2. B. Barss (ODFW). Aging Dover sole by using the "break and burn" technique.

3. J. Norton (SWFC). Large scale environmental influences on groundfish recruitment.

SESSION III - BIOLOGICAL PROCESSES (continued)
Thursday 8:00 a.m - 12:00 noon

Moderator - Frank Henry (CDFG)

1. R. Larson (SF State U). A Rockfish is what it eats.

2. C. Reilly and T. Echeverria (SWFC). Inter-annual comparison of pelagic juvenile rockfish diets.

3. Mei-Sun Yang (UW). Food habits and daily ration of the Greenland halibut (*Reinhardtius hippoglossoides*) in the eastern Bering Sea.

4. R. Smith (UA). Food evacuation in walleye pollock: Effects of meal size and temperature.

5. D. Erickson and E. Pikitch (OSU). The relative gonadal index: An alternative index of reproductive condition.

6. D. Woodbury (SWFC). Daily age determinations of juvenile rockfish from central California.

7. P. Adams, S. Smith and W. Samierre (SWFC). Preliminary results of age validation studies of lingcod (*Ophiodon elongatus*).

8. P. Neal (IPHC). Digitizing halibut otoliths for age determination.

9. P. Monroe (NWAFC). Differences in Gulf of Alaska pollock growth rates due to effects of regional and pre-recruit conditions.

SESSION IV - ECONOMICS and MANAGEMENT
Thursday 1:00 - 5:30 p.m.

Moderator - Ed Ueber (SWFC)

1. E. Ueber (SWFC). Economic and demographic conditions in the central California setnet fishery.

2. R. McKelvey (U of Montana). Specialist and generalist fishing vessels in a multispecies fishery.

3. C. Korson and W. Silverthorne (SWR). Economic performance of the groundfish trawl fleet, 1981-84.

4. R. Adu-Assamoah and B. Rettig (OSU). A spatial equilibrium analysis of groundfish management and development alternatives.

5. W. Leet (SWFC). Estimates of effort in the widow rockfish fishery from PACFIN data.

6. A. Hollowed (NWAFC). Management perspectives in the offshore Pacific hake fishery.

7. B. Culver (WDF). Effects of increased tag rewards on tag return rates.

8. P. Sund (SWFC). A new way of looking at fisheries landings data ... principal component analysis.

9. A. Gorham (UA). Determining a quota for Bering Sea yellowfin sole given a bycatch of king crab.

10. S. Kaimmer (IPHC). Management problems in the Pacific halibut fishery.

11. H. Richards (UA). An analysis of entry into the north Pacific halibut fishery.

BUSINESS MEETING - Thursday 8:00 p.m.

SESSION V - SAMPLE DESIGN, METHODOLOGY, SURVEYS and DISTRIBUTION
Friday 8:00 a.m. - 12:00 noon

Moderator - Ellen Pikitch (OSU)

1. B. Lenarz (SWFC). Rockfish sampling revisited.

2. C. Knechtel (NWAFC). An optimal compromise sample allocation technique used to aid planning of the 1986 Pacific west coast bottom trawl survey.

3. B. Leaman and R. Stanley (PBS). From nobility to nightmare: Some object lessions in planning and conducting fishery experiments.

4. T. Dark (NWAFC). Preliminary results of a 1986 west coast bottom trawl survey and cursory evaluation of a compromise sample allocation scheme.

5. J. Tagart (WDF). Review of WDF trawl survey in Grays Harbor: Distribution and abundance ofjuvenile groundfish.

6. N. Williamson (NWAFC). Results of the 1986 NMFS acoustic/midwater trawl survey of Pacific whiting.

7. M. Nelson and J. Traynor (NWAFC). Results of the 1986 NMFS acoustic/midwater trawl survey of Pacific whiting along the Pacific coast.

8. J. Stark and E. Brown (NWAFC). The distribution, abundance and size composition of the Gulf of Alaska rockfish, with age composition and growth of POP during the 1984 cooperative survey.

9. C. Rose (NWAFC). Overlapping distributions of rockfish species in the Gulf of Alaska: Descriptions for management applications.

10. M. Alton (NWAFC). Puzzling features of distribution and length composition of Greenland turbot.

11. D. Ayres (WDF). Black rockfish tagging off Washington state: An example of industry, government and citizen cooperation.

