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PACIFIC TIDINGS

Fish habitat can be damaged in ways both obvious and subtle, and by changes big and small. Human activity, residential or industrial developments all have an impact. It is one that can be lessened when planning and management is approached in an integrated and cooperative fashion. Several recent developments in B.C. reflect the success of this type of cooperation and adhere to DFO's Habitat Management Policy, following the Land Development Guidelines for the Protection of Aquatic Habitat. Three of these are illustrated in this issue of Pacific Tidings.

Spawning salmon grace the fairways

It's a new generation of golf course. One where it is not unusual to see wild blue heron hunt for salmon fry in creeks running through the course, nor deer and bear venturing out to feast on fairway grasses. Furry Creek Golf & Country Club is one of its kind in North America.

The site includes two creeks of value to the fishery resource: Furry Creek, one of the few significant watercourses that flow into Howe Sound, and its tributary, Middle Creek. It also includes a marine foreshore important to young rearing salmon. The site is large and complex and involved fishery officers and water use, water quality and land use biologists from DFO to ensure fish and their habitat were protected. Situated in Howe Sound, about 45 kilometres north of Vancouver, the development will include 920 residential units, a golf course and a marina.

The steep hillsides of Furry Creek development show the necessity for erosion and sediment control. Looking down from a golf tee on high shows how the control pond fits in with the overall design. This pond also serves as an organically balanced irrigation source for the course.

Many parts of the otherwise wild site were severely degraded from historical use. In the early 1900s it was logged extensively for timbers for the nearby and now unused Britannia Mine, sections were mined for gravel and used for log storage. Above spectacular falls that roar through a steep, rock-faced gorge, the upper reaches of Furry Creek were dammed to provide hydroelectric power for Britannia.

"Our ideal was to create a community in harmony with the natural environment," says David Rittberg, site coordinator for Tanac Land

INSIDE

Fisheries and Oceans Pêches et Océans

Canada

Development Corp. in Vancouver. That's an ideal that came directly from Shigenori Suzuki, the president of Tanac and its parent company, the Japan-based Tanabe Corporation. Suzuki's personal goal was to build a development with minimum negative impact on the natural system.

"We were concerned about several issues," says DFO habitat biologist Bruce Reid. "These included maintaining the fisheries sensitive zones—the vegetated buffer—along the sides of each creek, sediment control, storm water management and the proposed restoration of Middle Creek.

Waterfalls, fast flows and falling rock limit the spawning opportunities to the lower parts of Furry Creek where coho and chinook salmon plus cutthroat trout can be found.

The same species can be found in Middle Creek, but past abuse had resulted in an extremely undefined channel in the lower reaches, with water spreading out over the land. The creek didn't flow year-round, gravel bars were exposed and shallow pools formed where fish became stranded. Tanac and its consultant, ECL Envirowest Limited, worked with DFO to restore and stabilize the habitat. The channel was once again defined and

David Rittberg (left), site coordinator, talks to Bruce Reid of DFO about recent restoration work on the lower reaches of Middle Creek.

"complexed" through the addition of weirs, boulders and gravel in the stream to create the varying habitat needs of salmon. Stream bank vegetation was planted to provide shade, food and bank stability.

As the creeks wind their way down the slope, they run parallel and across the fairways. A greenbelt of cedar trees, other conifers and deciduous trees, plus wild shrubs and grasses form the 15-metre buffer on either side of the streams.

"Like any large project, problems can and do occur during development," says Reid. "Some areas proposed as tees or fairways in the initial plans had to be changed to protect the buffer zones along Furry Creek. Other plans, like the location of the clubhouse restaurant overlooking the falls, were sensitive to the environment. Listening, talking and learning about each player's needs was essential for real cooperation."

David Rittberg agrees. "Changes are easy to do when the work is still on paper. We had a good relationship with DFO. Anytime there was a problem, we'd call the fishery officer (Bert Ionson from DFO's office in Squamish) and he'd be right out here on the site."

Erosion and sediment from construction during severe rain storms was a serious issue and problems arose despite a sediment control plan, which included sediment ponds, already in place. In DFO's view, stated Reid and Ionson, there were unacceptable levels of sediment discharged into the fish bearing streams due to clubhouse construction. The company promptly responded with modifications to the sediment plan and the problem was remedied.

"Changes are easy to do when the work is still on paper."

One of the ponds also serves as an organically balanced irrigation source for the golf course. The technology for the BMW — "bacteria mineral water" — system was developed in Japan. At Furry Creek, a 60-ton BMW plant has been built. Using compost made from chicken manure and grass cuttings, one ton of BMW is produced every day and transferred into the sediment pond where it is used to fertilize and irrigate the course. The goal is to improve the soil and eliminate the need for chemical fertilizers, weed killers or insecticides.

"In essence, much of Howe Sound is a fjord with very sheer walls," says Steve Macfarlane, DFO habitat biologist. "There is not a lot of what we consider to be high quality shoreline habitat for juvenile salmon. However, the steep bluffs of Furry Creek that distinguish each side of the creek in the upper reaches, fan out into a delta where the creek enters the Sound. This delta, a gravel area, is known as an alluvial fan and is important for rearing salmon as well as other species. This type of habitat is scarce in Howe Sound."

"We couldn't accept the initial marina proposal," says Macfarlane. "The result would have meant significant loss of productive gravel cobble beach. However, after a great deal of discussion and adjustments, we feel positive that a proposal will come forward that will maintain the integrity of the area and protect the alluvial fan."

Marina developments lie in the future, but Mr. Suzuki's goal to minimize the destruction of nature as much as possible, to work with the topography and to try to restore and enhance damaged habitat has definitely been accomplished. ■

Housing development serves as model of environmental sensitivity

Winning awards was not the first priority of Cedarsprings Country Estates, but win them it did: three gold Georgie Awards by the Canadian Home Builders Association, for best multi-family development, best interior design and best environmental treatment. The accolades do not stop, either. Letters of commendation for being environmentally sensitive are added to the growing list. The 1992 development is now used as a model in the Fraser Valley for other developers for sediment and erosion control measures.

Cedarsprings sits on Sumas Mountain in Abbotsford in the Municipality of Matsqui. The site was complex, with steep slopes, several feeder springs, potential erosion, old growth trees, a watercourse important to the fishery resource and extensive volumes of storm water from upstream subdivisions. Springs and storm water run off the mountain, collecting at the base of the site, eventually flowing into Stoney Creek, a sensitive fish habitat stream.

Building on the side of a mountain is tricky at the best of times, but Stan Rogers, President of Bateman Place Developments Ltd. took what many would consider problems and turned them into opportunities. He clustered townhouses on natural terraced plateaus, designed roadways to follow natural contours, protected fish habitat and saved roughly 200 trees.

