In the eight-year (1956-1964) history of the Federal Water Pollution Control Act of 1956, supplemented in 1963-1964 by the newer Accelerated Public Works funds, the Federal program of grants for construction of municipal waste treatment works has helped in the building of 5,752 local works for the treatment of sewage. Federal funds include $485 million under the Water Pollution Control Act and $108 million under the Public Works Acceleration Act—$593 million in combined grants.

These grants have stimulated appropriations by state and local governments in the ratio of about $3.75 for each Federal grant dollar. Thus, about $2.8 billion have been invested altogether in projects that will serve a population of 48 million people and will improve the quality of water in 52,000 miles of streams.

A 1964 survey by the Conference of State Sanitary Engineers disclosed that 5,672 communities having a combined population of 35 million people, presently need new sewage treatment plants, plant enlargements, or additional treatment estimated to cost $1.9 billion including necessary ancillary works. The average annual cost for elimination of this backlog by 1970 is $267 million.
According to a report by David Howells, U. S. Public Health Service, at the November 10, 1964 meeting in Chicago of the Water Pollution Control Advisory Board, $215 million more annually would also be needed to replace by 1970 those existing sewage treatment works that have become obsolete due to aging, technical advancement, or population relocation. Moreover, the U. S. population continues to increase at a rate of nearly 3 million folk annually. The cost of providing adequate sewage treatment for these new citizens through 1970 was estimated by Howells to require $215 million additional annually.

To eliminate the backlog, replace obsolete treatment works, and provide for the continuing population growth in our urban areas will require an average annual expenditure exceeding $700 million at today's values for municipal waste treatment works nationwide for the remainder of the current decade. However, sewage works cost indexes indicate that the annual rise in construction costs, based on recent data, will probably exceed 3 percent through 1970. Therefore, the actual cost of municipal pollution abatement is expected to average nearly $800 million annually in future dollars over the balance of this decade.

Howells reported to the Board that construction rates reached this level during 1963, when the combined resources of Federal grant-in-aid programs under the Water Pollution Control and Public Works Acceleration Acts were brought to bear on the problem. The added effect of the public works acceleration funds has ebbed with the full utilization of authorized funds and current contract awards indicate that construction activity will probably return to the 1961-1962 level of about $600 million unless supplemental financial aid is authorized.

If the Nation is to have a reasonable chance of having its vital water resources cleaned up in the foreseeable future, it will be necessary as we see it to double the present rate of construction—and the Federal grant program that stimulates that rate. Present authorization is for $100 million of grants annually, never fully appropriated, and that authorization expires as of June 30, 1967.

For these reasons, the Board of Directors of the Sport Fishing Institute, in regular Semi-Annual Meeting on November 15, 1964, adopted a resolution in which they "urge the Executive Department and the U. S. Congress to take such actions as may be deemed necessary and desirable in their collective judgements to effect authorization and appropriation of more adequate funds to accelerate water pollution control through construction of essential sewage treatment facilities at a rate sufficient to eliminate the backlog of needed facilities and keep pace with population requirements such that 'clean water' may be everywhere available by 1975."

**NEW JERSEY FISH HARVESTS**

Yellow perch were caught in greater numbers than any other freshwater game fish in New Jersey waters during 1963. According to a report by Charles W. Wright in NEW JERSEY OUTDOORS for September, 1964, an angling census indicated that about 341,000 yellow perch were caught (an average of 7 per angler). The harvest of other species included 303,000 trout (4 per angler), 201,000 catfish (4 per angler), 150,000 chain pickerel (3 per angler); 139,000 largemouth bass (3 per angler), and 55,000 smallmouth bass (1 per angler).

Trout anglers experienced a banner year in 1959 (343,000 caught). That was also a peak year for largemouth bass angling (191,000 taken). Chain pickerel were caught most abundantly in 1957, when 235,000 were harvested. Pickerel catches have declined almost continuously since then (for undescribed reasons).

**HOME LOGS?**

For reasons yet unknown, dolphin, tunas, skipjacks and numerous other marine fishes often congregate near drift logs. This habit is not overlooked by Japanese commercial fishermen, who anchor specially constructed "tsuke" or fish rafts offshore for concentrating fishes. According to observations made aboard a skipjack fishing boat, by Japanese fishery biologists Hiroshi Yabe and Tokumi Mori, Nankai Regional Fisheries Research Laboratory, skipjack were the most abundant fish caught near drifting logs. However, small yellowfin tuna were also present in large numbers.

