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CCCC Nemuro Meeting

More than 40 scientists from all PICES member countries and from Secretariat participated in the PICES - GLOBEC Workshop on Conceptual/ Theoretical Studies and Model Development in Nemuro, Japan on 23 - 28 June 1996. The Workshop was an element of the Climate Change and Carrying Capacity (CCCC) program whose Implementation Panel and Task Teams: BASS (BAsin Scale Studies), MODEL and REX (Regional EXperiment) also met during the week. A day and a half was devoted to a Japan - GLOBEC Symposium on Development and Application of New Technologies for Measurement and Modelling in Marine Ecosystems. The objectives of the Workshop were: (A) to review the state-of-the-art, and gaps in knowledge of coupled physical-biological and ecosystem models in member countries, and in on-going international programs; and (B) to develop the model related requirements of the CCCC Implementation Plan: (1) to identify scientific, technical and methodological issues and (2) to identify requirement for model and theoretical approaches to guide the process and observation studies, and to integrate the results of the CCCC program.

The Workshop began with state-of-the-art reviews of modeling activities in the areas of atmospheric/ ocean circulation (Prof. Paul LeBlond, University of British Columbia, Canada), lower trophic levels (Dr. Michio Kishi, Ocean Research Institute, University of Tokyo, Japan), higher trophic level (Dr. Patricia Livingston, Alaska Fisheries Science Centre, NOAA, USA), and model integration and management (Dr. Jeremy Blackford, Plymouth Marine Laboratory, United Kingdom). The later topic involved a presentation of the experiences of the European Regional Seas Ecosystem Model (ERSEM) program, in which several institutes in Europe collaborated to develop a fully integrated ecosystem model for the North Sea. Workshop participants were then divided into discussion groups on these topics, in which they addressed a set of questions posed by the MODEL co-chairs Drs. Ian Perry (Nanaimo Biological Station, DFO, Canada) and Sinjae Yoo (KORDI, Republic of Korea).

There was strong support for a distributed modeling effort instead of a centralized modelling activity, with PICES playing a key coordinating and communication role. This would include efforts to obtain and make widely available the outputs from published ocean general circulation models; efforts to facilitate development of lower trophic level production models, and convening of workshops to encourage use of common programs such as ECOPATH II for initial comparison of North Pacific ecosystem properties.

(cont. on page 10)

FEATURE ARTICLE

Process modeling and red king crab year-class strength in the Bristol Bay region of the Bering Sea

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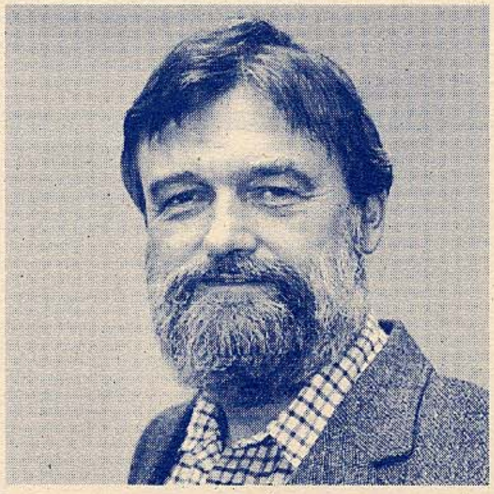

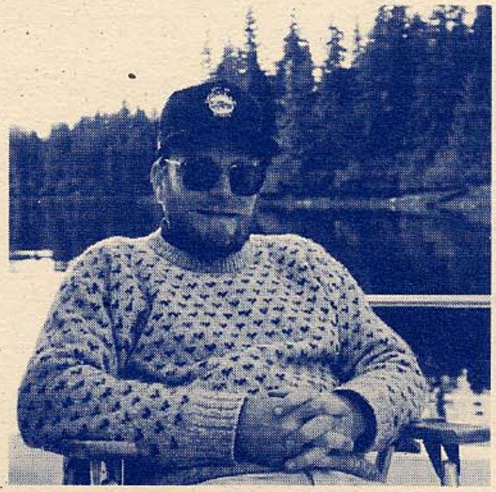

Dr. Albert Tyler is Associate Dean and Professor at the School of Fisheries & Ocean Sciences (University of Alaska, Fairbanks). Al carries out research and teaching dealing with fish population dynamics, including the effects of physical variables and biological factors on the formation of year-class strenght in marine fish stocks. He is active in developing of stock assessment models, at-sea surveys of groundfish assemblages and methods for estimaiting sustainable yields for species mixes in a multispecies industry. From 1993 Al has been chairman of PICES WG5 on The Bering Sea.

Dr. Gordon Kruse is head of Marine Fisheries Research Section at the Alaska Department of Fish & Game. His primary research interests are population estimation, analysis of alternative harvest strategies, and fishery and oceanographic effects on stock productivity. Gordon's recent research activities are focused on shellfish, particularly crabs and scallops.

The once large stock of red king crabs (Paralithodes camtschaticus) of the Bristol Bay region of the Eastern Bering Sea crashed in the early 1980s and has not recovered. It is one of the few stock demises in that area. One suspicion is that the fishery was to blame for the crash because of the large landings that occurred during the late 1970s and early 1980s, and another possibility is that the demise was caused by oceanographic factors. To sort out the facts it is necessary to decipher the historical record in terms of changes in spawning biomass, recruitment, fishing and natural mortality rates. This report presents some evidence that recruitment was affected by ocean conditions. The report is based on a study that was reported at the Annual PICES Meeting in the Bering Sea workshop in Qingdao, China, October 1996. The study is in press as a paper in the International Symposium on Biology, Management and Economics of Crabs from High Latitude Habitats, Lowell Wakefield Fisheries Symposium, Alaska Sea Grant College Program, University of Alaska Fairbanks, October 1995.