"He is one of the best developers I've ever worked with," says DFO habitat biologist Marissa Byrne. "Rather than molding the mountainside to create more land for development, as is usually done, Rogers worked with the topography, incorporating the project design into the lay of the land."

Sediment and erosion control, to keep silt out of fish habitat, was the major issue. (Among other things, silt clogs fish gills and smothers eggs). The biggest plus, in terms of habitat protection, was putting an excellent sediment erosion facility into place before any other site work started.

The plan, developed by Terrasol Environment Industries and Central Valley Engineering, called for a storm system to solve erosion and upstream drainage problems and for phased excavation and construction to reduce soil exposure to wind and rain. Unlike some developments which carve out the whole site, leaving a moonscape-like environment, Cedarsprings was completed one section at a time, with even the seeding completed before starting to clear another section.

The end result was the creation of a lake in the middle of the site which acts as a permanent silt retention, storm detention and flood control facility.

"Basically, we used the springs and the storm run-off to our advantage," says Rogers. "Water features were built right into the design. I knew the objectives of the Department of Fisheries and Oceans and we had a good working relationship. We put our ideas together and got down to the mechanics of meeting DFO needs, getting the issue resolved and developing a property that looked beautiful." ■

Incorporated as a feature of the new development, this lake is the key to sediment and erosion control, acting as permanent silt retention, storm detention and flood control facility.

First habitat bank completed on the North Fraser

Habitat banking is a key part of the North Fraser Harbour Environmental Management Plan, a joint initiative signed in 1988 by DFO and the North Fraser Harbour Commission. This plan helps ensure that environmental considerations become an integral part of waterfront development in the harbour. It requires construction of compensation habitat prior to approval of a project. In this way, habitat is created up front, and complements the no net loss principle of DFO's National Habitat Policy. It will be available to developers only in some areas of the river to replace unavoidable losses of habitat. It works with DFO's three-zoned foreshore classification system.

The three classification zones:

- ● **RED** – ***Highly Productive Habitat***
  No development permitted unless mitigation can be applied to ensure that no alteration or alienation to existing habitats will occur
- ◑ **YELLOW** – ***Moderately Productive Habitat***
  Development permitted subject to satisfactory mitigation and/or compensation
- ○ **GREEN** – ***Low Productive Habitat***
  Development permitted subject to environmentally sound design and timing restrictions

In 1988, when it was first conceived, the concept of "banking" fish habitat added a new and unique element to environmental management.

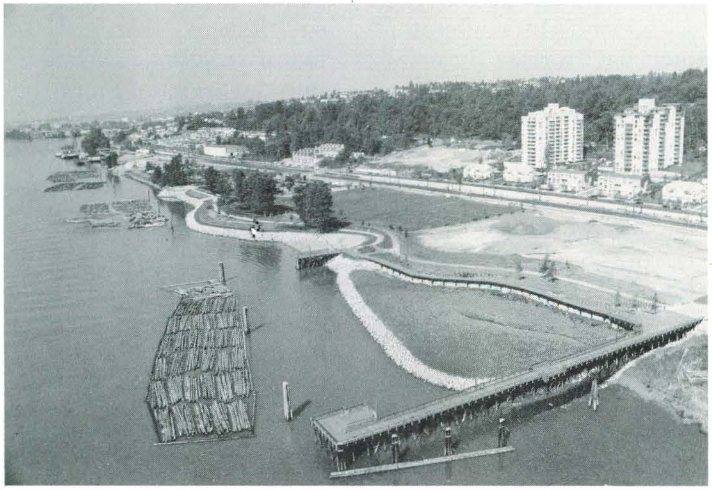
Today, that concept is a practical reality. Close to two kilometres of what was once heavily industrialized foreshore of the Fraser River has been re-worked to protect and include fish habitat features, river bank vegetation, boardwalks and a park for people. Just over 5,500 square metres of marsh habitat have been built into the Fraser Lands Riverfront Park development along the north arm of the river, creating the first habitat banking site in the North Fraser Harbour. A total of 8,000 square metres of marsh have been built into this development.

The north arm of the Fraser doesn't have a lot of marsh habitat—the nutrient-rich areas so important for young juvenile salmon on their way to sea—so when developments occur, it's an opportunity to build fish habitat right into the river. Rather than having a sterile degraded waterfront, the area is productive and aesthetically pleasing.

The Fraser Lands Riverfront Park proposal would change some of the existing waterfront. Any encroachments, (filling in and building out into the river) that were at the expense of habitat had to compensated for. DFO's policy of no net loss calls for two times the habitat used to be rebuilt as compensation. There were also other opportunities to do much more here.

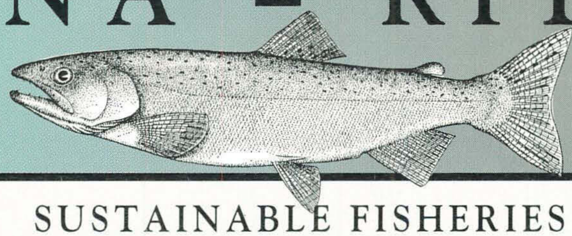
"We've been looking for banking sites for a couple of years," says Gary Williams, an aquatic ecologist with G.L. Williams & Associates, who acts on behalf of the Harbour Commission. "It's not easy to find sites that are economical and which fit DFO requirements. This site was ideal."

Balancing industrial, environmental and human recreational activities during the development of the Fraser Lands Riverfront Park depended on a cooperative partnership between DFO and the North Fraser Harbour Commission, as well as, the City of Vancouver and the Vancouver Board of Parks and Recreation. The intense planning process that followed took over a year to complete and



Waterfront development on the Fraser River creates fish habitat and a park for people.

SKEENA – KITIMAT



SUSTAINABLE FISHERIES

1994 • NUMBER 1

The Skeena-Kitimat Sustainable Fisheries Program addresses the complex and sensitive fisheries issues in the Skeena River watershed. The achievement of a sustainable fish resource in these mixed-stock fisheries is the program's major goal. A number of research programs and consensus-building activities are underway as a means to accomplish this. A few are presented in this publication.

USING GENETIC MARKERS TO IDENTIFY SALMON

Salmon from different regions often travel together for part of their return voyage to the spawning grounds. In the Skeena River system this presents a massive challenge to those who manage what are called mixed-stock fisheries. The challenge is great because different stocks (populations of one species) are genetically discrete and some stocks are more vulnerable to overfishing than others and must be protected.