Closing Remarks - Bob Demory and Bill Barss

1989 WESTERN GROUNDFISH CONFERENCE
THE DOUBLETREE HOTEL
MONTEREY, CALIFORNIA
JANUARY 9-11

AGENDA

Opening Remarks - Monday 8:00 a.m. - De Anza II Room

SPECIAL SESSION ON OCEANOGRAPHY: FACTORS AFFECTING RECRUITMENT
Monday 8:15 - 11:45 a.m., De Anza II

Moderator: Dick Parrish (NMFS-PEFG)

1. J. Simpson (SIO). The California Current system from Punta Baja to Cape Mendocino.
2. A. Bakun (NMFS-PEFG). The California Current System from Cape Mendocino northward.
3. J. Norton (NMFS-PEFG). Large scale-small scale coastal oceanography.
4. A. Hollowed (NWAFC). Recruitment of hake and large-scale environmental conditions.
5. R. Larson (SF State U). Distribution of pelagic juvenile rockfish in relation to upwelling and other factors off central California.
6. L. Haldorson and D. Ziemann (UA). APPRISE: Association of primary production and recruitment in a subarctic ecosystem.
7. A. Kendall (NWAFC). Oceanography and recruitment of walleye pollock in the Gulf of Alaska.

SESSION II - RECRUITMENT AND ECOLOGY
Monday 1:00 - 5:00 p.m., De Anza II

Moderator: Bob Lea (CDFG)

1. T. Hobson (SWFC). Importance of feeding conditions for adults in the success of recruitment in rockfishes, Sebastes spp.
2. R. Fagen (UA). Chaotic dynamics and recruitment thresholds in pollock of the Bering Sea.
3. W. Samierre (SWFC). Distributional effects in the ecology of demersal fishes from the continental slope.
4. L. Seeb (Southern Illinois U). Allozyme expression in juvenile and larval *Sebastes*.
5. K. Weinberg (NWAFC). The "other" rockfish off Oregon and Washington: Distribution, abundance and species associations.
6. B. Barss (ODFG). Heceta Bank submersible observations.
7. B. Pearcy (OSU). Fisheries assessment of Heceta Bank using submersibles.
8. S. Alderstein (UW). The interaction between Pacific hake and the Kudoa parasite.
9. M. Love (UC-MSI). Aspects of the biology of southern California rockfishes.
10. A. J. Paul (UA). Bioenergetics measurements for Pacific cod.
11. T. Wyllie-Echeverria (SWFC, UA). Tracing movements of pelagic juvenile rockfish using stable isotopes.

12. R. Smith (UA). Bioenergetics of yellowfin sole.

13. C. Reilly and T. Wyllie-Echeverria (SWFC). Mesenteric fat storage in age 0 rockfish.

SESSION III - LIFE HISTORY
Tuesday 8:00 a.m. - 12 Noon, De Anza II

Moderator: Tina Wyllie-Echeverria (NMFS-SWFC)

1. J. Hunter (SWFC). Reproduction of Dover sole and sablefish.

2. J. Butler (SWFC). Size, age, water content and caloric density of Dover sole.

3. G. Lippert (WDF). Search of evidence for compensatory changes in yellowtail rockfish maturity.

4. B. MacFarlane (SWFC). Interannual variability of serum lipids in yellowtail rockfish (*Sebastes flavidus*) in relation to environmental factors.

5. J. Whipple, M. Eldridge and B. Jarvis (SWFC). Temporal variability in condition of yellowtail rockfish (*Sebastes flavidus*) in relation to reproduction.

6. D. Ventresca, R. Lea and R. McAllister (CDFG). Reproduction and management implications of some nearshore California rockfishes; or was the last spawning season as good for you as it was for me?

7. J. Paul (UA). Reproductive success of male red king crab.

8. N. Lo (SWFC). Biomass of Dover sole in central California using a daily egg production method.

9. C. Schmitt (WDF). Marine mammal predation on Pacific whiting in Puget Sound, Wash.

10. B. Bracken (ADFG). Life history studies on starry flounder in southeast Alaskan waters.

11. B. Demory (ODFW). Life history and fishery studies on hagfishes.

12. A. McBride and J. Hightower (SWFC). Age determination of sablefish using otolith characteristics.

13. S. McDevitt (NWAFC). Sablefish growth: Fact or fiction?

SESSION IV - AGEING AND POPULATION DYNAMICS
Tuesday 1:00 - 5:00 p.m., De Anza II

Moderator: Alec MacCall (SWFC)

1. D. Pearson (SWFC). Age, growth, yearclass strength, and potential yield of shortbelly rockfish.

2. D. Woodbury (SWFC). Daily age and growth of juvenile shortbelly rockfish from central California, 1983-1988.

3. G. Gillespie and R. Stanley (PBS). The practicality of using otolith size and weight for age determination of Pacific ocean perch.

4. D. Nichol (OSU). Age and growth of darkblotched rockfish.

5. L. Botsford (UC-Davis). A comparison of computer-aided age determination from otoliths, with results from human readers.

6. L. Richards (PBS). Lingcod dynamics: Lessons from a size-structured model.

7. R. Methot (NWAFC). Population assessment: Synthesis of diverse data into a coherent whole.

8. J. Hightower (SWFC). A multi-species harvesting model for rockfish.

9. R. Kope (UC-Davis). Spatial dimensions in rockfish cohort analysis.

10. P. Adams (SWFC). The use of stomach contents of predators to estimate year-class strength of rockfishes.

11. G. Thompson (NWAFC). Yet another measure of optimal fishing mortality.

12. C. Knechtel (Fishstat). A robust test of the hypothesized functional form of variance about a regression line, with application to the design and analysis of fisheries surveys.