In a recent model (Zheng et al. 1995), we noticed that productivity of red king crab in terms of brood strength fell off following the mid-1970s (Figure 1). The authors gave two possible explanations for the recruitment pattern: that the decline could have been a density-dependent response, because strong recruitment from the 1968-1972 brood years pushed the spawning biomass to high levels where resultant recruitment would be depressed. The other explanation is that environmental factors led to the time series of brood strength. For instance, we also noticed that the decline in productivity started well before the heaviest landings of legal males of the late 1970s and 1980 (Figure 2, data from Zheng et al. 1995), and prior to the decrease in mature stock biomass (Figure 3, data from Zheng et al. 1995). That the decline in brood strength occurred well before female biomass decline and was associated with an increasing female biomass, indicates that something other than the fishery on legal males was responsible for this phase of decline of productivity, perhaps density dependence as well as natural, extrinsic factors.

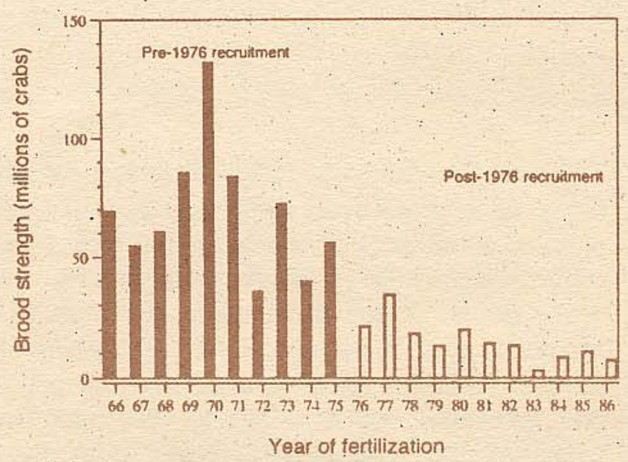

Figure 1. Brood strength of Bistol Bay red king crab determined at age-7 and plotted on the year of fertilization. The period of high brood strength, or recruitment, is given with dark columns, and the period of low brood strength is given with open columns for emphasis.

Yet the fishery likely contributed to the eventual decline in mature female biomass since both males and females are taken together in the traps, and there was likely incidental mortality of the females in such an intense fishery. The fishery was managed by the Alaska Department of Fish and Game, but there were no brood strength estimates at the time for the managers to use in assessments. Increases in catch rates were allowed on the basis of the estimated increase in accumulated legal crab biomass, which was reasonable. There was no indication of the simultaneous decrease in brood strength that was already occurring at this time. Today, changes in brood strength could be entered into an assessment model to forecast yield, and expectations of recruitment reductions could be a factor in setting annual catch quotas.

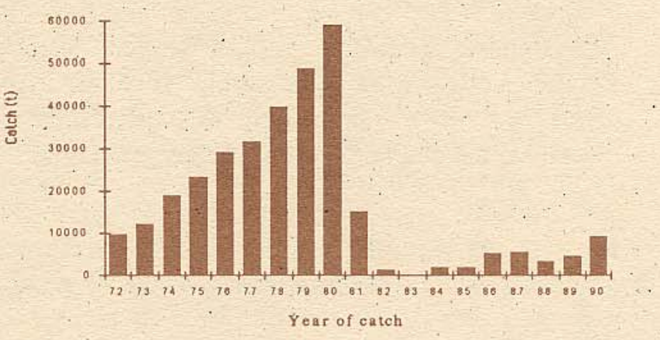

Figure 2. Bristol Bay catch of legal-sized, male red king crabs (metric tons) plotted on year of catch.

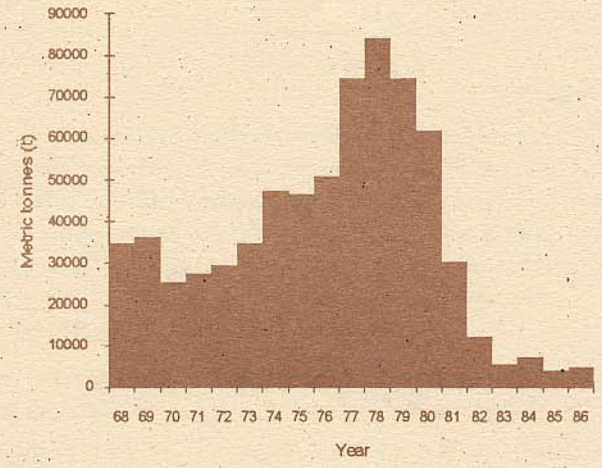

Figure 3. Biomass of female red king crabs in the Bristol Bay region during the study period.

We began an inquiry into factors that might bring about the decline in brood strength development. It is well known now that a shift in ocean climate occurred in the North Pacific Ocean in the mid-1970s. A change in the intensity and position of the Aleutian Low occurred that in turn brought about a number of other physical factor changes (Trenberth and Hurrell 1994). We looked at the January pressure anomalies for the North Pacific since 1966 for the area of the Pacific Ocean between 20 - 60^{o} north latitude. Except for three years the pressure was above average from 1966 though 1975 inclusive, and from 1976 to 1988 the pressure was lower than normal. It was during this intense low pressure that brood strength was progressively reduced. When we linearly regressed the brood strength against the atmospheric pressure changes (Figure 4), we found a significant relationship ($r=0.596$, $p<0.01$, d.f.$=18$). In making this calculation we removed the single 1970 brood strength outlier.

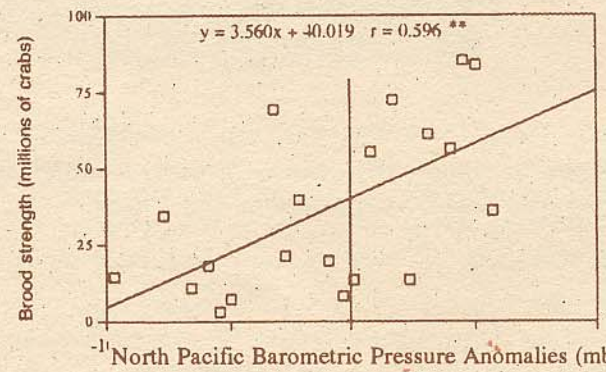

Figure 4. Brood strength for red king crab of Bristol Bay versus mean barometric pressure anomalies in mb at the year of fertilization for the period 1966 to 1986 inclusive. The point for 1970 ($X = -1.53$, $Y = 132$) has been deleted from the fit because it was an outlier for the series. The correlation coefficient is significant at the 1% level.