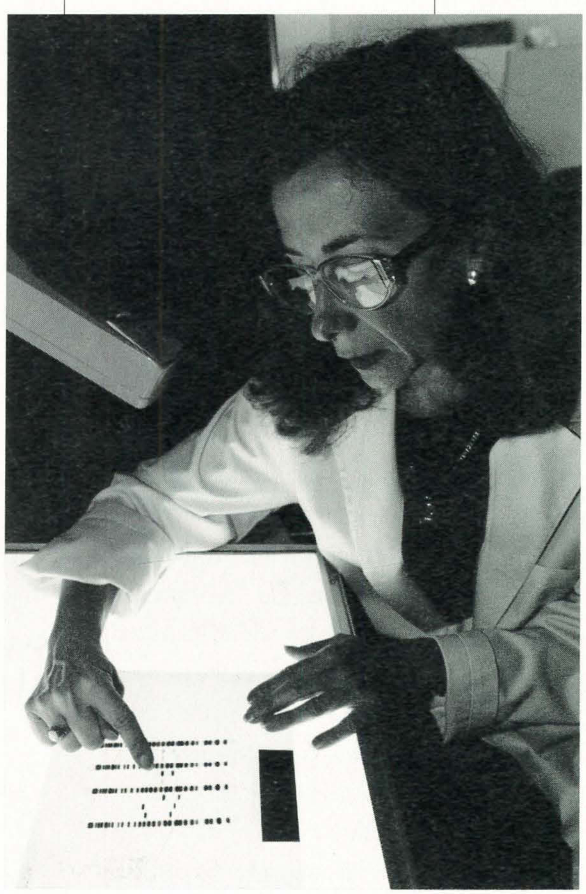
To protect individual populations of salmon, we have to be able to recognize them while they are enroute to their spawning grounds. Armed with stock identification techniques, fisheries managers will be able to manage more effectively the less productive wild sockeye, coho and steelhead populations in the Skeena River system.

A quick glimpse at just the sockeye in the Skeena system shows the complexity of fisheries management. At least 57 distinct sockeye populations exist in lakes throughout the watershed. Of the three "runs" defined for management purposes—early, middle and late—the early run includes many of these populations, whereas the middle and largest run consists predominantly of sockeye from the Fulton River and Pinkut Creek, including those from Babine Lake enhancement facilities.

Dr. Chris Wood, DFO research scientist at the Pacific Biological Station, is coordinating the genetic stock identification program for sockeye and coho populations in the Skeena River system. This is funded by Canada's Green Plan initiative. The Fisheries Branch of the B.C. Ministry of Environment, Lands and Parks is undertaking similar research on steelhead.

How do scientists know what to look for when they try to identify a fish?

"We look at what we call the "biological markers" for each



DNA work carried out by police departments, as shown here, illustrates in a similar manner how scientists "see" the genetic code, or fingerprint of each salmon within strands of DNA.

(Photo by Brian Giebelhaus, courtesy of the Peach Arch News)

salmon population," says Wood. "Scale patterns, the prevalence of parasites, the frequency of genes examined by protein electrophoresis or by DNA probes can all act as natural tags in populations."

A number of techniques to find and use these markers have already been developed, particularly for sockeye. Now they are being tested to see if they work and if they are cost-effective. Another of the program goals is to develop a genetic stock identification technique for coho. Less work has been done on coho and, according to Wood, genetic stock identification techniques may be more difficult to apply for this species than for steelhead and sockeye.

"This is partly because coho stray from their natal spawning site more than sockeye, and consequently their genes "flow" from one spawning area to another. The reason probably lies in their rearing habits. Juvenile sockeye typically rear in lakes, so adult sockeye must spawn in tributaries that provide their offspring access to a nursery lake. Coho don't rear in lakes and it is not as critical that they spawn in the same spot each generation. To define populations for conservation and management we need to know how much the genes "flow" or spread. If the exchange of genes between spawning areas is small, the salmon in these areas are likely to have very different

A sockeye salmon scale. The growth pattern is made up of circuli (dark lines). Freshwater circuli are much more delicately formed than the more robust ocean circuli. The pattern on this fish tells us it spent its first winter in fresh water and the next two winters in the ocean.

adaptations which should be conserved. This is something we don't know much about in coho."

Stock ID by Scale Pattern

Scale patterns, one of the earliest biological markers used for stock identification, are especially useful markers for sockeye which rear in lakes. The scales record how fast the fish grew. The growth rate, in turn, depends on the lake water temperature and how much food is available. The amount of food also depends on how many fish are "grazing in the pasture." If there are lots of fish, the food crop can be grazed down quite quickly. Sockeye from the same lake usually have similar scale patterns.

Identification through scale patterns is less suitable for chum and pink salmon which migrate directly to the ocean, and for coho or chinook which rear in rivers where the number of fish and the food supply varies among tributaries.

"Scales are a cheap, relatively easy way to identify fish," says Wood. "They store well and you don't have to kill the fish to get samples. However, as biological markers they are not stable from year to year because food abundance in the lakes can fluctuate from year to year. You can't know ahead of the season what the pattern will look like."

Parasites Serve as Markers Too

How many types of parasites a fish carries depends on the species and the population. Often one species of parasite is common in one population and rare in another. Like scales, parasites are an ecological marker; what type the fish carries primarily depends on its rearing environment. Most fish carry parasites and most pose no threat to humans.

"In our work with sockeye, we look at two parasites. One is a microscopic single-celled animal that forms spores that can be detected in the brain tissue. The other is a roundworm found in the body cavity of the salmon. Neither are communicable to humans," says Wood. "The brain parasite is particularly useful for determining whether a sockeye is from Alaska or Canada. It is found in most coastal lakes but few interior lakes. Most of Canada's sockeye rear in interior lakes and do not have this parasite. Most Southeast Alaskan salmon, on the other hand, rear in coastal lakes, so it is reasonable to assume that sockeye without the brain parasite originated in Canada."

This "rule", cautions Wood, is not perfect and works fairly well in northern BC and Southeast Alaska, but not elsewhere in the Pacific.

Looking at Genes Through Protein Electrophoresis

Electrophoresis is a process in which particles (in this case, enzymes in tissue samples) with an electrical charge migrate in a solution under the influence of an electric current. The process works like this: the sample is

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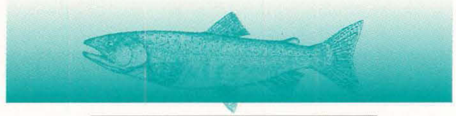

T H R E E

Working Towards Sustainable Fisheries

In August 1993, the Skeena and Kitimat rivers became the focus of a $14-million, four-year model fisheries program to be funded under Canada's Green Plan initiative.

The main goal of the Skeena-Kitimat Sustainable Fisheries Program is to develop and demonstrate the most effective ways to manage fisheries to ensure a healthy resource for the future– one that benefits all those who depend upon it for food and for their livelihood.

At the heart of the program is the Skeena Watershed Committee, a group of people who represent the stakeholders in this watershed: Aboriginal groups, commercial and recreational fishers and the provincial and federal governments.

"One of the earliest successes of the program was the work accomplished by the Skeena Watershed Committee," says Chris Dragseth, an area manager for the Department of Fisheries and Oceans.

