New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233

Thomas C. Jorling
Commissioner

July 20, 1989

The Honorable Francis W. Serbent
Administrative Law Judge
New York State Department of
Environmental Conservation
50 Wolf Road
Albany, New York 12233

Re: Expansion of Rapp Road Landfill -
Amicus Testimony by John Cryan

Dear Judge Serbent:

It is Staff's continuing view, previously enunciated and based upon Mr. Cryan's work -- both as consultant to DEC in the late 1970's and subsequently on his own -- that he presumptively has experience which would be valuable to compilation of a complete record. Moreover, since the witnesses for both the City and Save the Pine Bush have used Mr. Cryan's early work as a starting point for their analyses for lack of anything better, the quality of that work should be scrutinized for its reliability. By Mr. Cryan's being subject to cross-examination, a reasoned evaluation can be done of the quality of that work, the projections based upon it and the effectiveness of the mitigation proposed, as well as of his more recent observations, which provided the foundation for Save the Pine Bush's issues presentation regarding the Karner Blue.

Staff's opposition to Mr. Cryan's appearing on behalf of Save the Pine Bush was based upon the unequivocal Department policy regarding involvement of employees in situations in which there is a potential for conflict of interest, of which this was one explicitly enumerated. Once he had withdrawn his testimony on behalf of that party, the potential for conflict of interest was eliminated and our opposition mooted. However, by virtue of his experience and the Department's encouragement of constructive contributions by professionals, shortly after his withdrawal, Staff inquired of him whether he wished to offer testimony to the record as a "friend of the court", if Your Honor were interested in having him appear in such capacity. His response was in the affirmative.

Subsequent to our discussions with Mr. Cryan, actions have been taken to assist him in testifying. To assure total objectivity, and avoid even the perception that Staff was involved in any way in preparation of Mr. Cryan's testimony, we suggested that Region 2 Attorney Moore be permitted to work with Mr. Cryan, both to prepare him for his appearance and, with your concurrence, conduct oral direct examination and "defend" the witness. Mr. Moore, who has a long relationship with Mr. Cryan characterized by mutual trust, has no other involvement in this proceeding. Mr. Moore has informed me that Mr. Cryan will be prepared to appear during the session commencing July 24th.

In addition, Executive Deputy Commissioner Marsh has communicated to Mr. Cryan his specific determinations that an appearance as amicus would not be a conflict of interest and that, since it would benefit the record, his preparation and appearance would be considered to be Departmental activities and his expenses would be borne by the Department.

As Your Honor is aware, Staff assigned in this proceeding met with Mr. Cryan on June 5, 1989 for the purpose of apprising him of our goals with respect to Pine Bush protection and management, particularly with regard to how they are reflected in the Draft Permit. At the conclusion of that meeting, Mr. Cryan indicated to us that our position was far more consistent with his objectives than he had previously thought. For that reason, he believed that there was no need for him to offer testimony, and he subsequently withdrew his prefiled. Our outreach to him (at Executive Deputy Marsh's instance) was undertaken in order to benefit the record, not to solicit testimony in support of Staff's position. Indeed, we do not know what Mr. Cryan wishes to offer to the record. Given the circumstances, it would be inappropriate for Staff to call him as our witness, and we will not do so.

Staff's understanding is that the testimony which Mr. Cryan would present would be no greater in scope than his pre-filed and would be more limited, and that the pre-filed will not be introduced, since he has withdrawn it. It is further understood by Staff that Mr. Cryan will be subject to being cross-examined by Staff, Mr. Cryan understands this, and he waives his right to claim that the undersigned is barred from doing so by ethical restraints of the legal profession, if any, a statement to that effect to be elicited from Mr. Cryan upon his being sworn. The situation with respect to Save the Pine Bush is less clear, since the testimony would be a truncated version of what was put together with Mr. Oliver's active participation.

Finally, we are constrained to note that the City may be severe prejudiced if it is forced to cross-examine without the benefit of the materials upon which Mr. Cryan's testimony

is based, the subpeona for which has been ignored to date. At my request, Mr. Moore and Mr. Alessi have negotiated regarding these; however, I am not privy to the results of the discussions.

Based upon the foregoing, particularly what we perceive to be a contribution to a complete record of Mr. Cryan's appearing, Staff requests that you call Mr. Cryan to testify as described, upon condition that he produce the materials which provide a foundation therefor.