Of course atmospheric pressure changes do not kill king crab, and so we have not found the specific cause of mortality. It is likely that a combination of events have acted simultaneously through the complex life history of the species to produce the lowered brood strength. Unfortunately many measures will correlate with this nearly monotonic decline in brood strength and barometric pressure. Therefore we suggest that further exploration of correlation statistics will only produce many significant correlations but no new understanding. Instead we suggest the development of process studies.

We sponsored a workshop on king crab recruitment in Juneau, Alaska, and developed a conceptual model of the formation of red king crab year-class strength using an events-time approach. By this procedure a stage by stage description was set down as a table of the life history events with accompanying processes pertaining to survival and productivity. The critical life history stages are shown in Table 1.

Table 1. Life history stages critical to brood strength development.

Stage 1.	Development of the egg clutch
Stage 2.	Mating and egg fertilization
Stage 3.	Hatch timing
Stage 4.	Survival during hatching
Stage 5.	Survival during zoea stages
Stage 6.	Survival during the glaucothoe stage
Stage 7.	Juvenile survival (ages 1-6)
Stage 8.	Survival during adult stages (ages 5-15)

The ordered information included the location and timing of the life stages, along with the coincident physical oceanographic and biological factors that could influence the productivity and survival rate of the stages. From this summary we developed, in turn, a series of hypotheses related to year-class strength representing the combined information of the specialists participating in the modeling workshop. Several of these hypotheses related productivity and survival processes to physical factors (Table 2).

The change in weather pattern that occurred in the mid 1970s coincided with a decrease in brood strength of red king crabs. An accompanying increase in water temperature was correlated to decrease in the red king crab stocks of Kodiak and Bristol Bay (Müter et al. 1995), though their relationship appears more related to availability of crabs to the fishery and changes in fishing effort. There are several hypotheses presented here that relate temperature change to change in productivity of red king crabs. The optimum temperature for embryo development of red king crabs is 3-8 ^{O}C (Nakanishi 1985). For ocean fishes, hatching success is often highest at an intermediate temperature, with decreases at higher temperatures (Alderdice and Forrester 1971). Cumulative exposure to optimal temperature is sometimes necessary for both egg and embryonic development of some fish (Kruse and Tyler 1983), and so it may be for king crabs. In unusually warm years spawning may be skipped because a cool temperature cue is needed, or degree of maturation is insufficient. The mechanisms of response to warming that might bring about a decrease in brood strength are manifold. Specifics for the red king crab are wanting, and so it is not possible to rule out hypotheses presented here.

Table 2. Hypotheses relating survival and productivity to physical factors.

- a critical number of degree-days is necessary to bring on ovary maturation
- high temperatures will increase egg mortality
- after fertilization cool temperatures will delay hatching
- initiation of hatching depends on a water quality cue that is related to the abundance of a particular diatom (*Thalassiosira* sp.).
- high percentage of successful hatching is linked to an optimum temperature
- For the larval stages, water-mass mixing due either to tide or Ekman transport increases nutrients used in primary production, and consequent larval growth and survival
- since high-profile, rocky bottom with attached fauna is critical for survival of the glaucothoe larval stage during settling, an increase in the strength of currents moving larvae away from this bottom type would increase mortality

Other physical factors that could be of major influence are advection and mixing. Advection is critical to the development of brood strength in processes related to hatching, to survival of zoea, and to the settling of the glaucothoe stage. The prevailing currents flow to the northeast along the Alaskan Peninsula toward Bristol Bay then turn northward (Stabeno and Reed 1994). Changes in concentrations of diatoms are generated by the mixing of nutrients into the euphotic zone. The mixing could be tidal or possibly be from Ekman upwelling along the north coast of the Alaskan Peninsula caused by winds from the northeast, though this is not documented. It is possible that the fertilized embryos of red king crab hatch only if there are concentrations of diatoms present, as though a chemical cue were necessary (T. Shirley, University of Alaska Fairbanks, Juneau Center, unpublished). Investigations of advection along the north coast of the Alaska Peninsula, and of conditions that effect phytoplankton blooms, would be valuable. The bottom type along the north shore of the Alaska Peninsula is favorable for the settlement as glaucothoe, because it is rocky and encrusted with organisms favored by that stage (Powell and Nickerson. 1965). Our hypothesis is that if currents through this area are strong in some years, last stage zoea would be carried past these bottom types and out over muddy areas with resultant reduction in favorable settlement and increased mortality. It would be useful to look at the settlement rates of glaucothoe in this area in much the same way it has been done recently in the Kodiak area by the Alaska Department of Fish and Game (Blau 1992).

Several predation hypotheses emerged from our synthesis (Table 3). With regard to the egg stage, it was suggested that high temperatures might promote outbreaks of the egg predator, *Carcinomertes*.. Kuris et al. (1991) found high rates of prevalence of *C. regicides* and three other undescribed nemertean egg predators in the mid-1980s in some areas of Alaska.

It was postulated that zoea mortality increased with predator density, such species as pollock and salmon. In a recent study, Wespestad et al. (1994) proposed that outmigrating juvenile sockeye salmon (*Oncorhynchus nerka*) may adversely impact red king crab brood strength by predation of larvae. Unfortunately, few field studies on feeding habits of outmigrating sockeye salmon have been conducted. In Bristol Bay, total prey consumption and growth rates of juvenile sockeye salmon are very low until they pass through the inner bay to offshore waters (Straty 1974). Other predation hypotheses involved glaucothoe, juvenile and adult king crabs. As with salmon, hypotheses about effects of groundfish predation on red king crab year-class strength emerged from observations of recent increases in the abundance of some groundfish species (Bakkala 1993). Frequently-invoked groundfish predation hypotheses regarding red king crabs involve Pacific cod (*Gadus macrocephalus*), yellowfin sole (*Limanda aspera*), sculpins, and Pacific halibut (*Hippoglossus stenolepis*).

Table 3. Hypotheses relating survival and productivity to predation and biological factors.

