I will provide a model to indicate which subsystems are likely to be impacted adversely by energy development, utilization, and related activities.

22 One of the continuing objectives of the studies conducted in the forest and drainage basin is to compare the structural and functional features of this ecosystem to other ecosystems located in Puerto Rico and abroad. Another objective has been to devise and carry out field perturbation experiments to determine how changes in structural and process features of the ecosystem are related to altered environmental conditions.

Ecological Effects

A second principal goal of the Division is to determine the relationships between ecological effects at all levels of organization and energy and other resource development. The energy-efficient control of pests, landside distribution of wastes, and modern methods of pollution control may contribute to long-range ecological effects. These effects, per se, may or may not be directly relatable to energy problems but do relate to energy utilization. Consequently, the Terrestrial Ecology Division has very recently begun to establish objectives leading to the goal of prediction of long-term undesirable ecological effects which, at worst, could be irreversible. Basically, these objectives are as follows:

1. To determine the "assimilative capacity" of different representative ecosystems to absorb specific perturbants.
2. To examine and qualify relationships between ecological effects and quantitative bioassays & other measurements.
3. To evaluate the relative influence of: natural variability, sampling error, measurement errors, and sampling effort on the detectability of the potential effect.

Resource Management and Conservation

The most recently developed goal of the Division is to develop information necessary for the management of environmentally important resources such as land, water, and wildlife. Within the past 2 years, the Division has actively sought local and national roles leading to the

Application of IES background in environmental research to help identify and resolve both short-term and long-range problems in both the public and private sectors. The general objectives for the realization of this are:

1. To evaluate alternative methods for water reclamation in an effort to maximize energy efficiency, economy, and recovery.

2. To evaluate alternative methods for land space reclamation which complement the aforementioned.

3. To examine and describe factors important in the survival and well-being of biotic resources of economic and aesthetic importance to mankind.

Projects: A series of projects have been wholly or partially executed to satisfy the goals and objectives stated. A short list and description of such follows:

Site and Process Studies (er): The National Environmental Research Park (NERP) program was funded by the U.S. Department of Energy (DOE) and Commonwealth of Puerto Rico Conservation Trust. It is dedicated to the selection and characterization of certain sites which can be set aside and managed for purposes of ecosystem research. A site receiving DOE approval will be managed for specific studies related to environmental impacts due to energy generation and utilization. Long-term comparison with equivalent sites (possibly also NERP sites) would then be practical and could be structured to minimize cost.

Geology, Transport, and Mobile Baseline Studies: The overall transport study program is part of the base program of the Division funded by DOE. Measurement of nutrients and changes in nutrients in defined compartments such as leaf litter, soil horizons, tree bark, primary consumers, etc., can be used to define transport models which can then be operated upon synthetically or abstractly. Subsequent measurements after perturbation can demonstrate which compartments are most affected by man-made perturbations. Examples of field perturbations include forest irradiation and others.

Clear cutting as well as natural disturbances such as hurricanes and flooding. Long Term Ecological Monitoring: This program was undertaken in conjunction with the NERP program and potential sources of funds include the NSF Long Term Ecological Research (LTER) Program. It consists of a broad-based monitoring program which would examine long term variability of species composition, climatic conditions, stream flow and water quality among other parameters used to characterize a tropical rain forest.

3.2 Industrial Siting: With the steadily increasing world cost of petroleum and Puerto Rico's 95% dependence on petroleum for electrical power generation, alternative fuel-fired plants are now in the construction planning phase. The logical characterization of sites which would be appropriate for the construction of coal-fired plants is required by law and the Puerto Rico Electric Power Authority has requested the Terrestrial Ecology Division to scope and carry out studies on several potential sites. Such studies provide structure and function different local sites with which data from the El Yunque Tropical Rain Forest may be compared.

Ecological Effects of Cooling Systems on Aquatic Ecosystems: The Savannah River Laboratory in South Carolina is interested in long term effects in water bodies heated above ambient temperature by reactor cooling water. The study realized at the Savannah River Plant will seek to rationalize a large amount of structure and process data accumulated for such a water body over the past 20 years.

Intensive Biomass Culture: Little is known about the ultimate effects of intensive biomass culture

upon soil properties, drainage

3.2.3

Water quality and predator-prey relationships. Effects associated with potentially excessive dispersion of fertilizers, pesticides and soil conditioners are being assessed for intensive production of grasses to be used for energy production. Potential sources for funding of this research are: DOE, the U.S. Environmental Protection Agency.