Thank you for your consideration.

Sincerely,

Carl G. Dworkin
Principal Administrative
Litigator

cc: Richard M. Cogen, Esq.
Louis B. Oliver, Jr., Esq.

City of Albany - Mr. Bruce
NYSDEC Region 4 - Ms. Magee
Save the Pine Bush - Ms. Adams

Cyril Moore, Esq.
Mr. John Cryan

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233

Thomas C. Jorling
Commissioner

July 20, 1989

The Honorable Francis W. Serbent
Administrative Law Judge
New York State Department of
Environmental Conservation
50 Wolf Road
Albany, New York 12233

Re: Expansion of Rapp Road Landfill -
Amicus Testimony by John Cryan

Dear Judge Serbent:

It is Staff's continuing view, previously enunciated and based upon Mr. Cryan's work -- both as consultant to DEC in the late 1970's and subsequently on his own -- that he presumptively has experience which would be valuable to compilation of a complete record. Moreover, since the witnesses for both the City and Save the Pine Bush have used Mr. Cryan's early work as a starting point for their analyses for lack of anything better, the quality of that work should be scrutinized for its reliability. By Mr. Cryan's being subject to cross-examination, a reasoned evaluation can be done of the quality of that work, the projections based upon it and the effectiveness of the mitigation proposed, as well as of his more recent observations, which provided the foundation for Save the Pine Bush's issues presentation regarding the Karner Blue.

Staff's opposition to Mr. Cryan's appearing on behalf of Save the Pine Bush was based upon the unequivocal Department policy regarding involvement of employees in situations in which there is a potential for conflict of interest, of which this was one explicitly enumerated. Once he had withdrawn his testimony on behalf of that party, the potential for conflict of interest was eliminated and our opposition mooted. However, by virtue of his experience and the Department's encouragement of constructive contributions by professionals, shortly after his withdrawal, Staff inquired of him whether he wished to offer testimony to the record as a "friend of the court", if Your Honor were interested in having him appear in such capacity. His response was in the affirmative.

Subsequent to our discussions with Mr. Cryan, actions have been taken to assist him in testifying. To assure total objectivity, and avoid even the perception that Staff was involved in any way in preparation of Mr. Cryan's testimony, we suggested that Region 2 Attorney Moore be permitted to work with Mr. Cryan, both to prepare him for his appearance and, with your concurrence, conduct oral direct examination and "defend" the witness. Mr. Moore, who has a long relationship with Mr. Cryan characterized by mutual trust, has no other involvement in this proceeding. Mr. Moore has informed me that Mr. Cryan will be prepared to appear during the session commencing July 24th.

In addition, Executive Deputy Commissioner Marsh has communicated to Mr. Cryan his specific determinations that an appearance as amicus would not be a conflict of interest and that, since it would benefit the record, his preparation and appearance would be considered to be Departmental activities and his expenses would be borne by the Department.

As Your Honor is aware, Staff assigned in this proceeding met with Mr. Cryan on June 5, 1989 for the purpose of apprising him of our goals with respect to Pine Bush protection and management, particularly with regard to how they are reflected in the Draft Permit. At the conclusion of that meeting, Mr. Cryan indicated to us that our position was far more consistent with his objectives than he had previously thought. For that reason, he believed that there was no need for him to offer testimony, and he subsequently withdrew his prefiled. Our outreach to him (at Executive Deputy Marsh's instance) was undertaken in order to benefit the record, not to solicit testimony in support of Staff's position. Indeed, we do not know what Mr. Cryan wishes to offer to the record. Given the circumstances, it would be inappropriate for Staff to call him as our witness, and we will not do so.

Staff's understanding is that the testimony which Mr. Cryan would present would be no greater in scope than his pre-filed and would be more limited, and that the pre-filed will not be introduced, since he has withdrawn it. It is further understood by Staff that Mr. Cryan will be subject to being cross-examined by Staff, Mr. Cryan understands this, and he waives his right to claim that the undersigned is barred from doing so by ethical restraints of the legal profession, if any, a statement to that effect to be elicited from Mr. Cryan upon his being sworn. The situation with respect to Save the Pine Bush is less clear, since the testimony would be a truncated version of what was put together with Mr. Oliver's active participation.