Over 2,000 yellowfin were caught in the vicinity of a single 50-foot log during a 3-day period during which the vessel drifted 60 miles. The vessel was moored to the log at night. In addition, 85 skipjack and 40 dolphin were taken. Wahoo are believed to be found only in the vicinity of driftwood. When a wahoo is taken by trolling an immediate search for a log is begun.

Although unproven, Japanese skipjack fishermen believe that a school of tuna will adopt a "home" log. They also believe that the school may cruise as far as 10 miles from its "home" log, but will ultimately return. Fishermen sometimes wait at an unoccupied log for the fish to arrive. In addition to the "log-homing tuna," there are also believed to be "roving schools."

There is need for scientific understanding of the relationships of fishes to driftwood. Thorough understanding of this behavior might eventually lead to the use of regular anchored fishing stations by marine sport fishermen. This interesting report has been translated by U. S. Bureau of Commercial Fisheries biologist Wilvan G. Van Campen, Biological Laboratory, Honolulu, Hawaii.

**COAL STRIP-MINING**

A worthwhile article on coal strip-mining, by conservation director Donald E. Foltz, appeared in OUT-DOOR INDIANA (Indianapolis) for December, 1964. We hear a lot about the subject these days. Yet, few folks outside the states Pennsylvania, West Virginia, Kentucky, Ohio, Illinois, Indiana, and Missouri actually know much about the extent and nature of such operations, let alone the economic pros and cons. Equally
few folk have actually seen the activity first hand, witnessed its impact upon living natural resources attending its physical devastation of land surface, or are aware of growing programs to reclaim affected lands for recreational purposes.

The article by Foltz throws much light on the subject especially as it concerns Indiana, where there has been a helpful coal-stripping land reclamation act on the books since 1942, and where coal companies have worked along these lines since as early as 1917. Those actions have obviously paid off because, although coal-stripping is substantial and extensive in the State, Indiana was not cited in a recent Interior Department report as among those states having gross acid mine pollution problems resulting from such activities. (See U. S. Bureau of Sport Fisheries and Wildlife Circular 191, by E. C. Kinney, entitled “Extent of Acid Mine Pollution in the United States Affecting Fish and Wildlife.”)

Much about strip-mining will remain controversial and abhorrent to many Americans in many walks of life regardless of partial ameliorations that may prove possible in the long run. Most other such activity, especially in those states where stream pollution loads of acid mine drainage are seriously affecting fish production and the associated fishing economy, does not include substantial long-term reclamation programs. Everywhere that strip-mining occurs it should be insisted that the coal companies involved shall rehabilitate stripped lands as fully as possible, at company expense, as a part of the necessary cost of doing business (part of the cost of coal production).

**FORWARD LOOKING FISH**

The direction of most acute vision for greater amberjack, dolphin, and great barracuda is straight forward while that for sailfish and white marlin is slightly upward and forward. The king mackerel, blackfin tuna, little tuna, skipjack tuna, and wahoo see best when looking forward and upward (roughly 45°). These findings, by Miami Institute of Marine Science biologists Tamotsu Tamura and Warren J. Wisby, were reported in the September, 1963 issue of BULLETIN OF MARINE SCIENCE OF THE GULF AND CARIBBEAN following a thorough study of the eye structure of these fishes.

**SELECTIVE BREEDING PROBLEM**

According to a December 8, 1964, release from the University of Wisconsin News Service (Madison), the retreat of the Valders Glacier from northern and eastern Wisconsin 9,000 years ago left numerous barren lakes in its wake. Thereafter, these became populated by fish moving up-river. Clues to the exact routes of such up-river movements, presently unknown, may come from a study of the proteins present in the blood serum of fish being undertaken by a graduate student in limnology.

On the basis of protein differences in the blood serum, Thomas D. Wright told a fishery conference group at Indiana University early last December, white bass from Lake Mendota are distinguishable from white bass from Lake Kegonsa. Although the two lakes are presently connected by a shallow channel and locks, the clear differentiation between the two populations on the basis of this genetic factor indicates that there has been little intermingling between them, up to recent years at least.

Wright’s research, under the direction of Professor Arthur D. Hasler, is aimed toward determining the origins of white bass in the Fox River and Lake Winnebago, and how they got there. It has already been established that the fish originated from the Mississippi River, but not just how they invaded the waters in question.