Agency (EPA), the Puerto Rico Land Authority and the U.S. Department of Agriculture (USDA). Water Hyacinth Cover of Water Bodies The desirability of harvesting water hyacinth (Eichhornia crassipes) from surfaces of water bodies used as potable water sources has been under debate for the past 10 years. The CEER-DOE Development Fund has supported research aimed at determining nutrient uptake, productivity and ecological parameters associated with water hyacinth mats which currently dominate the surface of Lake Carraízo, a local potable water source. Resource Recovery Energy Reclamation and Water Purification A program largely financed through the CEER Development Fund, the Puerto Rico Aqueducts and Sewers Authority, and small grants from local industries has produced two projects of applied environmental research. They are devoted to the acquisition of data which would find direct application in the alleviation of water pollution and in the use of noxious weed pests for high quality energy (e.g., methane) generation.

Water Hyacinth Water Reclamation and Fermentation This project aims at determining if small well-managed water hyacinth lagoons can be effectively used for processing domestic sewage and industrial wastewater. It is also concerned with economic advantages of harvesting and anaerobically fermenting water hyacinth to obtain methane, a high quality energy source.

High Gradient Magnetic Filtration (HGMF) Particularly refractory wastewater streams can be treated more efficiently with respect to energy expenditure using an advanced separation and clarification technique to remove particulate matter, biochemical oxygen demand and heavy metals. The establishment of this project aims at examining the applicability of the technique in Puerto Rico, as well as studying long term effects of its application.

Waste Sludge Utilization and Disposal Of potential interest to EPA, USDA and to local funding agencies, composting and land distribution of waste sludge has associated with it some problems.

Migratory patterns of freshwater shrimp and crab species, cycling, and transport studies limited to the watershed might be very useful for characterizing biomass interfacial transport of carbon dioxide. Atmospheric buildup of carbon dioxide is of worldwide preoccupation because of its potential impact on climatic patterns.

The Rack 1 Environmental Research Park (NERP) Program: The Terrestrial Ecology Division is proposing that two sites, El Faro and El Verde, be included in the Department of Energy (DOE) supported National Environmental Research Park (NERP) system. At present, this includes research parks like the Savannah River Plant, S.C. and Oak Ridge National Lab, of Tenn. Designation as NERPs will make these lands available for use as field laboratories in which visiting

scientists, staff, and university participants may carry out ecological research programs designed to develop the data base necessary to make scientifically reasoned environmental decisions.

The focus of this program will be to evaluate the current and potential impacts of man's activities, in particular, those related to energy use and development, and will address the following NERP objectives:

1. Continuous and quantitative monitoring and assessment of environmental impacts and development of baseline, but site-specific comparable data, by means of network-wide standardized methods (e.g., meteorological monitoring network, species lists, mapping, population levels, life histories of identified sensitive species, site manipulation).

2. Development of methods to evaluate or predict environmental response to proposed activities (e.g., nutrient and mineral cycling, succession, pollutant deposition).

3. Demonstrate impacts to the public and evaluate methods to minimize adverse impacts.

A proposal was submitted in June 1979 to include El Faro in the NERP network. The 522-acre site is located on the extreme northeastern tip of Puerto Rico near the city of Fajardo and is privately owned by the Conservation Trust. This group contacted the Terrestrial Ecology Division.

Ecology Division to characterize the site and evaluate its potential as a NERP. Preliminary vegetation and faunal surveys were completed in the fall of 1978 and field work for three theses from UPR was conducted on-site. Included at #1 Faro are a wide range of habitat types: beaches, rocky shores, mangrove forests, a coastal lagoon, abandoned palm plantations, and xerophytic forest. These types are similar to those being adversely impacted in the coastal zone island-wide, making Faro an ideal reference area and site for ecological research. A second site, El Verde, is presently being evaluated with respect to its potential as a NERP and a proposal will be submitted to DOE during this fiscal year. The area includes research and living facilities located at the El Verde Field Station and the surrounding tracts of tropical rain forest. Already used by visiting scientists, staff, and university participants with a long history of ecological research, a large data base exists for the El Verde Site. Continued research concerned with indications of the impact of energy-related activities on tropical ecosystems should be facilitated by this data base. Although located within the boundaries of the Luquillo Experimental Forest operated by U.S.D.A. Forest Service, the field station and surrounding 160 acres have been used as a base for ecological research for an extended period of time by other agencies and groups such as the AEC, ERDA, DOE, UPR and other universities. Upon designation as a NERP, activities to be initiated include continued site characterization; further investigation of nutrient and mineral cycling, in particular the fate of sulfur in the system; and studies of the consumer trophic level. In addition, data and pertinent literature will be collected and evaluated in order to identify gaps and future research needs. The literature will be organized and a library will be established at the field station. A total evaluation and organization of the already existing herbarium and faunal museum will be conducted.

