EMP: Fallout over a naval EMPRESS

Since the Navy first announced its intent to build and operate an electromagnetic pulse (EMP) simulator in the Chesapeake Bay — one of the most productive estuarine systems in the world — there has been growing concern about the project's potential environmental impact. The most recent concerns appear in responses to a new environmental evaluation of the project, in strongly worded comments in a joint resolution by the Maryland legislature and in a lawsuit filed last week.

EMP is the rain of "Compton electrons" produced when gamma rays emitted by the detonation of high explosives — such as nuclear weapons — collide with air molecules. This electronic fallout will induce current or voltage surges through any electrically conducting material (SN: 5/9/81, p.300). While electrical equipment based on the old vacuum-tube technology is relatively immune to it, an EMP could literally fry sensitive electronic devices like those contained in computers, modern consumer electronics and communications systems.

The U.S. military's concern about EMP's possible incapacitating effects on weapons during a nuclear war launched a massive campaign to electronically shield all potentially vulnerable equipment (SN: 5/16/81, p.314). The Navy's proposed Electromagnetic Pulse Radiation Environment Simulator for Ships (EMPRESS-II) — an antenna system emitting simulated EMPs from atop a barge — would generate more realistic ("threat level") pulses than are now possible, to test how well shipboard electronics have been shielded.

Though in general EMP has been viewed as a problem only for electronics, a number of organizations are coming to question whether it is, in fact, biologically benign. In 1984, the Navy issued a draft "environmental impact statement" (EIS) on EMPRESS-II, as required by law for projects considered highly controversial or with the potential to "significantly affect the quality of the human environment." (There is a much smaller EMPRESS-I facility, for which an environmental assessment has not been done.) But the paucity of biological-effects data on EMP described in the EIS only generated more public concern.

So the Navy commissioned additional studies on potential short-term effects to aquatic life or waterfowl, and published these in a supplemental draft EIS, issued last December. Although the report does say there is evidence "to assure us that EMP has no effect on humans," official comments on this document, filed over the past six weeks, indicate significant public objections to EMPRESS-II still remain.

For example, the Environmental Protection Agency (EPA) reports that "we do not agree with the supplemental draft EIS that EMPRESS-II will cause no impact to organisms of the Chesapeake Bay." According to EPA's Feb. 27 letter, many questions EPA raised earlier about potential impacts of the project remain unanswered, and "statistics presented in the report do not clearly support the conclusions that were drawn."

EPA says that studies involving birds "were too limited ... to allow definite conclusions," and that too few tests on oysters and crabs were conducted "to allow for any conclusions." Some of the reports of tests on fish not only are confusing and contain discrepancies, according to the agency, but also "lack sufficient data points for reliable statistical analysis." And it says it is possible that some boaters in the bay during EMP-simulation tests could experience a "brief painful shock."

Both Maryland and Virginia, states bordering the bay, strongly oppose siting the EMPRESS-II facility in the Chesapeake. Among Maryland's objections are complaints that: EMP effects on marine electronics have not been adequately assessed, "the Navy has prematurely discounted the effects of [EMPRESS-II's] operation on the Calvert Cliffs Nuclear Power Station" 20 miles away, and the EIS fails to project chronic or long-term impacts of zapping estuarine life with EMPs. Among Virginia's concerns are potential hazards to humans, including cardiac-pacemaker failures and electrical shocks.

Last week Jeremy Rifkin and his Washington, D.C.-based Foundation on Economic Trends joined the fray with the filing of a lawsuit asking the Defense Department to prepare a programmatic EIS on its entire EMP-simulation program. As a precedent, Rifkin cited a similar suit he won asking for an EIS on the Defense Department's biological weapons program (SN: 2/28/87, p.132). But in this suit, unlike the biological weapons suit, Rifkin is seeking to halt the EMP program until a program-wide EIS is completed.

The Navy says it is "inappropriate" to comment on the lawsuit prior to its resolution, but hopes to decide whether to proceed with EMPRESS-II by late summer. — *J. Raloff*

Tuning in to songbirds and their songs

Next to humans, songbirds have perhaps the most varied language repertoire of any animal. Recent studies of their brains and behavior are revealing singing secrets that may help scientists understand how birds — and humans — learn and use the melodies they make.