Art Tautz, manager of fisheries research at the B.C. Ministry of Environment, Lands and Parks says participation on the committee has been very active, and many of the tough decisions were made by non-government members. "During negotiations on fishing plans, trade-offs had to be made on all sides. Representatives from the First Nations, commercial and sport fishing sectors were largely responsible for coming up with the agreement."

Dragseth, who also chairs the Skeena-Kitimat Technical Committee, a group which develops the technical programs taking place in the watershed, says the key to their success lies in the consensus approach adopted to deal with fisheries management issues. "This is, as far as I know, the first place that such an approach has been so successful."

Fisheries management on the Skeena is a complex and sensitive issue. The river supports all species of Pacific salmon, but each species consists of many stocks (or populations). Weaker stocks migrate at the same time as more abundant ones and are caught in the same fisheries. The very real danger of overfishing these more vulnerable stocks is the subject of public concern and debate.

The need to protect all the stocks is essential, says Bob Hill, president of the Tsimshian Tribal Council. "The issues surrounding the management of Skeena River salmon stocks is extremely sensitive, but I've found that all the stakeholders are committed to the committee process. The group has certainly had its differences, but we have worked them out. Hopefully, at the end of the day we will have developed a comprehensive fishing plan that involves everyone."

John Brockley, chair of the Sport Fish Advisory Board, says, "For years we operated in a conflict situation. This committee seems to be helping us work towards a much more cooperative approach. Its role is a meaningful one and I'm a little up-beat. I think we may have accomplished something monumental."

The program includes protecting the less productive steelhead and coho stocks, while maintaining and enhancing the Aboriginal and commercial fisheries of the more abundant sockeye and pink salmon stocks. More stock-specific fisheries management will be supported by the information gathered in projects dedicated to finding out more about the various populations of each species.

Greg Taylor, of Ocean Fisheries Ltd. and a representative for the fishing industry says, "Our work so far gives me hope. If we can rebuild and strengthen the salmon resource, the real benefit will go beyond the people towards healthy, sustainable fish stocks."

The work accomplished so far shows that conservation of the resource is a top priority for all committee members. As Brian Tobin, Minister of Fisheries and Oceans, has stated: "People were willing to make changes and those who had not been able to work together found a way to do so."

"THE COMMITTEE'S ROLE IS A MEANINGFUL ONE AND I'M A LITTLE UP-BEAT. I THINK WE MAY HAVE ACCOMPLISHED SOMETHING MONUMENTAL."

GETTING A COUNT ON BABINE SALMON

Each day this year, during the peak of BC's northern salmon runs, up to 40,000 salmon passed through the traps on the Babine River counting fence. By the first week of October, just over one million sockeye on their way to the spawning grounds had been counted .

All species of salmon spawn in the Babine River, but it is the sockeye that are so numerous. About 90 per cent of the Skeena River sockeye spawn in this river and other tributaries to Babine Lake. Crew members count each adult salmon individually—sockeye, coho, chinook, pink or steelhead—as it swims into the counting chute from one of the seven holding traps along the 100-metre fence.

Jim Hansen, crew member at the Babine Fence, measures the length of a spawned chinook salmon.

This counting fence is a major part of the effort to learn more about the mix of salmon populations in the Skeena River watershed. Among other things, the data collected here provides an accurate figure on salmon escapements, confirming the number of spawners getting to the spawning grounds.

Very little information is known about coho or steelhead and some of the wild sockeye populations. Thanks to Canada's Green Plan, the resources are available to put the effort into finding out more.

The Babine River counting fence was established in 1946 and rebuilt in 1993. Getting there is a long journey for both fish and people. Fisheries technician Mike Jakubowski, from DFO's Prince Rupert office, manages the counting fence biological program. The drive inland to the field camp from Prince Rupert on B.C.'s north coast is about 360 km and takes nearly a day. Once at Smithers, there are still 120 kilometres to go, with 90 of these on gravel logging roads. Settlements are few, with the Fort Babine Indian Band situated at the entrance to the Babine Lake. Wolves, lynx, eagles and osprey keep company with black bear and grizzlies in this country.

Fish carcasses and leaves are removed as they wash up on the fence, a 100-metre structure spanning the width of the Babine River. Inset: Jim Hansen and Ian Bergsma record the number of salmon which pass through the fence's seven traps.

Work begins early in the spring when the field camp opens for estimating the number of sockeye smolts migrating out of Babine Lake and down the river to the sea. A smolt enumeration program upstream from the fence has been in operation for more than 30 years and is an essential part of assessing the production potential of Babine Lake. With the new fence, facilities are in place so that smolts can be counted as they pass through. Last spring, about 180 million sockeye smolts were counted as they started their down-river journey.

In July, the fence is up and the crew is at work, sampling and counting adult spawners.

"With the camp and the fence already in place, the Green Plan enables us to do so much more," says Jakubowski. "Historically, we've worked primarily with sockeye, but this year we are counting and sampling coho and chinook and next April we're hoping to count the steelhead."

By early November, 3,930 coho had been counted. Very few steelhead had passed through, but these, as expected, were still downriver.

Every day some sockeye are removed from the traps for sampling. Scales are removed and sent to DFO laboratories for stock identification. The sex, age and length of each fish is recorded before it is returned to the water.

Biological samples of coho and chinook are taken after they've spawned and died. Carcasses are easily recovered as they wash up against the fence. The heads of any fish with missing adipose fins are removed for analysis of code-wire tag information.

Efforts at the Babine River fence are directed at improving the monitoring of salmon stocks for better and more stock-specific management practices. ●

Coho Habitat: How Productive is it?

In the headwaters of the Skeena River there are mounting conservation concerns about coho salmon. Northern interior coho are thought to be less productive than coastal coho, and recent declines in abundance in all indicator stocks are serious.

Despite the long history of use of the salmon resource of the Skeena River, there is little information available to assess species like coho. The few programs existing provide only part of the picture. Some of the basic biological characteristics of Skeena coho are unknown. Consequently, there is only a limited understanding of what the productive capabilities of the Skeena actually are for coho, and an even less complete picture of how those capabilities might be changing.

Dr. Blair Holtby, at DFO's Pacific Biological Station, specializes in escapement and habitat interactions. He's working on projects that will change what we know about coho. Improving programs that provide time series of catch distributions, ocean survival rates and harvest rates is one of the objectives of his work. He will also be studying the relationships between coho production and habitat to estimate the productive potential of the Skeena drainage. As part of the coho program, alternative assessment approaches will be developed that are better suited to coho in the Skeena.

"The Skeena is such a big and diverse place that it is inconceivable that detailed work will be possible on more than a small number of tributaries," says Holtby. "A reasonable approach might be to divide up the entire drainage into "bio-geo-climatic" zones and then work intensively on a few systems within each zone. Some of what we are doing is laying the goundwork for just such a classification."