Finally, we are constrained to note that the City may be severe prejudiced if it is forced to cross-examine without the benefit of the materials upon which Mr. Cryan's testimony

is based, the subpeona for which has been ignored to date. At my request, Mr. Moore and Mr. Alessi have negotiated regarding these; however, I am not privy to the results of the discussions.

Based upon the foregoing, particularly what we perceive to be a contribution to a complete record of Mr. Cryan's appearing, Staff requests that you call Mr. Cryan to testify as described, upon condition that he produce the materials which provide a foundation therefor.

Thank you for your consideration.

Sincerely,

Carl G. Dworkin
Principal Administrative
Litigator

cc: Richard M. Cogen, Esq.
Louis B. Oliver, Jr., Esq.

City of Albany - Mr. Bruce
NYSDEC Region 4 - Ms. Magee
Save the Pine Bush - Ms. Adams

Cyril Moore, Esq.
Mr. John Cryan

STATE OF NEW YORK
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

In the Matter of the applications for the proposed twenty-five acre expansion of the Rapp Road landfill (DEC #4-0101-171/1-0) by the City of Albany, New York.

Applicant

DIRECT TESTIMONY

OF

JOHN F. CRYAN

IN BEHALF OF
SAVE THE PINE BUSH

LEWIS B. OLIVER, JR., ESQ.
HARRIET B. OLIVER, ESQ.
OLIVER & OLIVER
Attorneys for Save the Pine Bush
156 Madison Avenue
Albany, New York
518-463-7962

PREFILED TESTIMONY OF JOHN F. CRYAN

Q. What is your name and address?

A. John F. Cryan, 413 West 47th Street, New York, New York 10036.

Q. What is your profession?

A. I am a professional biologist, employed by the New York State Department of Environmental Conservation at the Region 2 Office in New York City.

Q. What are your duties with the department?

A. Within the five boroughs of New York City, I have mapped, delineated, and evaluated wetlands for regulation and protection under the New York State Environmental Conservation Law (ECL). I have conducted research on wetland functions and characteristics relevant to wetland regulation and protection. I have received and evaluated hundreds of permit applications and project proposals for environmental impacts pursuant to the State Environmental Quality Review Law (SEQR; Article 8 of the ECL); many of these evaluations have resulted in project modifications or alternatives chosen which minimized or eliminated adverse environmental impacts. I have testified at departmental administrative permit application and enforcement hearings, and in cases before the state Supreme Court,

as an expert witness in biology. I have conducted enforcement investigations and documented violations of the ECL, particularly involving the destruction or alteration of wetlands, sometimes in conjunction with departmental law enforcement personnel. Most recently, I have coordinated the preparation of a wetland assessment and management study of freshwater wetlands on Staten Island, and worked on the preparation of a generic environmental impact statement on the cumulative and other impacts of freshwater wetland destruction, alteration, and protection throughout Staten Island. I have also recently testified extensively as an expert witness in biology before the Freshwater Wetlands Appeals Board, in cases brought pursuant to ECL Section 24-1104, the Staten Island amendment to the State Freshwater Wetlands Act.

Q. How long have you worked for the department?

A. Since September, 1982.

Q. I show you a document marked "Exhibit 1". Can you identify it?

A. Yes, it is a copy of my resume.

Q. Does your resume fairly and accurately represent your education and research experience, particularly with respect to the biology of pine barrens ecosystems and their rare or endangered species?

A. Yes.

Q. Outside of your professional work for the department, do you perform any other activities, such as research, related to your profession?

A. Yes. Since 1973, I have been conducting research on the plants, animals, vegetation, fire ecology, endangered species, and other scientific aspects of the Albany Pine Bush and other pine barrens areas of the Northeast. My resume reflects the extent of this research. I am also a member of the scientific advisory board of the American Pine Barrens Society, co-founder and board member of the Long Island Pine Barrens Society, and editor of the Society's journal, The Heath Hen.

Q. Is your testimony in this proceeding in any way connected with your work for the Department of Environmental Conservation?

A. No. I am testifying as a private citizen, on the basis of research experience gained outside of my duties and work for the Department. My research experience in the Pine Bush predates my employment with the Department by nine years.