Biologist Wright said that the white bass today is sufficiently isolated between the Yahara River and Fox River systems to account for genetic difference. Though measurable, the variations in the blood proteins between the two groups are slight. After all, Wright emphasized, the fish has had only 9,000 years to develop these differences.

The moral here, for impatient selective breeders and “practical” geneticists of present generations, seems fairly apparent. Don’t expect to develop spectacular new breeds of “space-age” fishes overnight—it may take a few generations (human, that is) to achieve significant results.

**MARITIME SALMON RESEARCH**

The large increase in grilse that occurred in New Brunswick in 1963 was believed to have resulted, in part, from the cessation of DDT spraying which was discontinued in 1959. The 1959 year-class returned for the first time in substantial numbers in 1963. Further studies (reported in the July, 1964, TRADE NEWS; Department of Fisheries of Canada, Ottawa) have indicated that under-yearling salmon were 90 to 98 per cent fewer in streams treated with DDT at ½ pound per acre than in untreated streams.

Numbers of small parr were reduced by 70 per cent and large parr by 50 per cent. DDT at ½ pound per acre reduced yearlings by 50 per cent, small parr by 20 per cent, and large parr scarcely at all. Spraying with Phosphamidon at ½ pound per acre was not followed by a reduction in native fish populations nor any demonstrable short-term ill effect on aquatic insect populations.

Other studies showed that year-round reduction of mergansers is needed to reduce predation on young salmon. More precipitous, rougher-bottomed river sections should have higher smolt production than smooth-bottomed sections. Large salmon parr “home” to small areas within a stream when displaced. Copper-zinc pollution caused 10 to 20 per cent of ascending salmon to return downstream and although one-third reascended the stream later, the rest did not reappear in any river system.
Complete removal of forest cover increases water yield at Coweeta 4 to 16 inches annually. Studies are also under way to find ways to regulate transpiration losses by non-destructive methods. (U.S. For. Serv.)

Thirty years of research in the hydrology of forested headwaters at the U. S. Forest Service’s justly-famed Coweeta Hydrologic Laboratory (located in the Southern Appalaches of western North Carolina at elevations ranging from 2,250 feet to 5,250 feet) have determined what happens to the 80-inch-average rainfall deposited annually upon this valuable 4,700-acre experimental watershed. In an oversimplification, it has determined that the 80 inches of precipitation (P) received by the watershed is equal to the sum of 20 inches of water lost through transpiration (T) from vegetative surfaces, 13 inches of rainfall subject to interception (I) by the forest crown and litter, and 1 inch of rainfall lost through evaporation (E) from soil and rock surfaces; plus a total water yield or runoff (R) amounting to 46 inches; plus or minus any changes in longterm storage (ΔS) of rainfall within the watershed.

The deceptively simple resulting formula, $P = (T + I + E) + R \pm \Delta S$, represents a gross understatement of the great amount of knowledge that has been learned at Coweeta since its founding in 1934, and of its fundamental significance in revolutionizing both the concepts of forest hydrology and the nature of needed research. Furthermore, it succinctly symbolizes the urgent need that remains to learn how to improve and preserve the amount, quality, and timing of water yield from forested and semi-forested slopes, and thus provide the scientific base required for its optimum management in the multiple-use of forests and wild lands.

At the outset, research projects on various of Coweeta’s 31 gaged small sub-watersheds, comprising the test plots of this unique outdoor laboratory, were designed to exploit revolutionary earlier discoveries concerning the precipitation-runoff relationship in certain forest areas. Notable pioneering studies of this relationship, in Switzerland (starting in 1895) and at Wagon Wheel Gap, Colorado (1911), had strongly challenged the traditional presumptive conviction that presence of forest cover increased total streamflow. The original Coweeta research objective, of learning what happened to waterflows when forest cover was changed, had been substantially met by the late fifties. Therefore, about five years ago, the Coweeta researchers (then headed
by Dr. John D. Hewlett; now Associate Professor of Forest Hydrology, University of Georgia) had become sufficiently informed to be able to initiate a more sophisticated and fundamental approach to the basic problem of forest hydrology. They now sought to find out why waterflows behaved as they did when the forest cover was altered.