A rotary screw trap, floated on pontoons, is used to capture coho smolts in Lachmach River, one of the study areas in the Skeena Watershed. The coho are counted, measured and coded-wire tagged before being released.

The idea, then, would be to first identify a reasonable number of zones based on geology chemistry, temperature and the biota (animal and plant life). Within each zone, one or two streams would be selected where populations would be closely monitored and perhaps manipulated.

An example of this is taking shape in the Bulkley and Morice drainages. For the past eight years, Holtby and his team have visited, in late summer, more than 30 sites in the Bulkley and Morice river valleys and sampled juvenile coho. These surveys confirm a serious conservation problem in this area.

"The size and density information collected during the surveys suggests that most sites in the Bulkley and Morice rivers are potentially more productive than coastal streams. This is a surprise because conventional wisdom is that interior sites should be less productive."

To explore this, Holtby has begun to collect basic habitat information for the area. This includes recording water temperatures at 10 sites scattered

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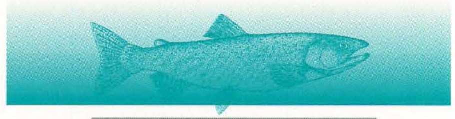


S I X

HIGH TECH TRACKING FOR SKEENA FISH

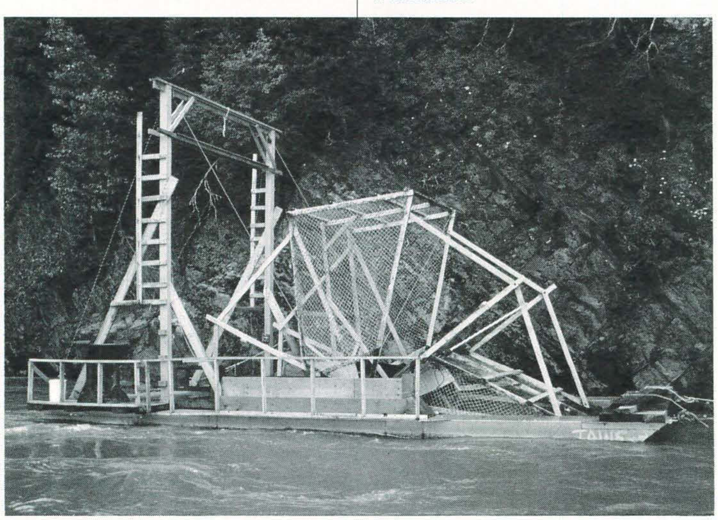
In a joint federal/provincial government program, coho and steelhead salmon are caught, implanted with a radio transmitter, externally tagged and released to continue their spawning migration.

Receiving stations at various migration points in the Skeena River watershed pick up the radio signals. The beauty of using radio transmitters, says Richard Alexander, of LGL Limited, the company contracted to carry out the program, is that they allow each individual fish to be tracked as they travel upriver and into various tributaries. Each receiving station picks up the frequency and individual code of the fish and records its arrival time at that point in the river. The technology is sophisticated; it can record whether the fish turned into another smaller tributary or continued its upriver passage.

The idea behind the program is to find out more about steelhead and coho populations throughout the Skeena system, and how many fish enter each tributary to spawn.

"Data recorded on the transmitters provides us with information on the distribution of coho and steelhead within the watershed," says Dave Peacock, senior biologist with DFO's north coast division. "We can learn how long it takes these fish to migrate upriver and evaluate how many steelhead and coho are spawning in the tributaries."

Radio telemetry surveys such as this have recently been used to provide reliable estimates of run timing, distribution and escapement of chinook salmon returning to the Nass River watershed.



A fishwheel similar to this one on the Nass RIver, was used to capture steelhead and coho for radio-tagging.

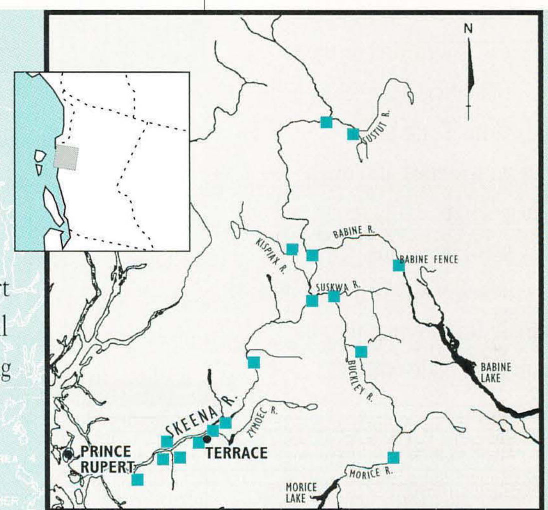
The radio tag is a very small device inserted into the stomach of the fish. A metal numbered tag is attached to each side of the radio-tagged fish on the operculum or gill cover. One of these tags indicates the presence of the radio transmitter; the other is part of an additional external tagging aspect of the program.

There are 17 receiving stations located at various migration points along the Skeena River, at the conjunction of important tributaries to the Skeena (such as the Bulkley and Babine rivers), and further inland along the shores of these tributaries.

In total, 288 coho were radio-tagged. Fifteen of these were caught and tagged in the river (about 100 km from the mouth of the Skeena) by means of a fishwheel. The majority, 273, were tagged in the Skeena River estuary using ocean seine vessels. In addition, 1023 coho were tagged with only one operculum tag.

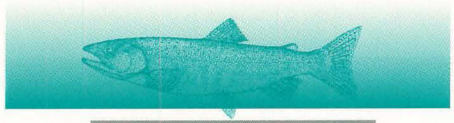
Steelhead were tagged from a variety of locations. Of the total 204 tagged, 113 of those were caught and tagged in the Skeena estuary, 12 at the Tyee gillnet test fishery in the tidal waters of the river, 42 at the fishwheel site and 37 tagged at Moricetown in the Aboriginal fishery, using a dip net harvesting method.

Preliminary figures—and these are just the earliest figures gathered—show that 75 per cent of the ocean caught steelhead have been tracked throughout the system. Of those tagged in the river, more than 90 per cent have been tracked.



The 17 receiving stations in the Skeena watershed.

Coho are more difficult. Thirty-five per cent of the coho have been tracked. The figures are not complete, and they may be showing that there is a great mix of coho in the estuary. In other words, many of the tagged coho may not have been Skeena stocks. Tag recoveries from commercial, Aboriginal and sport fisheries will help show where these coho migrated.



SEVEN

COUNTING FISH NET BY NET

Some of the largest and most concentrated fleets in British Columbia fish off the north coast of the province. Although all species of salmon are caught in these net fisheries, including the famed steelhead, information is scarce on how many of each are harvested and from what population they come.