Q. Are you being paid or compensated by Save the Pine Bush, Inc., for your testimony or any other work involving this matter?

A. No.

Q. Have you ever been paid or compensated by Save the Pine Bush, Inc., for any other testimony, affidavits, or other work?

A. No.

Q. Have you conducted research on the Karner Blue Butterfly?

A. Yes. Research which I have conducted includes the major studies of the biology, distribution, and status of the Karner Blue Butterfly (Lycaeides melissa samuelis Nabokov) in New York State. This research is summarized in two reports submitted to the Endangered Species Unit of DEC in 1978 and 1980. The Karner Blue is listed as endangered by New York State, and it has been a candidate for federal listing. My research on the Karner Blue, together with research conducted by my colleague Robert Dirig, led to its listing as an endangered species in New York, and to efforts to protect its pine barrens habitat in the Albany Pine Bush. I have also studied the Karner Blue at other populations of the butterfly located in New Hampshire, Ohio, and Michigan.

Q. Have you conducted research on the Buck Moth?

A. I have conducted the major research on the Buck Moth (Hemileuca maia) in New York State, including studies of the inland populations at pine barrens at the Glens Falls Sand Plain and the Albany Pine Bush, and studies of the distinctive coastal populations inhabiting the Long Island Pine Barrens. My research was used to support placement of the Buck Moth on the list of Species of Special Concern, one of three categories of listing on the New York State Endangered Species List. Additional research is being conducted to determine whether the Buck Moth should be listed as a threatened or endangered

species in New York State. My work on the Buck Moth has led to protection efforts for essential Buck Moth habitats in pine barrens areas including the Albany Pine Bush, the Glens Falls Sand Plain, and sections of the Long Island Pine Barrens, including the Oak Brush Plains, Central Pine Barrens, and the globally rare Dwarf Pine Plains.

Q. Have you conducted research on other endangered species in New York State?

A. Yes. My research also includes the major New York State status survey and biological study of the Eastern Tiger Salamander (Ambystoma tigrinum tigrinum), a rare pine barrens amphibian species which once reached its northern limit at the Albany Pine Bush and which now occurs only on Long Island in New York State. This research has been used to support the listing of the Tiger Salamander by New York State as an endangered species, and as a basis for protection of Tiger Salamander habitats, including many valuable pine barrens wetlands on Long Island.

Q. Have you conducted research on pine barrens vegetation?

A. Yes. My research has also included scientific studies of the soils and vegetation of the Albany Pine Bush, Long Island Pine Barrens, and other pine barrens regions of the Northeast. I have conducted some of these studies in part with the late Robert H. Whittaker, who was recognized worldwide as one of the pre-eminent authorities on vegetation science and community ecology.

Q. Have you been qualified as an expert witness in pine barrens biology?

A. Yes. I have prepared and submitted scientific reports, affidavits, and given oral testimony in administrative and court proceedings regarding the plants, animals, endangered species, biology, fire ecology, conservation, and other aspects of over one hundred tracts of land located in over twenty regions of the northeastern United States, including pine barrens areas such as the New Jersey Pine Barrens, Long Island Pine Barrens, Albany Pine Bush, Saratoga County Sand Belt, Glens Falls Sand Plain, and other areas. In one of these proceedings, I was accepted as an expert witness on the Karner Blue Butterfly and the ecology of the Pine Bush and testified as such at DEC hearings on the Crossgates Mall proposal.

Q. Have you served as an expert in the recent Supreme Court cases involving the Albany Pine Bush?

A. Yes. I provided the pivotal biological material in the recent cases involving the Albany Pine Bush which have resulted in several ground-breaking court decisions bearing on the major issues at hand in the Albany Landfill expansion proposal. These court decisions mandated that the cumulative impacts of many proposed development projects within a distinct geographic area (in this case, the distinctive pine barrens vegetation of the Albany Pine Bush) must be evaluated before any decisions on the individual projects could be rendered. The courts further ordered that, as part of the cumulative impact analysis of the Albany Pine Bush, the minimum amount of acreage

necessary for the survival and perpetuation of the rare pine barrens vegetation and its associated endangered species (especially the endangered Karner Blue Butterfly) must be determined before any decisions could be made to approve or deny individual projects.