- a molt may be skipped if egg development is delayed;
- fecundity and molt frequency are dependent on rations;
- fertilization rate is higher in copulation with larger males;
- timing of mating depends on water temperature as well as the female's previous reproductive history;
- predation rate is likely to be variable on the zoea larvae depending on the abundance of predators, particularly walleye pollock, sockeye salmon, and euphausiids;
- the cannibalistic nature of newly settled glaucothoe larvae leads to density dependent mortality;
- predation rate on juveniles is variable and dependent on abundances of predators, particularly sea otters, Pacific cod, and sculpins;
- competition with flatfish will likely bring about reduced growth rates and molting frequency.

Livingston (1991) and Livingston et al. (1993) reported on king crab predation from samples of fish stomachs collected primarily during May through September 1984-1989 by trawl gear on research and commercial vessels. Among nine groundfish predators investigated, these studies found that Pacific cod is the primary predator of red king crabs; many of the red king crabs consumed were soft-shell females. Livingston (1989) estimated that 3.8%, 2.8% and 1.4% of the female red king crab stock were consumed by Pacific cod in 1981, 1984, and 1985, respectively. These predation rates led her to conclude that cod were not the major factor behind the crash of the red king crab population in Bristol Bay during the early 1980s. In the Gulf of Alaska, red king crabs occur infrequently in stomachs of Pacific cod sampled off Kodiak Island (Jewett, 1978) and Southeast Alaska (Clausen, 1981) during summer. Jewett and Powell (1979) examined the stomachs of sculpins, *Myoxocephalus* spp. and *Hemilepidotus jordani*, during summer 1973-1975. Red king crabs were never found in stomachs of *Myoxocephalus* spp. and they were found infrequently in stomachs of *Hemilepidotus jordani*. Despite occasional impressive reports, published studies of stomach contents of Pacific halibut reveal low incidences of predation on red king crabs (Simenstad et al. 1977, IPHC 1985, Best and St-Pierre 1986). Walleye pollock (*Theragra chalcogramma*) and yellowfin sole are minor predators of king crabs and consume mostly glaucothoe and small juveniles.

Red king crabs have a far more complex life history than the abundant groundfish that surround them and that have been more common subjects of fishery oceanography studies. These extra complexities need to be included among the processes that lead to brood strength variability. The females develop their unfertilized eggs for a year or more, then carry developing embryos for a year, an reproductive energy output not shared by most ocean fishes. Unlike most crabs that have a maturity molt and mate only during that molt, mature red king crabs have the complexity of molting and mating each year. Mating and carrying embryos is more similar to the reproductive biology of the rockfishes (genus *Sebastes*). However they are far more complex than the rockfishes in that they have two types of larvae, the zoea instars and the glaucothoe instars.

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PICES-GLOBEC Climate Change and Carrying Capacity Program
Workshop on Conceptual/Theoretical Studies and Model Development

Mayor Kaiji Ooya making a welcome address to participants at the Opening Ceremony

One of the Plenary Sessions in progress

Dr. Warren S. Wooster, Chairman of PICES, addressing participants at the Welcome Reception

A special lion dance by locals at the Welcome Reception

Mayor Kaiji Ooya having a chat with Dr. Warren S. Wooster and Prof. Yutaka Nagata

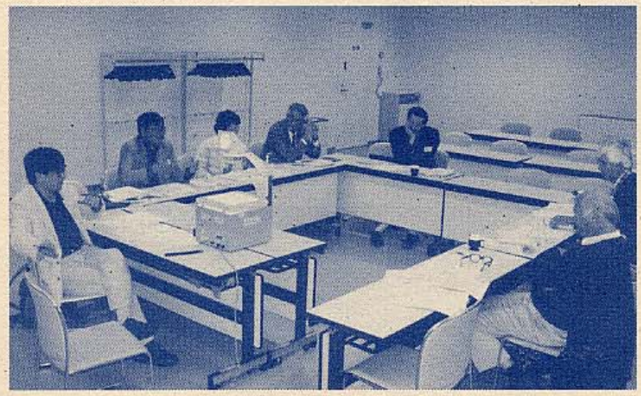
Ladies from local women associations help provide delicious lunches to all participants

Vigorous action in the service room - coffee sipping, snacking, discussions, e-mailing and net-surfing etc.

Prof. Y. Nagata and Drs. M.L. Dahlberg, N.B. Hargreaves and R.J. Beamish were invited to a meeting with local fishermen

"Higher trophic level processes" Discussion Group in session

BASS Task Team in session



"Lower trophic level processes" Discussion Group in session

"Model integration/management" Discussion Group in session

Dr. Sinjae Yoo proposing a toast at the Participants' Party

One of the many highlights of the Workshop for Dr. Wooster

Visiting scientist to Nemuro Brad Stevens and volunteer helper to the Workshop Meri Holden giving a dynamic husband and wife duo performance at the Participants' Party

The 'PICES Cocktail' invented by Pub Suzuki at the PICES Third Annual Meeting in 1994 is formally patented this time by Chairman, Dr. Warren S. Wooster, and Chairman of Science Board, Dr. Makoto Kashiwai

CCCC Nemuro Meeting - (Cont. from page 1)

Other recommendations include the integration of vertical mixed layer models into the general circulation models for development of coupled physics-plankton production models; standardization of models for lower trophic level processes such as nutrient uptake and grazing, and prediction; and comparison of fish bioenergetics, movement, and "bottom-up" and "top-down" multispicies trophodynamic models. The documentation, evaluation and distribution of component sub-models to the broad Pacific marine science community is an important issue that needs to coordinated as part of the PICES/CCCC program in order to make this distributed model development activity successful.

Preliminary reports of the discussion groups and task teams will be revised during the summer and made available for discussion at the PICES-V. It is expected that these reports, together with the invited review papers, will be included in a scientific report to be published by PICES.

To facilitate regional comparison, REX is recommending development of monitoring program at key cross-shelf locations in as many regional seas as possible. These transects should be complemented with measurements from moorings, especially if placed in "pulse point" which may represent locations of strong system variability or control. Recommendations from the BASS include retrospective comparison of lower trophic level dynamics between eastern and western subarctic gyres, standardization of zooplankton sampling methods and time series measurements of primary productivity and zooplankton in order to compare changes in plankton population with changes in the physical environment.