Dr. Hewlett outlined the broad implications of forest hydrology in a paper describing the Coweeta program at the 1964 North American Wildlife and Natural Resources Conference. As he put it, "Water, the universal raw material, is the common element which draws together all who are concerned with the conservation of natural resources [because] good resource management and good water management are often the same, right down to the particulars." Human activities on the land always have some influence on the flow of water from the land, whether the activity is road construction, timber harvest, grazing or other agriculture, building construction, sewage disposal, or recreation. So, as human population expanded and water use per capita increased, water supplies of some regions began to show signs of seasonal shortages. Thus, the question whether heavy vegetation cover reduces total water yield led the Forest Service to undertake actual observations through the only approach available at the time. This was to measure precipitation and streamflow before and after changes in land management.

By 1950, several classic experiments along this line had been carried out at Coweeta. For example, Hewlett summarized, several forested watersheds at Coweeta were deliberately abused by bad farming, logging, and grazing practices. The movement of silt and rocks, and the change in timing of streamflow were measured and shown to be even greater than expected. Not only the total yield and quality of water but the all-important timing of its delivery as watershed runoff were affected by poor management. Destruction of protective vegetation, trampling by cattle, and careless road building produced a feast-and-famine type of water supply.

In one early experiment, complete clear felling of all trees and shrubs (left where they fell) produced an unmistakable increase of 16 area inches in the first year (equivalent to 50% of the pretreatment yield of 32
inches—in other words, the increase alone was more water than falls as total precipitation throughout a quarter of the United States). Late summer streamflow was more than doubled, and increased streamflow persisted for many years. There was no change in water quality or in timing of flows because the highly permeable soil conditions were not disturbed initially by removal of the cut timber and were subsequently maintained by vigorous regrowth.

Further experiments at Coweeta and at other Forest Service units verified the conclusion that total water yield and timing of water delivery can be changed substantially by drastic changes in forest cover. Annual water yield increases at Coweeta ranging from 4 to 17 inches—greater, for unknown reason(s), on some watersheds than on others—have been measured following complete felling of mature hardwood forests. As the forest regrows, yield gradually decreases to former levels, a process that lasts from 5 to 40 years depending on the size of the initial increase.

At this state of knowledge Coweeta can demonstrate to a watershed planner that water flows will tend to increase after any substantial reduction of forest vegetation. Impressive and encouraging as this is, Coweeta cannot yet demonstrate, however, just how much the water flow can be made to increase, or just how it will come, or just how long it will last. Timber removal is one approach, but what of techniques that do not require destruction of the forest stand to control transpiration? Solutions to these problems would make feasible the production of large quantities of high-quality water for export to other less well-watered areas, much as oil is now piped to distant consumers.

The object of full utilization of surpluses, while continuing to meet normal or even increased downstream demands represents the real challenge. At Coweeta, for example, high quality fresh water has been produced in quantity surpluses, at production costs well under 50 cents per thousand gallons, available at an elevation of 2,000 feet. If it becomes feasible to pipe surplus water from the Southern Appalachians to cities of the plains, the way oil is pumped the other way, the production of extra water would take on great economic significance. Already, Dr. Hewlett noted, Switzerland is selling fresh water to Germany on a large scale, taking advantage of gravity to deliver the water to its customers.

Before this can become practicable in the humid East, it will be imperative to learn the mechanics of water behavior as influenced by forest soil, atmosphere, and streamflow, and to develop sound principles and predic-
tation methods for effective management of forest watersheds for optimum water yield. This, in turn, necessitates detailed understanding of the processes of precipitation and evapotranspiration over the forest canopy and of the specific influences of forest vegetation upon the water cycle. It will be necessary to learn precisely how water is stored and moved in the soil mantle, and to measure and explain the regimen of water yield (usable supply) of a watershed.

In spite of surprisingly impoverished annual budgets and very limited staff (even for a research project), some beginnings have been made toward solving these very difficult yet very significant problems. Should budgets be substantially increased to accelerate the program, as we strongly believe they should be, the Coweeta Hydrologic Laboratory will take on added importance as an ideal research location. It possesses what is probably the most accurate set of long-term hydrologic records in the entire world. It obviously provides an uniquely valuable opportunity to employ thoroughly calibrated experimental watersheds (the ultimate testing ground) in pilot tests of ideas resulting from previous research.