Q. I show you six documents marked "Exhibit 2", "Exhibit 3", "Exhibit 4", "Exhibit 5", "Exhibit 6", and "Exhibit 7". Do you recognize these documents?

Y. Yes. They are documents relating to the Pine Bush court decisions and the debate surrounding the cumulative impacts of development within the Pine Bush, and the question of minimum area requirements for the Pine Bush and the Karner Blue Butterfly. Exhibit 2 is an affidavit I prepared on 3 March 1985 for Save the Pine Bush, Inc., on the cumulative impacts of projects proposed in the Pine Bush. Exhibit 3 is the first Pine Bush decision of the Supreme Court, dated 17 May 1985, mandating the study of cumulative environmental impacts in the Pine Bush. Exhibit 4 is a letter from me to the City of Albany, dated 21 March 1986, in which I criticized the draft generic environmental impact statement issued by the City and stated that the minimum area question must be addressed. Exhibit 5 is an affidavit I prepared on 8 September 1986 for Save the Pine Bush, Inc., in which I criticized the cumulative impact analysis of the City and reiterated that the minimum area required for preservation of the Pine Bush and the Karner Blue must be determined. Exhibit 6 is the second Pine Bush decision of the Supreme Court dated 17 October 1986, which ordered the City to answer the minimum area question. Exhibit 7 is the decision of the Appellate Division dated 30 July 1987, on the appeal by the

City of the Supreme Court's second decision, which affirmed that the Pine Bush minimum area question must be answered.

Q. Are you familiar with the Pine Bush and the proposed landfill expansion site?

A. I am thoroughly familiar with the Pine Bush and the Albany landfill expansion site. I have made hundreds of field trips and spent thousands of field hours in the Pine Bush conducting the previously described research. Hundreds of these hours have been spent on or in the immediate vicinity of the Albany Landfill expansion site. I am also familiar with the details of the landfill expansion proposal and its environmental review. I have read the Draft Environmental Impact Statement (DEIS) for the landfill expansion proposal, and its appendices, especially Appendix T, entitled "Minimum Area Requirements for the Long-term Conservation of the Albany Pine Bush and Karner Blue Butterfly: An Assessment", by a panel of consultants to the City of Albany (hereafter called the panel report).

Q. Have you recently participated in the debate over Pine Bush minimum area requirements and management needs?

A. I have participated in, and contributed to, the debate over the minimum area requirements and management needs for the Pine Bush and Karner Blue Butterfly, most recently through verbal comments and my letter of 31 March 1988 to the city's consultants, in which I outlined a scope of work needed to answer the court-ordered questions involving minimum area and management requirements for the Pine Bush. The panel

report's major findings and recommendations echoed my own, made earlier, in Exhibits 4 and 5, and in my 31 March 1988 letter. The panel found that approximately 2,000 acres of contiguous pine barrens vegetation is the minimum area needed for the long-term preservation of the Pine Bush and Karner Blue, and recommended a comprehensive, three-year research program to assess the current status of the Karner Blue and other rare Pine Bush species, to study lupine biology and habitat requirements, to study and test Pine Bush fire management and other techniques, and to conduct other research needed to formulate a sound management plan for the Pine Bush.

Q. I show you a document marked "Exhibit 8". Do you recognize it?

A. Yes. It is my letter of 31 March 1988 to the City's consultants outlining a scope of work necessary to determine the minimum area and management requirements for the Pine Bush.

Q. Have you visited the proposed Landfill Expansion site in the past?

A. Yes. Every year since 1975, I have conducted field trips to the Albany Pine Bush. One of the primary purposes of such trips was to monitor the fluctuations of Karner Blue and lupine populations at the Pine Bush. In the period between 1975 and 1986, I included the proposed Albany Landfill expansion project site within the areas visited on my field trips.

Q. Where is the project site?

A. The project site is at the eastern margin of a body of pine barrens vegetation covering some of the most extensively developed, best preserved, and highest dune features in the Pine Bush. This body of pine barrens vegetation is presently bounded by Karner Road (Route 155) to the northwest, AMTRAK and Penn Central railroad tracks to the northeast, the New York State Thruway (Route 90) to the southwest, the Albany Landfill to the south, and Rapp Road, the ANSWERS facility, and Whitestone Trailer Park to the southeast and east. This area, also known as the "northeast quad" of the Pine Bush, contains one of the most extensive tracts of undisturbed, continuously burned pine barrens vegetation in the Pine Bush, and has been at the center of the stronghold of the Karner Blue and other rare, pine barrens-dependent organisms in the Pine Bush. The importance of the northeast quad to the preservation of the Pine Bush was recognized by the early acquisition of a large portion of the area by the City of Albany using federal Land and Water Conservation Trust Fund monies.