Useful discussions were held in Nemuro with the four members of the North Pacific Anadromous Fish Commission Science Sub-Committee on the development of future cooperation in pursuing research topics common to the NPAFC and PICES/CCCC Science Plan.

PICES Secretariat News

The latest Secretariat photo: Christie McAlister, secretary; Alexander Bychkov, Assistant Executive Secretary; Christina Chiu, Administrative Assistant; and W.Doug McKone, Executive Secretary.

Alexander Bychkov became the Assistant Executive Secretary of PICES replacing Dr. Motroyasu Miata as of May 1, 1996.

He has a Ph.D. in analytical chemistry from the Moscow State University and most recently was the Head of Climate Chemistry Laboratory at the Pacific Oceanological Institute of the Far-Eastern Branch of Russian Academy of Sciences in Vladivostok. His research interests focused on water circulation and its effect on the basic patterns of the carbon cycle in the Western Subarctic Pacific and its Marginal Seas (Sea of Okhotsk and Sea of Japan).

During 1994-1996 Dr. A.Bychkov was member of the Physical Oceanography & Climate Committee of PICES. Presently, he is member of the Scientific Steering Committee for the Joint Global Ocean Flux Study Project and member of the National Oceanographic Committee of Russian Federation.

Who is ALACE? What is she?

Howard Freeland
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Dr. Howard Freeland is Head of the State of the Ocean Section at the Institute of Ocean Sciences (Department Fisheries and Ocean, Canada). Howard is interested in the climatic state of the ocean and low frequency variability. Presently, he is responsible for maintenance of Line-P, a line of CTD stations that has been monitored for over 40 years between the mouth of the Juan de Fuca Strait and Ocean Weather Station Papa at 50°N and 145°W (also known as WOCE Repeat Hydrography Line PR6). Howard was the scientist primarily responsible for Canadian interests in the WOCE Lines P15 & P1. Earlier this year he was the winner of the Applied Oceanography Prize awarded annualy by CMOS, the Canadian Meteorological and Oceanographic Society.

This article was originally printed in the Bulletin of CMOS, the Canadian Meteorological and Oceanographic Society. It is reprinted here with some modifications and updates.

A new device, a profiling ALACE float, is available for the exploration of the oceans. I have managed to purchase several of these for use in the N.E. Pacific and in the Labrador Sea and have now acquired some experience working with the device. I would like to share this experience, and this short article will, I hope, outline how well the device is working and what it can do for us.

The device itself was first designed by Webb Research (Falmouth, Massachusetts) to allow the exploration of currents in remote areas of the global ocean. ALACE is an acronym for Autonomous Lagrangian Current Explorer. The ALACE is designed to sink to a predetermined depth and drift for a predetermined time. At the end of that time the float adjusts its buoyancy, rises to the surface, is fixed by the Système Argos satellite, and then returns to its pre-set depth. A recent innovation has involved adding a CTD to the float so that on the way up a CTD profile is obtained, some have dubbed the modified float a P-ALACE (Profiling ALACE). Anyway, it is one of these that was deployed in September 1995 at Station Papa (Figure 1), in the N.E. Pacific, at a depth of 850 metres, and I am going to call it an ALACE float from now on. The original concept for the ALACE float comes from the Scripps Institute of Oceanography (Russ Davis) and at the time that the units reported here were purchased the float body was manufactured by the Webb Research in Falmouth, Massachusetts, and integration of the CTD was still carried out by the Scripps group. Now the complete profiling units can be ordered directly from the Webb Research who completes all phases of the manufacture

The ALACE float consumes power both when it transmits its data to the Argos satellite and when it adjusts a piston to change its buoyancy, however, the latter adjustment dominates the power requirements. The standard ALACE has energy sufficient for about 100 repeat trips between a parking depth of 1000 metres and the surface. The energy demand is roughly proportional to pressure, so it will have energy sufficient for only 50 trips if it is launched to drift at 2,000 metres. In its present configuration the float near Station Papa should have power sufficient to execute up to 130 profiles. I set the first float to ascend once every 5 days. The object was to explore the evolution of the open ocean mixed layer, and 5 days is about the storm interval, so we should get measurements for about 650 days, or 1.8 years.

Figures 1 - 4 summarize the performance of our first ALACE deployment. As of writing, March 13th, the float has completed 38 cycles between 850 metres and the surface. The plots of potential temperature (Figure 2) and salinity (Figure 3) show the steady deepening of the thermocline as early fall turned to winter. More intriguing is the double halocline that can be seen in early fall that deepens and then merges with the main halocline near profile number 11. Recently we see a rapid change developing in the deep salinity fields. This may be correct, we must remember that the float is near some major oceanographic fronts, and its position , Figure 1, is changing.

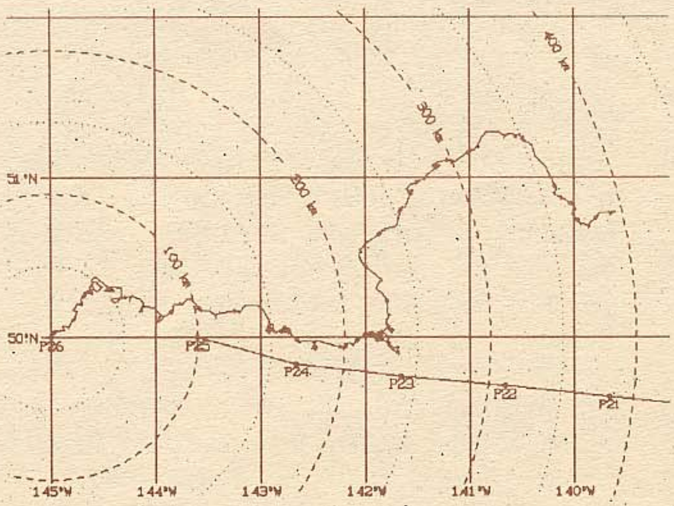

Figure 1: The drift of a profiling ALACE float over a period of 190 days in the N.E. Pacific.