To get an accurate count of these fish, 30 observers on board seine and gillnet vessels observed and reported the catch of each net set — a tough job on a seiner where several hundred fish are caught in one set. Observers worked from July to mid-September recording not just how many of each species were caught, but when and where and for how long each net was set. The program focussed on catches off the north coast, in areas west of Portland Canal, including Chatham Sound and in the mouth of the Skeena River.

Managing mixed-stock fisheries implies, in the ideal sense, avoiding areas of aggressive catches on vulnerable stocks and prolonging fisheries in areas where there are fewer catches of these weaker and smaller stocks.

One of the observers in the Skeena program prepares to take tissue samples for genetic stock identification.

The catch observer program, one component of the Skeena-Kitimat Sustainable Fisheries Program, was funded primarily by the Ministry of Agriculture, Fisheries and Food and is part of the Green Plan initiative. J.O. Thomas & Associates Ltd., a company with over two decades of this kind of work in BC fisheries, undertook the project.

Observers worked in unique environments, counting sockeye, coho and steelhead caught during all fishing operations, without impeding the operations of the vessel. Species mixing would be extreme in these fisheries; observers had to be able to quickly and confidently recognize each species. Biological samples—recording size and sex, and taking scale samples of coho, steelhead and chinook—were also undertaken by the observers.

"We tagged and released those steelhead that were still alive," says Jim Thomas, executive director of J.O. Thomas & Associates. "Observers recorded the size and tag number, took scale samples and noted the condition of each before they were released."

When these tags are recovered in any of the commercial, Aboriginal or sport fisheries, they provide an idea of migration patterns and the behaviour of the steelhead from the tagging location to the point of capture.

Tissue samples were taken from dead steelhead and sent to the provincial government labs for DNA stock identification research. A missing adipose fin indicated the possible presence of a coded-wire tag. On these fish, the head was removed, tagged and returned to labs for examination of the tag.

The program relied on volunteers from the commercial fleet. Participation was lower than anticipated, but a core of people worked very hard. Many of the small gillnet owners were concerned about seriously impeding operations with an extra person in an already restricted space.

"We were very impressed with the participating commercial fishers," says Thomas. "They allowed observers full reign in their tagging and sampling work."

Analysis of the numbers collected, taken with information provided to other aspects of the Skeena-Kitimat Sustainable Fisheries Program (such as stock identification research) will give stakeholders and fisheries managers a substantial pool of real data and much will be learned about the numbers and timing of fish to specific catch areas. ●

Coho Habitat

CONTINUED FROM P.5

throughout the Bulkley and Morice drainages. "To do that," says Holtby, "we are using miniature data loggers. These little marvels are the size of a matchbox, and will operate for two years recording a temperature every 15 minutes. In addition, we have installed automated stations at three sites in the Morice to monitor dissolved oxygen in side-channels and ponds known to be important for over-wintering coho. At the same sites where we are monitoring temperatures, we are taking water samples during summer low flow and just after spring break-up. These are being analyzed by the lake enrichment lab at DFO's West Vancouver Laboratory for concentrations of major nutrients and dissolved solids."

All of this information will be used to compare this particular part of the Skeena with coastal systems in the north and south. Holtby is now planning a study site to build fences for counting coho adults and smolts, and studying the juvenile biology of this species.

Over the next couple of years this approach will be extended to the entire Skeena drainage. The work began this year with a late summer survey for the collection of juvenile data and basic habitat information at 90 sites from the coast to the headwaters of the Skeena. ●

Genetic Markers

CONTINUED FROM P.2

placed on a gel substance, something like a slab of jelly, and subjected to an electric current. The length of time and amount of current is strictly controlled. The proteins in these enzymes have electrical charges that move under the electric current. Some move faster than others and in specific directions. Eventually, when the current is turned off, strings or bands have formed on the gel, each band with specific characteristics or patterns.

BY "LOOKING" AT THE DNA, VARIATIONS IN THE CHEMICAL SEQUENCE (THE GENETIC CODE) WITHIN THE STRANDS OF DNA CAN BE SEEN. THESE ARE WHAT MAKE EACH FISH UNIQUE.

"From this," says Wood, "we can infer genetic characteristics of individual fish. We want to determine the percentage of fish in each population that have specific genes. Unlike scales or parasites, we believe that these patterns of genes will remain constant from year to year. This is the chief advantage of genetic markers over ecological markers.

"In science, looking at the same thing in different ways can lead to different results," says Wood. "This proved true for protein electrophoresis research in coho. Enzymes useful for sockeye didn't prove useful for coho. By finding the right enzyme, researchers at the US National Marine Fisheries Service in Washington State are finding that electrophoresis can be used to identify coho stocks. We plan to examine the same enzymes in Skeena River coho in a joint study with the National Marine Fisheries Service."

Probing the DNA

Another technique—genetic "fingerprinting"—gives science a way to find many more genetic markers for identifying salmon populations. Salmon DNA research coordinated by Drs. Ruth Withler and Terry Beacham at DFO's Pacific Biological Station is among the most advanced in the world. Withler can directly examine the differences in DNA by probing DNA extracted from small samples of tissue or blood.

There are two basic kinds of DNA: that which comes from the nucleus of a cell, called nuclear DNA and that which is found in the mitochondria of a cell, called mitochondrial DNA. They look quite different from one another. The mitochondrial DNA occurs as a single-stranded loop, whereas the nuclear DNA occurs as a double strand. By "looking" at the DNA, variations in the chemical sequence (the genetic code) within the strands of DNA can be seen. These are what makes each fish unique.

Dr. Beacham will be leading the research to find useful nuclear DNA markers in Skeena coho and sockeye. Dr. Wood is completing a survey of mitochrondrial DNA markers in Skeena sockeye.

Results of this research to date show extensive genetic differences among populations of sockeye and steelhead in the Skeena River system. Research will continue with emphasis on screening additional populations and developing and verifying cost-effective procedures for sustainable fisheries management in the Skeena watershed. ●

Skeena-Kitimat Sustainable Fisheries Program
Department of Fisheries and Oceans
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included considerable input from the public and other stakeholders.

The marshes were constructed by installing a low rock berm at the mid-tide level parallel to the shore and backfilling with sandy soil to create an intertidal bench that would support the growing marsh. About 14,000 plants were planted in the marsh alone. Other features were incorporated into the shoreline. These included existing large trees, a small beach area and native plants such as red osier dogwood, snowberry, willow and spiraea. Native grasses have been planted right up against the shore, so when the tide is high, they're right by the water's edge.

The large cottonwood trees gracing the banks of the river are necessary to fish habitat. "DFO asked us to save these trees," says Williams. "They help the marsh productivity, providing leaf litter and insects which drop from overhanging branches. They also add a maturity to the park. You can build marsh, but you can't replace 30-m cottonwoods that quickly. We've placed riprap in and around these trees and others to protect them."

In a working river like this, there is a lot of wave action from boat traffic and quite a significant amount of debris. Waves erode the river bank and debris smothers the marshes. Log storage in the river helps solve the problem.