Q. Did you record observations on your visits to the site?

A. On many of my visits to the proposed Landfill Expansion site, I made field notes of observations of the Karner Blue, lupine plants, other rare species, and the vegetation of the area. These field notes clearly document the presence of lupine and the Karner Blue Butterfly on the site between 1975 and 1986; in addition, many of these notes provide information on the abundance of butterflies and their hostplants observed.

Q. I show you five documents marked "Exhibit 9", "Exhibit 10", "Exhibit 11", "Exhibit 12", and "Exhibit 13". Do you recognize these documents?

A. Yes. They are field notes made by me during visits to the landfill expansion site. Exhibit 9 is a field site checklist completed by me at the site on 25 May 1975. It records that over 100 Karner Blues were seen at the site on that date, along with 2,500 lupine plants scattered through the pine barrens vegetation and along the trails. A sketch map locates the Landfill Expansion site. Exhibit 10 is a field form used to record mark-release-recapture activities by me. It was completed on 24 May 1977 at the site. Again, a sketch map locates the Landfill Expansion site. The notes on the form record my observation that a sandy clearing on the site had been enlarged by human activity recently. On that date, I marked 56 Karner Blue adults on the site and found three full-grown Karner Blue caterpillars on lupine. Exhibit 11 is the same field form as Exhibit 10, but completed by me at the site on 31 May 1979. Once again, a sketch map clearly locates the Landfill Expansion site. On that date, I marked 78 butterflies on the site. I also noted the location of three clusters of Buck Moth larvae found on the site, as well as further disturbance of the site. Exhibit 12 is field notes made on 25 July 1983. On that date, I noted the sandy clearing on site, the west end of the ANSWERS parking lot which protrudes onto the site, and the presence of about 1,000 lupine plants in the area. I also noted that Karner Blue butterflies were observed flying, feeding, mating, and ovipositing on lupine, as well as feeding at the flowers of many wildflower species growing on the site. Exhibit 13 is field notes

made by me during a site visit on 20 July 1986. On that date I noted 35 Karner Blue butterflies, most near the large patch of lupine near the excavated pond. The butterflies were observed feeding at a variety of wildflowers, and moving westward toward the remainder of the northeast quad along a sandy trail. I also noted other butterfly species on the site, as well as a full-grown, wandering Buck Moth larva.

Q. Did you produce any reports on the status of the Karner Blue?

A. In 1978, Robert Dirig and I produced a report on the status of the Karner Blue Butterfly in the Hudson Valley Sand Belt stretching from Glens Falls To Albany.

Q. I show you a document marked "Exhibit 14". Do you recognize it?

A. Yes. It is the 1978 report written by Robert Dirig and me, entitled, "A Report on the Status of the Karner Blue Butterfly (Lycaeides melissa samuelis Nabokov) in New York State".

Q. Can you summarize the contents of this report as they relate to the project site?

A. This report included maps depicting the distribution of the Karner Blue at the Pine Bush. The maps clearly show that most of the site was occupied by lupine and the Karner Blue at that time.

Q. Prior to completion of your 1978 report, what did your field work show about the site?

A. Field work done by Dirig and myself prior to completion of our 1978 report revealed lupine to be scattered in clumps along the crests and slopes of the dunes on the site, along the sides of sandy trails in the area, and in patches in the interdune flats. A small, cleared area of bare sand on the site south of the Whitestone Trailer Park contained abundant lupine along its margins. The Karner Blue was abundant throughout the site, using the entire site as breeding, feeding, and resting habitat. Aside from the small, unvegetated cleared sandy area, which totalled under ten acres, the site contained three major duneforms, each covered with pine barrens vegetation dominated by Pitch Pine and Scrub Oak. The easternmost duneform, directly south of the trailer park, was fire-suppressed and had been invaded by Aspen, Cottonwood, White Pine, Red Oak, Black Cherry, and Black Locust, but still was dominated by pine barrens vegetation. The Buck Moth was present on the site and used virtually the entire site as breeding habitat, as evidenced by observations of egg masses, caterpillars, and adult moths.