The conductivity sensor is an inductive type sensor, manufactured by Falmouth Scientific Instruments and remained stable from deployment in September 1995 through March 1996. For example, the float reported a salinity of 34.291 psu at 850 metres depth shortly after deployment, and a value of 34.290 psu at the same depth 105 days and 21 profiles later. However, forthwith after that time the conductivity cell showed evidence of a rapid drift in calibration and the conductivity measurements soon became useless. We suspect that insufficient antifouling was used on this device, and the more recently manufactured devices are more aggressively anti-fouled, however, it is not certain that fouling by biological growth is the reason for this failure. We will attempt to recover this device during a cruise late this summer and if all goes well we may have more to report on the case of this failure.

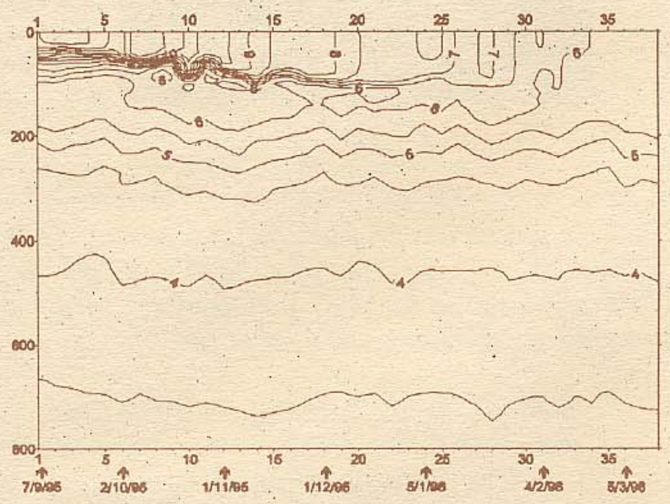

Figure 2: A contour chart of potential temperature plotted against consecutive profile number (1 per 5 days) and depth (dbar)

An ALACE float is extremely easy to deploy. Prior to deployment the unit is activated and completes a self test. Some hardware is then attached and the unit is deployed from a vessel maintaining way of 1 to 2 knots. I am informed by the electronics technician who deployed the first one at Station Papa that, even a Ph.D. could deploy it.

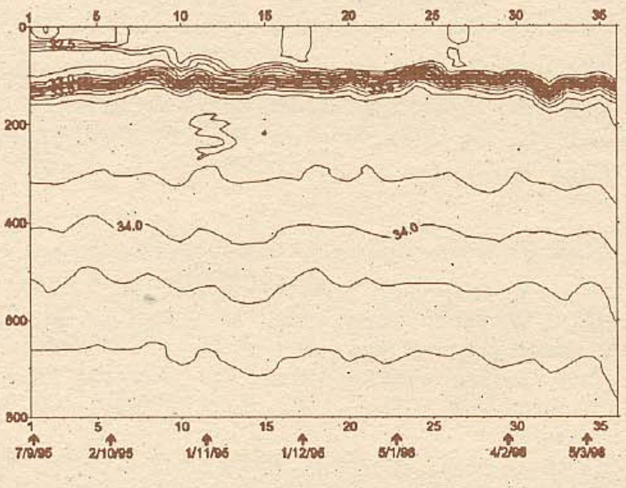

Figure 3: A contour chart of potential salinity plotted against consecutive profile number (1 per 5 days) and depth (dbar).

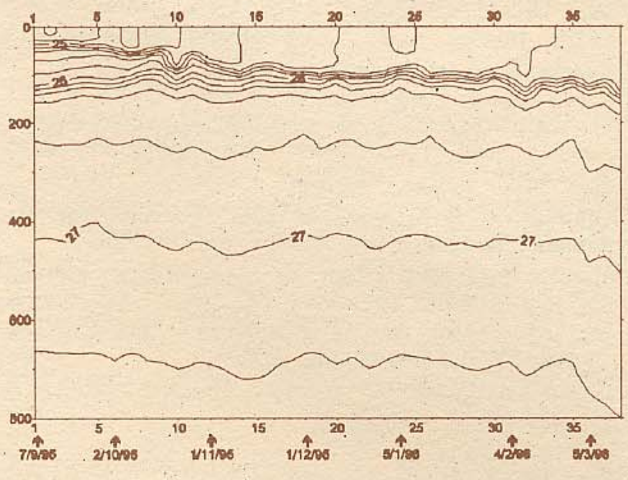

Figure 4: A contour chart of potential density (σ_t) plotted against concecutive profile number (1 per 5 days) and depth (dbar).

Data from the ALACE float are received by Système Argos, converted to E-Mail messages and transmitted to the user. I usually receive the messages after normal work hours, and so process the data from home. Conversion of the highly compressed E-Mail message to a final CTD profile is a more complex task than I had expected. The Scripps group that integrate the CTD into the ALACE have put great effort into maximising the information content of the Argos messages, and hence have adopted an impressive data compression algorithm. Essentially, the CTD data comprises measurements in 60 bins, and four Argos messages are transmitted representing data in bins 60-46, 45-31, 30-16 and finally 15-1. In each message the actual value of temperature and conductivity in the first bin of each message (bins 60, 45, 30 and 15) is converted to a bit string and transmitted en clair. For each successive bin only the difference in the number of bits is transmitted to a maximum of 256 bits for temperature and 64 bits for conductivity. If the ALACE passes through a region of very high temperature gradient (about 2.2C/10 metres) then the difference can become 257 bits and is transmitted as one bit. Thus there is no unique transformation from the received message to a CTD profile. Usually a little common sense, and a graphical editing program, allows easy conversion of the received bit strings to a rational bit string. Occasionally it has required a considerable amount of effort, and some degree of imagination, to determine the most probable CTD profile from the received message.