The text should be fixed as follows:

While there is a great diversity of species contributing to the leaf drop, the average caloric content of leaves in each forested section can be related, as a base of comparison, to the average caloric content of Tabonuco (Dacryodes excelsa) leaves. The turnover time for Tabonuco leaf litter has been shown previously to be about 16 months (c.f. personal communication from F. La Caro). Thus, it should be possible to derive an approximate value for the energy transfer per year via leaf drop. This number is of great importance in the determination.

The limitations of energy contribute to the population of arthropods, soil micro-organisms, and leaf-eating insect primary consumers. Using the data currently available, the estimated average caloric value of leaves from all 25 stations after a single collection (5-31-72) is 4,656 cal/g with a standard deviation of 189 cal/g. The estimated uncertainty in the measured values is no greater than 22. Measurements of the average nitrogen and sulfur content of the leaves will also be taken since the cycling of these elements is related to soil nutrient return and worldwide pollution models.

Long Term Ecological Research (LTER) is currently being conducted by the Terrestrial Ecology Division in collaboration with the U.S.D.A. Forest Service, Institute of Tropical Forestry. They are preparing a National Science Foundation (NSF) proposal to designate the Luquillo Experimental Forest as a site where an LTER program may be initiated.

The NSF has recognized the need for continuous collection of quantitative data so that long-term changes, either natural or man-made, in biological systems can be evaluated. Changes over time at the same site and comparisons between sites or within the network are the focus of five core research questions:

1. Pattern of primary productivity.
2. Population dynamics of selected populations, including the evaluation of population fluctuations and their relationship to physical and climatic variables.
3. Organic (biomass) accumulation and movement over time.
4. Inorganic (atmospheric and hydrologic) accumulation and movements.
5. Spatial and temporal patterns, frequency, and responses to disturbances.

Financial support will enable the TED, CEER, and ITP to initiate the necessary long-term measurements required to evaluate these five core research areas.

A proposal for the study of two potential power facility sites was submitted to the Puerto Rico Electric Power Authority (PREPA). Both flora and fauna on the proposed sites will be characterized.

Respect for populations, number, and frequency - and, in the case of flora: percent ground cover. An analysis of damage to fragile aspects of the ecosystems at the sites will also be made.

Other Progress: Limnological survey work on the Rio Espiritu Santo River drainage basin was completed and an analysis of data made. Preparation of some manuscripts was completed and the Limnological survey is being written at this time.

Ecological Effects: Cooling Water Effects on Aquatic Ecosystems. A small water body - Park Pond - has been used for discharge of atomic reactor cooling water for more than 20 years. During that time, a large body of Limnological data has been acquired, but little systematization of it has been

attempted. An effort was begun at Savannah River Laboratory (SRL) to analyze those data in the context of long-term effects and has been continued by the CEER Terrestrial Ecology Division in collaboration with SRL. A database has been assembled for the SRL computer and time series summaries are in preparation.

Intensive Biomass Culture: A new project and no data have yet been taken on biomass cultivation effects on soils or water, but a site for the studies has been arranged, and the studies can be carried out in association with yield per-acre experiments now underway.

Water Hyacinth Cover on Lakes: A man-made lake - Lake Carraizo - is used as a potable water source for San Juan and several other municipalities. During dry seasons, the lake conventionally supports a lush superficial growth of water hyacinths (Eichhornia crassipes). Growth of biota associated with the water hyacinth mat is responsible for considerable nitrogen, phosphorus, and carbon turnover, effectively treating influents to the lake, some of which are from municipal sewer treatment plants.