Q. What happened to the site between 1976 and 1979?

A. Between 1976 and 1979, a series of severe disturbances were caused by human activities on the site. The most serious was the clearing of pine barrens vegetation and extensive sand mining which destroyed most of the original pine barrens vegetation in the central and southeastern portions of the site. The clearing and sand mining

encompassed an area of ten to twenty acres on the site, and occurred simultaneously with other clearing and sand mining activities taking place to the southeast, southwest, and northeast of the site, on lands owned, upon information and belief, by the City of Albany and John Garry. Some of the clearing and sand mining occurred contemporaneously with the clearing, grading, sand mining, and construction activities on the ANSWERS site adjacent to the Landfill Expansion site to the southeast. The activity also took place simultaneously with clearing and grading of Pine Bush vegetation along the northeastern face of the existing landfill, and with extensive clearing, grading, and sand mining which removed most of the original pine barrens vegetation on lands northwest, north, and northeast of the Whitestone Trailer Park. Simultaneously, attempts were made through clearing, filling, and the excavation of drainage ditches to destroy freshwater wetlands located north and northwest of the Landfill Expansion site and the trailer park. All of these land-clearing and sand mining actions were apparently conducted in violation of the Mined Land Reclamation Law (Article 23, Title 27 of the Environmental Conservation Law), the Freshwater Wetlands Act (ECL Article 24), the "taking provision" of the Endangered Species Act (ECL Section 11-0535), and the State Environmental Quality Review Law (SEQR; ECL Article 8), in that no permits were obtained pursuant to the cited sections of the Environmental Conservation Law, and no reviews of the environmental impacts of the illegal sand mining, filling, excavation, clearing of pine barrens vegetation, or destruction of Karner Blue colonies were conducted.

Q. What effect did these activities have upon the Karner Blue at the site?

A. The clearing and sandmining activities described destroyed most of the lupine and Karner Blues inhabiting the Landfill Expansion site and the lands around the trailer park. Lupine and Karner Blues still inhabited the duneforms at the northern and northwestern ends of the site, where the pine barrens vegetation had been disturbed but not destroyed, and also persisted in small, isolated patches of pine barrens vegetation remaining after the destruction. The central portion of the sand-mined area in the middle of the Landfill Expansion site was excavated to form a pond at the time of construction of the ANSWERS plant and parking lots on the adjacent city-owned parcel to the southeast. One of the ANSWERS parking lots was built partially intruding onto the cleared and sand-mined portion of the Landfill Expansion site from the southeast.

Q. Did you produce a second status report on the Karner Blue?

A. In 1980, I prepared a report for the Endangered Species Unit of the State Department of Environmental Conservation which detailed the location, population size, and status of each Karner Blue population known in the Upper Hudson Valley Sand Belt, a region of sandy soils and pine barrens vegetation stretching from Glens Falls to Albany. Approximately fifty Karner Blue populations were known at that time in the Hudson Valley Sand Belt.

Q. I show you a document marked "Exhibit 15". Do you recognize it?

A. Yes. It is a copy of part of the set of maps showing the distribution of the Karner Blue which accompanied my 1980 report.

Q. What do the 1980 maps show about the Karner Blue on the site?

A. The maps submitted with my 1980 report clearly reflect the distribution of the Karner Blue in the Pine Bush at that time, and show the presence of the Karner Blue on the two major duneforms at the northern and northwestern half of the Landfill Expansion site. These portions of the site, and the scattered patches of pine barrens vegetation supporting lupine and the Karner Blue on the cleared, bare sandy portions of the remainder of the site, were considered part of the largest Karner Blue population remaining in the Pine Bush (and within the state), the "Pine Bush Main" population. The numbers of both lupine plants and Karner Blues on the site were still high, as documented by Exhibit 11.