Finally, this discussion would not be complete without a discussion of costs. I have been able to submit only rather small orders to Webb Research and so have not been able to take advantage of some large reductions in cost associated with large orders. A profiling ALACE float, ready to go into the ocean, is presently costing me C$24,500 per unit delivered to IOS. However, the single unit presently operating in the N.E. Pacific is continuing to operate without the attention of a ship. The John P. Tully could be used for getting CTD profiles, and would cost about C$10,000 per day. So, the profiling ALACE float is worth about 2.5 days of ship time. The float can be deployed from almost any vessel, and, in its present configuration, should supply 140 profiles, for a cost of C$175/profile. The cost would be even lower if we could recover the float. In principle this is possible, but it would not really be a rational thing to do. The ALACE float barely penetrates the sea surface when it rises to the surface and would be a very difficult optical target at sea. I would anticipate spending several days searching for an ALACE float, at a cost of $10,000/day, and either failing to find it, or finally seeing it moments before it gets sucked into the propeller of the John P. Tully. The costs of an attempted recovery will always be too high. Despite the previous comments, we propose attempting to recover one float in August 1996. The reasons go beyond coast-effectiveness, this is a developing technology and there is a need to know exactly what happened to cause the rapid drift in the conductivity sensor. In this case scientific benefits outweigh the coast of recovery. However, at a cost of $175/profile this is clearly a technology that should be considered in any major attempt to monitor the state of the ocean, in GOOS, for example.

Beside the CTD profiles we also get the drift trajectories. Despite its name the device is not a Lagrangian device. In the configuration of the one presently in the N.E. Pacific, we get periods of drift at 850 metres followed by a 22 hour drift at the sea surface. In the diagram above the drift is summarised. The arrows indicate the deep drift segments and the wiggly lines the drifts at the surface. It is clear that the deep drifts are highly correlated with the surface drifts, and also that my intention to park the device at Station Papa by deploying it at 850 metres was a failure.

After processing is complete, I automatically generate a KKXX file[1] that is transmitted to MEDS and then on the GTS. Thus the data from ALACE WMO number 578 are going directly into global data bases that are monitoring the climatic state of the world ocean. As part of my routine processing of the P-ALACE float data I generate displays that evolve every 5 days and can be viewed by any interested readers on my WWW home page. Anyone interested is encouraged to look at the up-to-date output from two ALACE floats at http://www.ios.bc.ca/ios/sos/freeland.htm

Footnote:
1 KKXX is the IGOSS message code for sending Temperature/Salinity data onto the GTS.

Meetings of Interest

The following is a list of some future meetings that might be of interest. More comprehensive list is available by E-mail or on PICES WWW Home Page: http://pices.ios.bc.ca

1996

Sept 4-6, Dartmouth, Nova Scotia, Canada
NAFO Workshop "Assessment of Ground-fish Stocks Based on Bottom Trawl Survey Results"
Hans Lassen, Danish Inst. for Fisheries Res., Charlottenlund Slot, DK-2920 Charlottenlund, Denmark;
t: +45-33-96-3300 f: +45-33-96-3333
e: hl@dfu.min.dk
Tissa Amaratunga, NAFO Secretariat, P.O. Box 638, Dartmouth, Nova Scotia, Canada B2Y 3Y9;
t: +1-902-469-9105 f: +1-902-469-5729

Sept 18-21: Anchorage, Alaska, USA
BESIS (Bering Sea Impact Study) Workshop and Session during the Annual Arctic Meeting
Jack Kruse or Mary Killorin,
f: +1-907-786-7739 e: auaaas@acad2.alaska.edu

Sept 24-26: Vienna, Austria
International Conference on Fish Migration and Fish Bypass Channels
Manuel Hinterhofer, Dept. of Hydrobiology, Fisheries and Aquaculture, University of Agriculture, Forestry and Renewable Natural Resources, Max Emanuel-Strasse 17, A-1180 Vienna, Austria;
t: +43-1-47654-5202 f: +43-1-47654-5217
e: confer@mail.boku.ac.at

Sept 24-29: Stanford, California, USA
42nd Annual Eastern Pacific Oceanic Conference
M.Kostro, College of Oceanic & Atmospheric Sciences, Oregon State Univ., Ocean Adm.Bldg.104, Corvallis, OR, USA 97331-5503;
t: +1-503-737-3079 f: +1-503-737-2064
e: kostro@oce.orst.edu

Sep 27-Oct 4: Reykjavik, Iceland
ICES 1996 Annual Science Conference
t: +45-33-154-225 f: +45 33-934-215
e: postmaster@server.ices.inst.dk http://www.ices.dk

Oct 11-20: Nanaimo, British Columbia, Canada
PICES Fifth Annual Meeting
PICES Secretariat, c/o Inst. of Ocean Sciences, P.O. Box 6000, Sidney BC, Canada V8L 4B2;
t: +1-604-363-6366 f: +1-604-363-6827
e: pices@ios.bc.ca

Oct 21-26: Tokyo, Japan
NPAFC (North Pacific Anadromous Fish Commission) Forth Annual Meeting
NPAFC Secretariat, 6640 Northwest Marine Drive, Vancouver BC, Canada V6T 1X2; .
t: +1-604-228-1128 f: +1-604-228-1135)
e: wmorris@unixg.ubc.ca

Oct 28-29: Sapporo, Hokkaido, Japan
International Symposium on Assessment and Status of Pacific Rim Salmonid Stocks
NPAFC Secretariat, 6640 Northwest Marine Drive, Vancouver BC, Canada V6T 1X2;
t: +1-604-228-1128 f: +1-604-228-1135
e: endo@unixg.ubc.ca

Nov 8-9: Bodega Marine Lab, California, USA
2nd Conference on Fisheries and Pollution Population-Level Effects of Marine Contamination
Daniel Grosse, Rifkin & Associates, Suite 2332, World Trade Center Baltimore, 401 E. Pratt St., Baltimore MD, USA 21202;
t: +1-410-962-1401 f: +1-410-962-1065
e:dgrosse@access.digex.net

Nov 12-14: Mutsu, Hokkaido, Japan
International Symposium on The Biogeochemical Processes in the North Pacific
Dr.Shizuo Tsunogai, Marine & Atmospheric Geochemistry Lab., Graduate School of Environmental Earth Science, Hokkaido University., Supporo 060, Japan;
t: +81-11-706-2370; f: +81-11-726-6234
e: norit@eoas.eoas.hokudai.ac.jp)