In the last decade, scientists have linked the size of certain regions of a bird's brain with its ability to sing. For example, one brain region in male canaries appears to grow during breeding season, when songs are used to attract mates and stake out territories from other males.

Recently, Sarah W. Bottjer at the University of Southern California in Los Angeles and her colleagues demonstrated that in the course of learning their species' song, baby male zebra finches show growth in one brain region while another region is diminished. Specifically, the caudal nucleus of the ventral hyperstriatum (HVc) increases its number of neurons by 50 percent during the 70-day maturing period; the magnocellular nucleus of the anterior neostriatum (MAN) loses half of its cells. According to Bottjer, this is the first demonstration in any animal species that one brain region grows at what appears to be the expense of another.

The loss of neurons in the MAN suggests to Bottjer that zebra finches are born with a wide capacity for possible notes and that later, once they've learned the species' songs, they discard the cells for notes they no longer need. This idea, which the researchers are now testing, is supported by other scientists' findings that baby zebra finches raised by different species learn the other species' songs and ignore zebra finch songs later in life. In addition, adult zebra finches appear incapable of learning new songs, according to Bottjer.

This trait is somewhat similar to the behavior of humans, in that the human capacity to learn languages diminishes considerably after puberty. Because of such similarities, Bottjer says she would like to examine human brains at postmortem to see if there is any evidence that the region involved in human vocal development gets smaller as children reach puberty.

There is evidence, however, that early in the 70-day maturing period, the MAN "is important for vocal learning," Bottjer says. She and her co-workers have found that when they damaged the MAN early in a zebra finch's development, its later vocal repertoire was diminished and the sounds it made were abnormal. But MAN lesions in older juveniles and adult birds had no effect.

"This suggests to us that there may be some [very early] function carried out in the MAN region," she says, "such as taking in auditory information or programming motor information with respect to vocal behavior." It appears, she adds, that HVc may be taking control of vocal behavior as the bird ages.

In the March JOURNAL OF NEUROBIOLOGY, Bottjer and her co-workers also report that early in a zebra finch's

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vocal development, MAN neurons don't accumulate the male hormone testosterone very effectively. Toward the end of development, however, when the MAN region appears no longer needed for song learning, its nerve cells are full of testosterone.

"We see this as a very intriguing finding," says Bottjer. One possibility is that testosterone "causes certain neural circuits to become hardwired in the brain. And once those circuits are wired in, they seem to lose their capacity for forming new kinds of behavior." In particular, she posits that the increase of testosterone directs the MAN to send certain signals to another section of the brain, which permanently stores the bird's songs.

Another approach to learning about bird songs is to monitor the singing behavior of birds in the field. In the February THE CONDOR and in upcoming issues of ANIMAL BEHAVIOR, Stephen I. Rothstein at the University of California at Santa Barbara and Robert C. Fleischer at the University of Hawaii in Honolulu report on the "flight whistles" — songs that flying male birds use to communicate with males and females over long distances — of brown-headed cowbirds in the eastern Sierra Nevada.

The researchers found that groups of cowbirds separated by several kilometers have very distinct flight-whistle dialects. For example, the flight whistle of one group near Mammoth Lake in California contains three syllables, or continuous sounds, while a group to the south has a flight whistle made up of four syllables, three of which are identical to the whistle of its northern neighbors. Rothstein says there are dozens, if not hundreds, of dialects within a 300-kilometer band.

"Even though these flight-whistle dialects are only now being described," he says, "we feel that they're one of the most clear-cut examples of dialects in songbirds." Unlike other kinds of songs, flight whistles are simple and short, so researchers have little difficulty identifying different dialects.

"The big question in dialects, about which there's been a lot of controversy, is how they are maintained — what is making all the birds within one population converge to one type of vocalization," says Rothstein. He and Fleischer propose a new theory called "honest convergence," in which female cowbirds judge the suitability of a male caller by its whistle; males who do not know the proper dialect are either newcomers or yearlings, who are too young to mate.