Plants harvested from Lake Carraizo were re-established in salt 3-foot-deep pools with plastic liners and fed effluent from a secondary aerobic activated sludge treatment plant - El Conquistador plant in the municipality of Trujillo Alto. The mean...

Dry weight of plants raised in this manner was 5.2% of the wet weight. A linear regression equation which relates wet weight to dry weight is as follows:

$Y = 6.05129 + 0.3130x$ in which Y represents dry weight and X represents wet weight. Wet weight was determined after drip drying for 5 minutes. No significant relationship between growth rate and water retention time was discernible. Productivity on a dry weight basis was determined to be 108.195 Kg/Ha/day.

Resource Recovery Water Reclamation Using Culture Clarification

Using water hyacinth dominated lagoons can help secondary treatment plants meet effluent requirements with respect to total suspended solids, nitrogen, and phosphorous levels. The pond system described in 4.2.3 was used to determine water clarification performance of water hyacinth used to create effluent from the El Conquistador aerobic activated sludge plant using a nominal holdup time of 2 days. A mean 98% reduction of total nitrogen, 25% reduction of total phosphorus, and 90% reduction in total solids was measured over the short term.

Somewhat puzzling was the ability of the water hyacinth mat to regenerate the water, with lagoon effluent frequently showing a dissolved oxygen content between 100% and 200% higher than the treatment plant effluent entering the lagoon. Equally puzzling was an apparent increase (107%) in the 5-day biochemical oxygen

demand after lagoon treatment. This may be related to the chlorination of the final plant effluent. An energy and nutrient interaction diagram for organisms associated with hyacinth lagoon treatment is shown in Figure 1.

High Gradient Magnetic Separation

A program of water treatment using a very advanced technology - high gradient magnetic separation - was begun in FY-79. Primarily aimed at industrial and municipally generated waste streams, a 3-day workshop of international and local experts concluded that the use of seeded high gradient magnetic filtration (HGMF) could be of significant benefit for effluent compliance problems in Puerto Rico.

A mobile laboratory was rented from Sa Magnetics, Inc. of Cambridge, Massachusetts. After a brief training period, raw sewage effluent was treated during runs of 55-300 gallons. The sewage was fresh influent to the El Conquistador secondary aerobic activated sludge treatment plant. The plant performance was judged to be between adequate and exceptional for that particular waste. Raw sewage from the plant conventionally required an alum dose of 50 mg/l, powdered magnetite at a level of 350-400 mg/l, and settler/flocculant Hercofloc 831 at 3 mg/l. Turbidity was routinely reduced by 90-95%, with a total suspended solids removal of above 90% and biochemical oxygen demand reduction between 60% and 69%. Rum distillery wastes have not been treated as successfully so far.

Waste Sludge Utilization and Disposal: A proposal for detoxification of waste sludge from secondary aerobic sewage treatment plants was submitted to EPA Minority Institute Research Support (MIRS) Program in May of 1979. The detoxification will be tried using static pile thermophilic composting techniques and a locally generated bulking agent - bagasse, the cellulosic fiber waste from sugarcane processing. The research will be done in cooperation with the University of Puerto Rico School of Medicine which will be responsible for microbiological and parasitological examination of the treated wastes. The product will be used for perturbation effects in ecosystem structure and function studies, and for agronomical studies of soil amendment regimes for intensive biomass production.

5 Publications, Theses and Reports: The following publications were accepted and/or appeared. Block, A.M., Santos, F.A., Clements, R.G., Bhajan, W.S., and Goldman, G., 1978. "Survey of the Elemental Burden Potential for Benthic Organism Uptake in the Rio Espiritu Santo River Estuary of Northeast Puerto Rico". Science-Ciencia 6 (1), 30. Surface sediments collected at some 16 stations in the Rio Espiritu Santo River Estuary were analyzed with

Respect £0.40 for different elements using emission spectroscopy and visible estimation techniques. Most of the estuary contained a metals distribution typical of new estuaries, probably reflecting the presence of a 5 kg. salt wedge.

Canals, M., 1979, some ecological aspects of the Biology of Macrobrachium crenulatum (Holthuis, 1950) Palaemonidae Decapoda in Puerto Rico including notes on its taxonomy. Science-Ciencia 6 (3): 130-132.