1997

Mar 2-7: Ventura, California, USA
Gordon Research Conference on Sea Ice Ecology
Stephen F. Ackley, Chairman GRC on Sea Ice Ecology Cold Regions Res. and Engr. Lab. 72 Lyme Rd., Hanover, NH 03755;
f.: +1-603-646-4644 e: sackley@crrel.usace.army.mil
Gordon Research Conferences Univ. of Rhode Island, PO Box 984 West Kingston, RI 02982-0984:
e: grc@grcmail.grc.uri.edu http://www.grc.uri.edu

Mar 19-21: Kiel, Germany
ICES Symposium on "The temporal variability of Plankton and Their Physico-Chemical Environment
ICES Secretariat, Palagade2-4, DK-1261 Kopenhagen K, Denmark; t: +45-33-154-225 f: +45-33-934-215
e: ices.info@ices.dk

May 20-26 Argyll, Scotland, UK
JGOFS Symposium on Synthesis and Modelling
Trevor Platt, Bedford Institute of Oceanography, P.O.Box 1006, Dartmouth, NB B2Y 4A2, Canada;
f: +1-902-426-9388 e: tplatt@ac.dal.ca
Graham Shimmield, Dunstaffnage Marine Lab., P.O.Box 3, Oban, Argyll, Scotland,
f: +44-1631-65518 e: g.shimmield@ed.ac.uk

June 18-20: Bled, Slovenia
Fourth International Conference on Water Pollution Modelling, Measuring, and Prediction
L.Kerr, Water Pollution 97 Conference Secretariat, Wessex, Inst.of Technology, Ashurst Lodge, Ashurst, Southampton SO40 7AA, UK;
t: +44-1703-293-223 f: +44-1703-292-853;
e: wit@wessex.witcmi.ac.uk
http://www.witcmi.ac.uk

Sept.(last week):
ICES Annual Science Conference in USA
"The Role of Physical and Biological Processes in the Dynamics of Marine Populations"
for current details see http://www.ices.dk)

Oct 8-11: Anchorage, Alaska, USA
International Symposium on Fisheries Stock Assessment Models for the 21st Century: Multiple Information Sources. 15th Lowell Wakefield Symposium
Brenda Baxter, Alaska Sea Grant College Program;
t: +1-907-474-6701 f: +1-907-474-6285
e: fnbrb@aurora.alaska.edu)

Oct (Week following Oct.10): Pussan, Korea
PICES 6th Annual Meeting
PICES Secretariat, c/o Inst. of Ocean Sciences, P.O. Box 6000, Sidney BC, Canada V8L 4B2;
t: +1-604-363-6366 f: +1-604-363-6827
e: pices@ios.bc.ca

Oct 27-31: Victoria BC, Canada.
NPAFC (North Pacific Anadromous Fish Commission) Fifth Annual Meeting
NPAFC Secretariat, 6640 Northwest Marine Drive, Vancouver BC, Canada V6T 1X2;
t: +1-604-228-1128 f: +1-604-228-1135)
e: wmorris@unixg.ubc.ca

1998

Aug.-Sept.: Tromso, Norway
IASC/SCAR Symposium on Global Changes in the Polar Regions: Results and Challenges from Bipolar Science
Executive Secretary, IASC, Secretariat, P.O. Box 5072 Majorstua, 0301 Majorstua, Oslo, Norway;
t: +47-22-959-600 f: +47-22-959-601
e: iasc@npolar.no

PICES Annual Meeting 1996 - Nanaimo, Canada; 1997 - Korea

The PICES 1996 meeting will be held 11-20 October in Nanaimo, British Columbia, Canada.

The Republic of Korea has confirmed that it will host the Sixth Annual Meeting in Korea in October, 1997.

Error in Final Announcement

Double room rates for hotels quoted in the Final Announcement for the PICES Fifth Annual Meeting are for double occupancy, NOT per person. Sorry for any confusion.

New Area Code for British Columbia

This is an early notice that area code for British Columbia will change from 604 to 250 as of Oct. 19, 1996. Please, change PICES Secretariat phone and fax numbers accordingly on your records, phone or fax speed dials.

General mailing List

This is to remind you that if you wish to stay in our general mailing list to receive PICES Press and Meeting Announcement, and have not return the little form in previous newsletters to notify us, please drop as a line with your name and current address etc. by mail, fax or e-mail

PICES Publication List

The following publications are available upon request, free of charge, as long as stocks last.

1. **Annual Reports 1992-95 (ISSN 1192-7771)**
2. **PICES Press (ISSN 1195-2512)**
   Vol. 1 No. 1, June 1993 (out of stock)
   Vol. 2 No. 1, January 1994 (out of stock)
   Vol. 2 No. 2, July 1994
   Vol. 3 No. 1, January 1995
   Vol. 3 No. 2, July 1995
   Vol. 4 No. 1, January 1996
3. **PICES Scientific Reports (ISSN 1198-273X)**
   No. 1 (October 1993, 130 pp.): *Part 1: Coastal Pelagic Fishes and Part 2: Subarctic Gyre* (out of stock)
   No. 2 (April 1995, 227 pp.,): *The Okhotsk Sea & the Oyashio Region* (out of stock)
   No. 3 (December 1995, 94 pp.): *Monitoring Subarctic North Pacific Variability*
   No. 4 (March 1996, 64 pp.): *Science Plan, Implementation Plan Report of the PICES-GLOBEC International Program on Climate Change and Carrying Capacity*
   No. 5 (March 1996, 91 pp.): *Modelling of the Subarctic North Pacific Circulation*
4. **The PICES Papers:** Reports of Meetings Leading to the Establishment of the North Pacific Marine Science Organization (PICES), 1978-1992 (1994, 143 pp.)
5. **PICES Scientific Workshop** (Seattle, WA, December 1991): *Part A: Summary Report* and *Review Papers* (1991, 90 pp.) *and Part B: National Reports* (1991, 115 pp.)

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