"The industrial base in this section of the river is giving way to urban uses," says Steve Macfarlane, DFO habitat biologist, "but industry still needs the river to move logs, and we need to protect the river banks from erosion.

"Traditionally, DFO didn't favour log booms up against marshes. There were problems with bark settling into the marsh and the logs themselves grounding on the marsh. But if the logs are located offshore, away from the marsh, those problems don't exist. It's amazing how they break the waves down and keep the debris off the marsh."

For the first five years of its life, Williams monitors the growth and success of the transplants and the marsh benches. This marsh is nearing its second birthday and all indications so far point to a healthy, successful endeavour. ■

New chart atlas for BC's Gulf Islands

A new chart atlas for BC's Gulf Islands is expected to be off the presses and available to recreational boaters by summer 1995. This is the second self-contained atlas designed and created specifically for the recreational boating community by the Pacific region's Canadian Hydrographic Service (CHS).

CHS, with offices at DFO's Institute of Ocean Sciences, charts all navigable waters off the British Columbia coast, the western Arctic, the Mackenzie River (the main commercial transportation link to the Arctic), and inland waterways as far east as the Manitoba border. Cartographers incorporate data collected from hydrographic surveys into chart revisions and new charts.

"The Gulf Islands Atlas has been a massive undertaking," says Ken Holman, manager of Nautical Publications for CHS in the Pacific. "At one time or another all of our staff have been involved, and we have been working on it since 1987."

The existing Gulf Islands chart, 3310, is not very conveniently laid out for small boaters. It is out of date in terms of presentation and recent changes to the area. A lack of supplemental information also makes the purchase of Small Craft Guide Volume 1 essential.

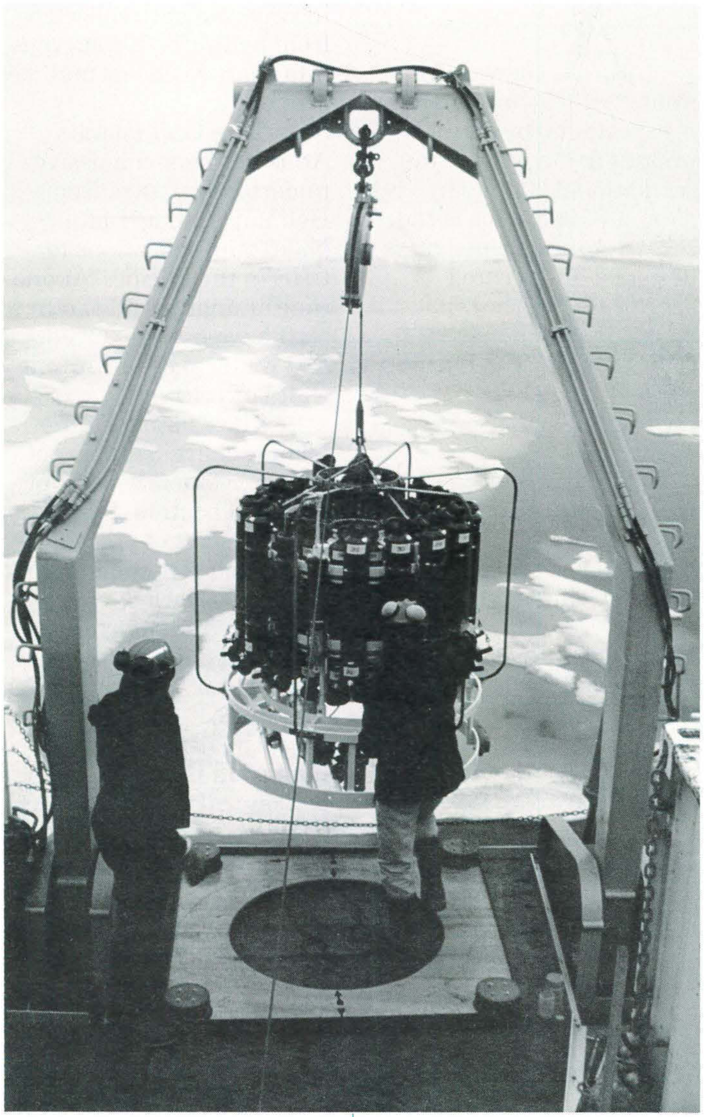
The new atlas will change all this. The first section will include all necessary extra information. This is followed by 24 chartlets for safe navigation. Each chartlet has its own page and is one quarter the size of a standard nautical chart. This makes handling and storage much easier on small vessels.

A substantial amount of planning, including input from the

continued p.8

Everything must be accurate on a nautical chart and quality control is a rigorous part of each stage of the production process. A cartographer touches up a four-colour tint negative.

Science takes an incredible journey into the Arctic



A specially designed CTD/ rosette sampler was used to collect samples for the contaminants program and for water property measurements from ocean surface to ocean bottom.

From sky to sea floor and from the bottom to the top of the food chain, scientists have probed the Arctic Ocean on an incredible journey of discovery.

Early in September, the Canadian Coast Guard ship LOUIS S. ST. LAURENT and the United States Coast Guard Cutter POLAR SEA successfully completed the first surface crossing of the Arctic Ocean to the North Pole by North Americans. From the time they left Seattle until they emerged out through Fram Strait into the Greenland Sea to Iceland, these modern day explorers never saw the sun set.

"From a climate change perspective," says Dr. Ed Carmack, a physical oceanographer at DFO's Institute of Ocean Sciences (IOS), chief scientist on the LOUIS ST. LAURENT and the Canadian program coordinator, "we found unequivocal evidence that the Arctic Ocean is undergoing a large warming trend."

When compared to climatological data collected by Russian scientists since WW II and data from North American ice-camps established since the 1960s, the differences are significant. The subsurface layer of water (200 to 1000 metres deep) that flows into the Arctic Ocean from the Atlantic was as much as one degree Celsius above that reported by other investigators only three years ago. What this warming trend will do to the Arctic icepack, scientists don't know.

"What we found surprised us," says Carmack. "The abundance of life was of a magnitude that we had never imagined. Because of the low level of sunlight and the ice cover, we have always assumed that primary (plankton) productivity would be very low." But they were wrong, as discovered by Pat Wheeler, a biologist from Oregon State University, when she found strands of algae up to one metre long growing under the ice.

The carbon mill rate (the rate at which carbon, which is fixed in plants, is devoured and regenerated) is much faster than previously believed. It's a bit like finding out your lawn grows 10 times faster than you thought it did.

One of the joys of discovery for everyone, was the sighting of a mother polar bear and her two cubs at least 700 kilometres north of Alaska, far from the coast where they should have been. The four-month old cubs were believed to have been born on the pack ice, more evidence that the food chain is strong and abundant enough to support these large animals. Samples were taken from seven of the twelve bears observed on the trip for analysis of contaminants.