The distribution and ecological aspects of Macrobrachium crenulatum in P.R. are discussed. The species is more abundant at middle altitudes (200-600 m.) where it is the dominant species of the Palaemonidae. The distribution is limited to northeastern Puerto Rico. Taxonomic variations in

coloration and length of dactyl are influenced by age and sex. Gravid females present a peculiar coloration of the protopodites never reported for any member of the Palaemonidae.

5.3 Viblauit, ., 1975. 2 Jucinto de Agua, Eichhornia crassipes (Mart.) Solms. Progress in Science-Ciencia 6, 167-168.

Since its introduction in Puerto Rico, the water hyacinth has gone from a floral curiosity to a nuisance and pest in waterways. This work presents a new image of total utilization of the plant. A wide variety of uses are presented in this paper; some of these are: domestic wastewater treatment, chemical wastes treatment, compost, methane production, paper pulp, and management in water.

Theses

The following theses were finished by students working in the Division during 1979.

Corujo, I., 1979. Species Diversity and Distribution of Fish in the Rio Espiritu Santo River Estuary. M.S, Biology, University of Puerto Rico, (in press).

Pelegrina, D., 1979. The Effect of Light and Salinity on Rotation of Rhizophora mangle Seedlings. M.S. Biology, University of Puerto Rico (available).

Tirado, W, 1979. Faunal Ecology of the El Faro Reserve. M.S. Biology, University of Puerto Rico (available).

Viera, D., 1979. Colonization of Communities on the Roots of Rhizophora mangle. M.S. University of Puerto Rico. (available).

Zayas, J., 1979, The Ecology of a Coastal Lagoon. Studies on the El Faro Reserve, M.S, University of Puerto Rico. (Available).

Report: In 1979, a CEER volume summarizing the Rio Espiritu Santo drainage basin was edited by members of the Terrestrial Geology Division. The volume, entitled "River Basin Energy and Environmental Planning, Methodologies and Instruments" (CER No. 1-40) is available upon written request.

The following papers by members of the Terrestrial Ecology division appeared in the volume: Block, A.N., 'The Human Waste Problem in Rural Zones of High Rainfall Watershed', 43-36.

18, M., 'Some Economic Aspects of the Fauna of the Espiritu Santo River Estuary', 29-38.

Clements, R.G., 'Physical and Ecological Aspects of the Espiritu Santo Drainage Basin', 7-12.

Clements, R.G., 'Hydrology of the Espiritu Santo River Basin', 67-76.

Holben, B.T., J.A. Cols, M. Canals, F.A. Santos, and R.G. Clements, 'Precipitation Distribution and Rain-gauge Networks in the Luquillo Mountains', 51-66.

The final report on the El Faro Reserve of the Conservation Trust which was prepared for DOE consideration of the reserve as a NERP site was also finished in June of 1979. The document is available and is referenced as follows:

Clements, R.G. and R.C. Bunnell, 'Proposal to Establish a National Environmental Research Park at El Faro, Fajardo, Puerto Rico.'

One additional report concerning structure and function of ecosystems was completed during 1979. It concerns the impact of freshwater flooding on reef populations and the reference with abstract is as follows:

Menaga, C. and M. Canals, 1979, 'Relacion de Mortalidad Masiva de Millepora complanata (cnidaria, hydrozoa) con alta pluviosidad y escorrentia del Rio Fajardo en Cayo Ahogado, Fajardo.' Proc. of the Sixth Symposium of Natural Resources, Dept. of Natural Resources, Commonwealth of Puerto Rico (in press).

Salinities lower than 25 ppt. and high turbidity occurred on May 29, 1979 in the reefs close to the mouth of the Fajardo River due to high precipitation.