Rothstein thinks the honest convergence theory is better than the three existing hypotheses because it is the only one that adequately explains how a large population of birds can maintain one dialect while still having a large amount of gene flow and exchange between dialect groups. — *S. Weisburd*

Energy for life among the waves

The thunderous crash of a large wave breaking on an ocean beach is a vivid reminder of the sizable amount of energy that such a wave dissipates. Although marine plants and animals can't harness this energy directly, it now appears that wave energy probably contributes in a variety of ways toward enhancing the productivity and diversity of organisms that live on wave-beaten shores between low and high tide.

"The intertidal zones of rocky weather coasts receive far more energy from the waves than from the sun," say Egbert G. Leigh Jr. of the Smithsonian Tropical Research Institute in Balboa, Panama, Robert T. Paine of the University of Washington in Seattle, and their colleagues. This abundant wave energy allows marine organisms in places such as the coast of Washington state "to maintain exceptionally high productivity," the researchers say. Their report appears in this month's PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES.

The researchers base their conclusion on a detailed study of the quantity and type of organisms, such as algae, sea palms and mussels, produced at several exposed and sheltered sites around Tatoosh Island, off Washington state. They discovered that two species of algae that grow only on wave-beaten shores are the most productive algae at Tatoosh. Beds of these algae often produce twice the dry weight of organic matter generated by an equal area of rain forest. Even more surprising was the finding that some intertidal mussel beds are as fruitful (also measured as dry weight) as any plant community on earth.

"Animals and plants shouldn't be equally productive," says Paine. "This is a rather remarkable phenomenon that's not easily addressed without asking questions about the kinetic energy impinging on the shore."

The researchers list several possible reasons for the presence of lush, diverse plant and animal communities in turbulent water. They suggest that on exposed shores, the stirring action of breaking waves increases the capacity of resident algae to collect nutrients and use sunlight. Waves also protect intertidal inhabitants by knocking away their enemies or by preventing potential predators and grazers from feeding. Even devastating winter storms help by clearing away patches of old material to allow fresh, vigorous growth.

Wave energy, says Paine, "is an important contributor to the overall richness of this type of environment." Similar effects can be seen along other wave-battered shores or on the margins of coral reefs where waves pound hardest. — *I. Peterson*

Bound for the crown of Neptune

A decade ago, when Voyager 1 and 2 took off from Florida's Cape Canaveral, the official mission plan called only for both probes to fly close to Jupiter and Saturn. There was hope that Voyager 2 would then go on to Uranus in 1986, but the craft would have to survive more than twice as long to do so, and speculation about its lasting yet another three and a half years to reach Neptune produced even more cautious prognoses.

The Uranus encounter in 1986 was a ringing success, however, and the long-lived vehicle is looking ready and able for Neptune. So it was not concerns about the probe's longevity that prompted engineers last week to fire Voyager 2's rocket engine for a slight increase in speed hastening its Neptune arrival by 12 hours, on Aug. 24, 1989.

The reason was to improve the reception of the craft's radio messages from what is now the solar system's most distant known planet. It is a matter of getting to Neptune when the earth is turned as to allow the signals to be picked up from Australia, where one of the antennas of NASA's Deep Space Network has been electronically arrayed with the big dish of the Parkes Radio Astronomy Observatory, about 200 miles away. The result will be a larger, more sensitive antenna.

And when the Neptune "flyby" passes 3,100 miles from the cloud tops, Voyager 2 will be going about 16 times closer than it went to Uranus, 20 times closer than it went to Saturn and 55 times closer than Voyager 1's visit to Jupiter.

Voyager 2's trajectory past Neptune has been dubbed the "polar crown," approaching from the south, swooping up through the plane of the planet's equator and then bending back down over the North Pole on a path that will carry the probe about 25,000 miles from Neptune's big moon, Triton. One official called the maneuver the Neptune encounter's "holy grail."

But the quest for the grail has involved trying to be as sure as possible that it will not risk Voyager's life by sending the probe through material from the planet's rings, which have been detected only as incomplete "ring arcs" in earth-based occultation studies. Another concern has been possible danger from Neptunian trapped radiation belts, concern that prompted a special meeting of Voyager scientists on Jan. 16 to see if they felt that the polar crown would be a safe route. The group reached a favorable consensus after evaluating the possibility of hazardous radiation on the basis of last year's experience with Uranus. — *J. Eberhart*