Carmack's personal goal was to make this a voyage of cooperation. With half of the more than 60 scientists on the expedition (DFO had the largest representation in the science program, with

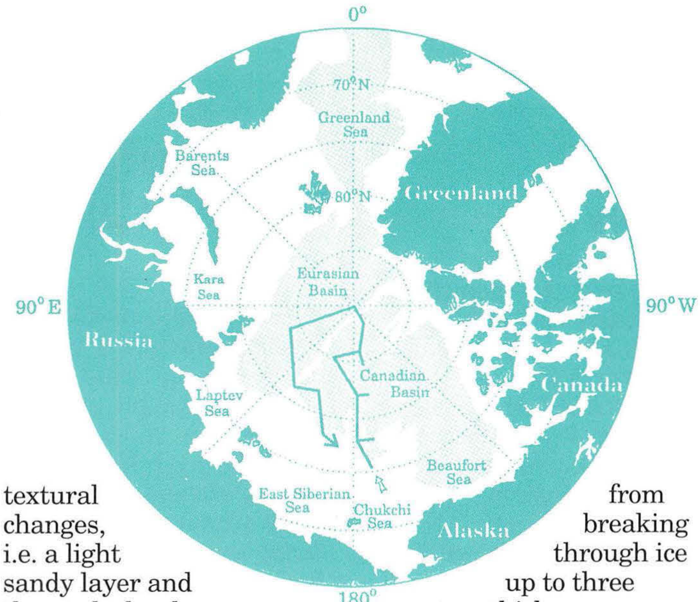
18 people), each needing time and space for their programs, the task was a daunting one. At each "station" the ship stopped, and ice cores, nets, pumps, sampling gear, and people were immediately over the side. On some stations there were up to 12 programs going on at the same time. Stops lasted anywhere from four to sixteen hours at stations from 30 to 60 nautical miles apart. To describe ocean features, stations must be close to each other to determine any differences.

Dr. Robie Macdonald, chemical oceanographer from IOS, led the group of Canadian scientists studying the extent to which the Arctic is affected by global contaminants. An unprecedented amount of samples to study for radionuclides and organochlorines were collected along the dividing line between Eurasia and North America. Analysis of water samples, sediments, Arctic cod and samples of snow and ice will help identify how these chemicals are turning up in the Arctic. For example, animals, such as the tiny 10-cm micro-cod are filters for organochlorine contaminants. One fish was caught and sampled for every degree of longitude across the ocean.

Using a portable CTD lowered through holes drilled in the ice, Ron Perkin and Oolalteetah Iqaluk, an Inuit from Grise Fjord, map the lateral distribution of warm water.

Other studies focussed on the physical, chemical and optical properties of the ice and the role that ice plays in transporting sediments. At the beginning of the voyage, the ships cut through 200 kilometres of "dirty ice"—ice full of sediment—that was thought to have come from North America. Near the North Pole they went through another band which appeared to come from the Siberian Shelves.

One interesting find during examination of sediment cores showed such immediate boundaries between textural changes, i.e. a light sandy layer and then a darker layer, that they couldn't be separated by even a razor blade. These changes in texture mean something dramatic has happened at various times during the past several thousand years. At some point, when these sediments came into the Arctic Ocean, either from river wash or ice packs, something immediate happened and the whole environment changed; perhaps rivers were diverted or the ice cover disappeared.



The voyage demonstrated that large ships can travel where they want and operate efficiently. The captains of the two icebreakers employed specialized radar during ice reconnaissance flights to pick a path through the ice field. Scientists representing Environment Canada's Atmospheric Environment Service recorded radiometric signatures of sea ice to improve satellite sensing of the ice surface for the ship's ice navigation. Sensors were devised to measure stress on the ships produced from breaking through ice up to three metres thick.

Many old theories are challenged by the discoveries on this expedition and many new have been put forward. The unusual happened too, ocean circulation was the focus of Dr. Ron Perkin's research, but that focus expanded when he became the discoverer of an uncharted sea mount. A physical oceanographer from IOS, he and his team were taking readings from a helicopter when they discovered an undersea mountain about four kilometres high.

All in all it *was* an incredible journey. There was the Arctic wedding of Doug Sieberg and Louise Adamson, both technicians in oceanography from IOS, and, says Carmack, with a twinkle in his eye, "I think we've verified the existence of Santa Claus, too." ■

Atlas, *cont'd.*

recreational boating community, has gone into the design and content. Here's an idea of what can be found: a general description of what is there and what to look out for—tides and currents, winds, aids to navigation, anchorages, floats, dangers, plus photographs introduces the atlas. Large-scale charts cover the Gulf Islands and two small-scale charts cover areas one would travel from Vancouver (or Seattle and Bellingham) to get to the Gulf Islands.

Descriptions of commercial traffic terms and fishing vessels are provided, as is information on surface water temperature, wind charts and radio channels for weather broadcasts. There are illustrations of various distress signals and instructions on how to use flares and flashlight signals, including emergency information–and the list goes on.

The Gulf Islands off the southern coast of BC draw boats like magnets. This is a shipping and transportation corridor. The area is beautiful and the waters are busy not only with recreational boaters, but commercial ships, ferries, and fishing vessels. This is an atlas the recreational boater will want to have on board. ■

Code of conduct sought for fishing operations

Canada's fishing industry provides a high quality supply of fish and fish product to the global marketplace. It is an industry worth $2.9 billion dollars wholesale. However, there are serious problems facing the resource—problems that extend beyond Canada's borders.

The world's fisheries are in trouble. To continue to fish as in the past is a formula for disaster and fishing practices must be improved. Recognizing that responsible fishing operations can have an impact, DFO has introduced the Canadian Program for Responsible Fishing to promote and develop more selective fishing gear and conservation harvesting practices. There is an urgent need to improve size and species selectivity. Selectivity is the ability to target and capture fish by size and species, allowing by-catch (juvenile fish, non-target species, sea birds and mammals) to be released unharmed.

In June 1994, DFO hosted and, in collaboration with the Food and Agriculture Organization (FAO) of the UN, organized a six-day international expert consultation on responsible fishing. Fisheries experts from 22 nations gathered on the west coast of Canada to develop a set of principles for an International Code of Conduct for Responsible Fishing.

To continue to fish as in the past is a formula for disaster and fishing practices must be improved.

In dealing specifically with fishing operations, participants at the consultation adopted over 40 principles dealing with harvesting practices, selective fishing gear and energy use. These will be presented to the FAO Conference in Rome in 1995.

In Canada, DFO has moved on to another stage in its responsible fishing program. Andrew Duthie, chief of fisheries technology, has developed an industrial training program for responsible fishing. This has been incorporated into the curriculum at the New Brunswick School of Fisheries. ■

PACIFIC TIDINGS

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