Knowledge of how water moves underground to small streams, now being studied in large sloping models up to 200 feet long and seven feet deep, will help forest managers prevent pollution of water by insecticides, herbicides, and even radioactive materials. In a recent cooperative study with the U. S. Public Health Service, evidence was obtained at Coweeta that the pattern of DDT application on a watershed makes the difference between no detectable DDT in stream water and a continual decreasing concentration of DDT for months after spraying. The "filtering power" of a watershed was found to be related to the depth and location of the soil masses and the velocity of water moving through them. Studies of soil moisture fluctuations and the physics of flow through porous materials have shown that rainwater moves very rapidly through some portions of watersheds, but very slowly through other portions.

What's needed, now, is an immediate and substantial increase in the Coweeta budget for research into the mechanics of forest hydrology. New work should take advantage of Coweeta's virtually unmatched set of hydrologic records. Even with a tripling of the program there, Coweeta would still be a small research laboratory. As we understand it, present Forest Service plans for a ten-year program call for a $480,000 laboratory to be built at Coweeta to house 10 scientists and a supporting staff. This is a modest program, indeed, but the results would almost certainly repay the investment many times over.

We've visited the area and discussed the program several times with the dedicated scientists involved. As a result, we are convinced that it represents a priceless if little-known asset having enormous potential significance to America. We are further convinced that it would at least be reprehensible, if not actually irresponsible, to fail to implement the rich heritage that has resulted from 30 years of unparalleled forest hydrologic research at Coweeta. We urge strongly that this very promising Southern Appalachians watershed research program be substantially expanded and, further, that Coweeta is the best location. . . .

**CHANNEL DAMAGE**

Game fish have been reduced 90 per cent in some North Carolina streams as a result of channelization. In a significant paper, EFFECTS OF CHANNELIZATION UPON THE FISH POPULATIONS OF THE LOTIC WATERS IN EASTERN NORTH CAROLINA, Wildlife Resources Commission (Raleigh) biologists Jack Bayless and William B. Smith compared fish populations in channeled and natural streams. Reductions of game fish over 6 inches long ranged from 241 to 41 pounds per acre (82 per cent loss) in "robin-war- mouth" streams. They ranged from 277 to 13 pounds per acre (97 per cent loss) in "largemouth-pickerel" streams. They ranged from 655 to 37 (88 per cent loss) in "redfin-warmouth" streams. There were increases in numbers of small, non-game fishes.

A total of 62 watershed applications involving 2.9 million acres have been authorized for planning under P.L. 566 in North Carolina and 400 miles of streams have been altered or are presently being "recon- structed." By our rough calculations, this will result in an initial direct loss of approximately 14,000 pounds (seven tons) of game fish. Considering the loss of stream acreage caused by channel straightening, the ultimate loss will be much greater.

To partially offset the destructive effects of channelization on fish habitat, biologists Bayless and Smith suggest: (1) block off oxbows to provide permanent ponds, (2) replace fish habitat destroyed with impounded water on an acre-for-acre basis, (3) construct small, deep ponds adjacent to channels as fish sanctuaries during low water periods, and (4) offset dredged channel from natural channel and maintain water in the natural streambed.

In view of the extreme destruction caused by channelization, these suggestions should be accorded full consideration. . . .

**DESALTING WATER**

Water needs are becoming acute and competition for fresh water is keen. In arid areas the problem is especially difficult. Value of water used for fishing and other recreational activities in New Mexico has been calculated by a University of New Mexico special study team to range from $200 to $300 per acre-foot. For agriculture it came to only $50, although for industry it amounted to $3,000 to $4,000 per acre-foot. Competition for water is not restricted to arid areas. Nationwide demands for fresh water have led competitors for water to the edge of the world's greatest reservoir, the world ocean.

Major problem was, and remains, to convert sea water into fresh water at feasible cost levels (under 50 cents per thousand gallons). The Interior Department's Office of Saline Water boldly maintains in its SALINE WATER CONVERSION REPORT, 1963, that desalinization must compete favorably with nature's own
distillation system (an impossible goal if we ever heard one)! Interior Secretary Stewart Udall anticipates a substantial breakthrough in research that will result within the next four years in more economical desalination processes. The present funding level of $12 million is expected to be more than doubled for 1966.

Radically new approaches to desalination include such methods as "reverse osmosis," use of clathrate compounds, and freezing. Reverse osmosis consists of exerting pressure on sea water in the presence of a membrane which is permeable only to fresh water. Although the life of present membranes is only a few weeks, and they allow passage of some salt, efforts are being continued because it is potentially most economical. The clathrate compound method consists of bubbling propane through sea water to form a solid composed of fresh water and propane. Freezing methods hold promise because low temperature processes are relatively free from corrosion problems that give rise to costly maintenance in other processes.