13. M. Dorn (NWAFC). Growth of Pacific hake (*Merluccius productus*): Evidence for a decline in mean size-at-age.

14. B. Lenarz (SWFC). Some consequences of interactions between management and stock assessment in the widow rockfish fishery.

BUSINESS MEETING - Tuesday 8:00 - 9:00 p.m., Cottonwood I

SESSION V - TAGGING AND FISHERIES MONITORING
Wednesday 8:00 a.m. - 12 p.m., De Anza II

Moderator: Jim Golden (ODFW)

1. K. Silberberg (SWFC). Description of the Pacific coast lingcod fishery, 1981-1985.

2. T. Jagielo (WDF). Preliminary results of lingcod tagging at Neah Bay, Wash.: Movement, abundance, and exploitation rate; use of a Seber-Jolly model framework and Monte Carlo variance estimation procedure.

3. M. Sigler (ABL-NWAFC). Tracking short-term movements of sablefish using sonic telemetry.

4. R. Stanley (PBS). Estimation of commercial catch rates for the Canadian trawl fishery.

5. R. Hoff (UW). Spatial and temporal variability in flatfish: Implications for survey sampling.

6. C. Rose (NWAFC). Effects of variability in trawl shape during groundfish surveys.

7. S. Ralston (SWFC). A consideration of size-selective properties of fish hooks.

8. P. Dawson (NWAFC). Bering sea pollock stock structure implications from size-at-age data.

9. V. O'Connell (ADFG). Aspects of the life history and fishery for yelloweye rockfish in southeast Alaska.

10. J. Harvey (NWAFC). Natural mortality of fishes attributed to harbor seals in Oregon.

11. R. Starr (ODFW). Fishery catch mapping: Current uses and potential for research and management.

SESSION VI - ECONOMICS AND MANAGEMENT
Wednesday 1:00 - 4:00 p.m., De Anza II

Moderator: Wes Silverthorne (NMFS-NWR)

1. E. Ueber (SWFC). The value of your sole.

2. C. Wiese (Alaska Sea Grant). Equilibrium fleet size model for Alaska's groundfish trawl fisheries.

3. D. Pearson and B. Leet (SWFC). Estimating effectiveness of widow rockfish and Pacific ocean perch regulations using PacFIN data.

4. J. Norris (UW). Incorporating political objectives in fishery models.

5. J. Golden (ODFG). Recent innovations in west coast trawl gear and implications for management and research.

6. E. Pikitch (UW). A preliminary look at the effectiveness of trip limits in managing the west coast groundfish trawl fishery.

7. M. Bergh (UW). West coast groundfish mesh size study: Design and preliminary results.

8. D. Erickson (UW). An examination of reasons for ending commercial otter-trawl groundfishing trips. Do management-imposed trip poundage limits "really" have a major impact on trip duration?

9. J. Rogers (OSU). Preliminary definition of fishing strategies in the Columbia Area groundfish fishery.

POSTER SESSION - De Anza II

1. M. Dorn (NWAFC). Growth of Pacific hake (*Merluccius productus*): Evidence for a decline in mean size-at-age.

2. M. Eldridge (SWFC). Fecundity in yellowtail rockfish (*Sebastes flavidus*).

3. L. Garrett (NMFS-PFEG). Trends in the Monterey Bay partyboat and skiff catches from 1959 to 1986.

4. J. Gold (UC-Bodega Marine Lab). Reproductive morphology of male yellowtail rockfish.

5. R. Henry and C. Rose (NWAFC). Testing, analysis and results of an electronic on-deck data entry system for enhancing acquisition of size composition data for fishes.

6. B. Jarvis (SWFC). Methods used by the Tiburon Laboratory physiological ecology investigations for the assessment of condition and reproductive state in rockfishes (*Sebastes* spp).

7. M. Kudumu (SWFC). An annotated bibliography of lingcod (*Ophiodon elongatus*).

8. T. Laidig (SWFC). Problems in daily ageing of juvenile rockfish.

9. M. Leet (SWFC). Annotated bibliography of the biology of the demersal habitat of the continental slope.

10. D. Tryde (PGE). Recreational fish catch trends in central California.

11. B. Megrey (NWAFC). FOCI - Fisheries Oceanography Coordinated Investigations.

12. E. Norton (SWFC). Annual pattern in proximate composition of yellowtail rockfish (*Sebastes flavidus*) in relation to reproductive development.

13. L. Wold and G. Moreno (CSU-MLML). Descriptions of nearshore central California *Sebastes* larvae.

14. D. Woodbury (SWFC). El Nino check in otoliths.