In Fajardo and the Luquillo Mountains, in Cayo Abogado these conditions were responsible for high mortalities of the hydrocoral, Millepora complanata. After three days, colonization by algae started on the skeletons of the dead corals. Diversity Indexes and Percentage of Mortality are compared between Cayo Ahogado and Cayo Largo where salinities were not less than 34 PPT during the period of high precipitation. The following reports pertaining to resource conservation were completed during 1979. Block, A.McB., U. Ortabasi, and M.B. Riesco. High Volume, High BOD Wastes: The Magnetic Separations Option. GEER Tech. Publ. 0-19 (available). Ortabasi, U., coordinator and A.McB. Block, R.Cruz-Pérez, T. Harland, J.A. Oberteuffler, M.B. Riesco and J.H. Watson. An Assessment of Magnetic Filtration: "A New Approach to Puerto Rico's Effluent Pollution Problems. Proc. Workshop Magnetic Separations Applications in Puerto Rico (available). Villamil, J. and A.McB. Block. CEER Sewage Management and Research Program: Analysis and Selection of Study Site Location. Villamil, J., R.G. Clements, A.McB. Block, F.A. Santos, P. Weil, A. Garcia, and K. Lao. Water Hyacinths for the Clarification of Wastewaters and the Production of Energy. CEER Tech. Publ. C-36. The following is a list of presentations and seminars given by members of the division during FY-1979.

Block, A.McB., U. Ortabasi, and M.B. Riesco. High Volume, High BOD Wastes: The Magnetic Separations Option. Tech. Cong. Assoc. Engr. of Puerto Rico, San Juan, PR. May, 1979. Costa, M. "La Fauna de Crustaceos del Caribe," Youth Conservation Naval Sta., Ceiba, Puerto Rico, July, 1979. Villamil, J., R.G. Clements, A.McB. Block, F.A. Santos, E. Craig, A. Garcia, WU, Lao and P. Weil, "The Use of Vascular-Plant-Dominated Lagoons for Water Treatment and Wastewater Reclamation," 3rd ACS/PR Sy. Tech. Meeting Poster Session, Mayaguez Hilton Hotel, Mayaguez, P.R., Dec. 1978. Villamil, J., R.G. Clements, A.McB. Block, F.A. Santos, A. Garcia, K. Lao, and P. Weil, "Water Hyacinths for the Clarification of Wastewaters."

"Wastewater and the Production of Energy" - Tech, Cong. Assoc. Eng. of Puerto Rico, P.R., May, 1979. Juan Vildanii, J., RG Clements, A.McB. Block, F.A. Santos, L.L. Rosa, A. Garcia, W. Tao,

and P. Weil: "Mater Bvacinche for the Treatment of Wastewater", Aquatic Vascular Plant Manage. Soc. Ann, Meeting, Chattanooga, T.N., July, 1979.

Terrestrial Ecology Division Scientific Staff During FY-1979: Field ecologist Ronald Bunnell left the group to pursue graduate studies at University of California, Berkeley, CA. Félix Santos, Research Technician, left to pursue Ph.D. studies in toxicology at the University of Tennessee. Oak Ridge Associated Universities Fellow Fred Ta Caro returned to the University of California at Davis. In September of 1979, William Bhajan left the Division. Also in September, Richard C. Clements, Director of the Terrestrial Ecology Division for the past 10 years at CEER and its predecessor institution, Puerto Rico Nuclear Center (PRNC), resigned to take a position with the regulatory section of U.S. Environmental Protection Agency.

Staff Addition: Jude Susan Silos, a specialist in tropical forests, Douglas P. Reagan, an ecologist/herpetologist, and Laurence J. Tilly, an ecologist, recently from Savannah River Laboratory, as director of Environmental Programs and acting director of Terrestrial Ecology Division. Tilly's expertise includes primary consumer analysis and aquatic biology.

A complete list of the scientific staff is as follows:

Laurence J. Tilly, Acting Director, Ph.D. (Ecology), State University of Iowa, Iowa City.

Arthur McB. Block, Scientist II, Ph.D. (Physical Chemistry), Rutgers University.

Johnny Villamil, Scientist I, M.S. (Biology), University of Puerto Rico.

Susan Silander, Research Associate, M.S. (Biology), University of Tennessee.

Miguel Canela, Research Associate, B.S. (Biology), Inter-American University, San Juan, P.R.

Other Staff Activities: Arthur McB. Block attended the 53rd Colloid and Surface Science Symposium.

An American Chemical Society Meeting was held June 11-13, 1979 in Bell, Missouri. Johnny Villamil attended the Annual Meeting of the Aquatic Vascular Plant Management Society held in July, 1979 in Chattanooga, Tennessee. Johnny Villamil conferred with members of the Texas Dept. of Health in Austin, Texas in July of 1979 about water treatment strategies using water hyacinth. Johnny Villamil also conferred with NASA officials in Bay St. Louis, Mississippi in July of 1979 about utilization of water hyacinth for energy generation.

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