An interesting article by Secretary Udall, in the October, 1964, issue of UNDERSEA TECHNOLOGY, indicates that cost of desalting water ranged from $4 to $5 per thousand gallons prior to the OSW program (begun in 1962). The two present largest OSW demonstration plants—at San Diego, California and at Freeport, Texas—have recently produced up to 1.4 million gallons of fresh water daily at costs said to range from $1 to $1.25 per thousand gallons. Largest known desalination plant, on the Dutch island of Aruba in the Caribbean, has a capacity of 3.5 million gallons per day. A nuclear-fueled combination desalting and power plant is presently under construction in Russia.

Multi-megawatt, nuclear-fueled, combination desalting and power generation plants offer new possibilities for production of both low-cost fresh water (20-25 cents per thousand gallons) and low-cost power (2.3-2.5 mills per kilowatt-hour). Daily production by such plants is anticipated to be from 500 to 800 million gallons of fresh water and 1,000 to 1,500 megawatts of electricity.

Desalination obviously offers important new possibilities for obtaining needed fresh water. Even so, repeated re-use of natural water through efficient water pollution abatement offers vastly more potential and requires far more attention. Research in forest hydrology to permit efficient management of large surpluses available at high altitudes and comparatively unused should be accelerated as well.

Editor Philip H. Abelson stated the priorities clearly in the December 8 issue of SCIENCE, "... it should be remembered that most of this nation's water problems will be solved by wise use of what is naturally available."

KELP DISAPPEARANCE

California kelp beds have furnished some of the finest fishing in West Coast waters. In addition, kelp is harvested for its chemical content and for use as food additives and fertilizer. Since 1940 productive beds of this giant seaweed ringing the Palos Verdes peninsula have deteriorated, and beds off Point Loma have suffered the same fate. Recognizing the urgent need for information on the kelp environment generally and the effects of pollution on kelp, a 5-year program of research sponsored by the State Water Pollution Control Board has been conducted by the University of California's Institute of Marine Resources.

An understanding of reasons for the disappearance of the once-flourishing kelp beds could only be obtained by having an adequate understanding of normal conditions in these submarine jungles. Since these conditions were not well known, a large part of the study was devoted to the general ecology of the near-shore region and detailed accounts of the life histories of certain critical organisms, their physiology, and behavior.

The significant results of this study have been reported in the Resources Agency of California (Sacramento), State Water Quality Control Board Publication Number 26. Possible harmful effects of waste disposal on kelp beds were of primary concern since three major kelp areas—the Point Loma, Palos Verdes, and Santa Barbara beds—exist near sites where wastes are discharged. The Point Loma and Palos Verdes beds have deteriorated badly, those regions nearest the sources of wastes being affected first. Areas for investigation of the possible harmful effects of discharged wastes included (1) toxicity, (2) sedimentation, (3) turbidity, (4) disease, and (5) grazing.

Tests on toxicity thresholds for metallic ions, organics, and a variety of complex mixtures including diesel oil, refinery wastes, and chlorinated and unchlorinated sewage indicated that the pollution was not sufficiently toxic to account for the widespread losses of kelp. Diluted sewage actually stimulated plant growth. Sedimentation and disease were not found to be important in the two beds. Turbidity was indicated as a possibly significant factor, the importance of which could not be determined because of changing water clarity in the kelp environment.

Grazing by two species of sea urchins was found to be especially devastating to kelp. Test plots were treated with pebble quick-lime (which is especially toxic to closely related starfish). The quicklime produced a 95 to 99 per cent kill of sea urchins. Fish and other animals did not appear to be affected. Kelp plants became re-established in the treated area within two months. These plants flourished until the subsequent invasion of migrating sea urchins again reduced the vegetation.

Reasons for the large populations of sea urchins in outfall areas are presently obscure. Apparently the environment has been altered in such a way as to favor their survival. The possibility for treating larger areas with quicklime was suggested.

OFF THE PRESS

BETTER WAYS OF PATHFINDING, by Robert S. Owendorf. Direction finding with the sun's shadow, the moon and stars, map and compass for the outdoorsman, camper and scout. This 96-page book has been published by Stackpole Books, Cameron and Kelker Streets, Harrisburg, Pa. 17105, and is available for $2.95.