Q. What happened to the Karner Blue from 1980 to 1986?

A. From 1980 through 1986, a major decline in lupine and Karner Blue numbers took place throughout the Pine Bush, as well as throughout the distribution of the Karner Blue in the Hudson Valley Sand Belt. Approximately one-half of the Karner Blue populations documented in my 1980 report were extirpated, many by habitat destruction accompanying development, by shading of lupine caused by pine barrens vegetation reaching advanced successional stages in the absence of wildfires, or by inadvertent mismanagement of road verges, power line rights-of-way, and public lands. During this period, the entire Hudson Valley Sand

Belt experienced rapid suburban development, particularly in the areas north and west of Glens Falls, central and southern Saratoga County, and the Pine Bush region. In the Karner Blue populations remaining, lupine and Karner Blue numbers fell as much as 90 percent from their 1980 levels. Many lupine patches vanished entirely, replaced by dense thickets of woody vegetation; others became thinned out by shading and invasion by woody species, especially Aspens, White Pine, Black Cherry, Black Locust, and, within pine barrens vegetation, by blueberries, huckleberries, and Scrub Oak. Open, grassy patches supporting lupine, once a prominent feature of the pine barrens vegetation at the Pine Bush, became smaller and more widely scattered.

Q. What were the causes of this rapid decline?

A. The causes of this rapid decline of lupine and Karner Blue numbers in populations scattered throughout the Hudson Valley Sand Belt, including the Pine Bush, have been debated, most recently at a conference I attended on the Karner Blue sponsored by the Nature Conservancy and the New York State Department of Environmental Conservation held in Delmar, New York, on 6 and 7 February 1989. It was generally agreed by conference participants that habitat destruction by development, and vegetative shifts deleterious to lupine caused by fire suppression were the two primary causes of the sharp decline in lupine and Karner Blue numbers. It was also agreed that other factors may be at work, including increased mammal grazing of lupine, acidification of the surface layers of poorly buffered pine barrens soils by acid precipitation, and nutrient enrichment of pine barrens soils through atmospheric deposition of nitrogenous compounds.

The latter two factors would cause vegetative shifts deleterious to lupine, by either favoring existing acidophilic woody pine barrens vegetation at the expense of lupine (such as blueberries, huckleberries, and Scrub Oak), or by encouraging the invasion and persistence of tree species like aspens, locust, and cherry, which generally require richer soils than the Pine Bush sands.

Q. Was the Karner Blue on the site affected by this regional decline?

A. During the period 1980 through 1986, the Landfill Expansion site suffered a decline in the numbers of lupine plants and Karner Blue Butterflies along with the rest of the Pine Bush Main population to the west. Part of this decline was caused by the shading of lupine plants on the two duneforms in the northwestern part of the site. The pine barrens vegetation of these duneforms became progressively overgrown during this period by aspen, Black Cherry, Red Oak, Black Locust, White Pine, Cottonwood, and other invasive tree species which were present in the late 1970's on the site but were far less predominant components of the vegetation. By the early 1980's, in the absence of fire, these trees had formed a semi-closed canopy over the pine barrens vegetation which was sufficient enough to significantly suppress lupine by shading. In many cases, the above-ground growth of lupine thinned out or died out in response, but the rootstocks remained alive, awaiting release from shade by the next wildfire. Karner Blue Butterflies, which avoid shaded areas in general and do not oviposit on shaded lupine plants, were thus progressively excluded from the fire-suppressed pine barrens vegetation remaining on the

site, particularly the remaining duneforms, and were increasingly restricted to breeding on sunlit lupine patches along the sandy roads and trails on the site, and at the margins of the large, sandy opening in the center and southeastern parts of the site created by the clearing and sand mining operations described earlier.

Q. Why was lupine unable to extensively colonize the sandy, excavated opening created by disturbance on the site?

A. Lupine, despite its tendency to invade sandy openings near pine barrens vegetation (which serves as a seed source because it often contains lupine), was unable to colonize more than the margins of the sandy opening in the middle of the site for several reasons. First, the center of the sandy opening was excavated to form a pond which later revegetated with freshwater wetland plant species; this pond and its wet margins were unsuitable for lupine recolonization. Second, the remainder of the sandy opening around the pond was kept in a state of constant disturbance by frequent off-road vehicle use, which prevented successful lupine recolonization. Lupine stems are very fragile and sensitive to destruction by off-road vehicle use.

Q. Have you visited the project site in 1987 and 1988?

A. I have visited the proposed Landfill Expansion site during the first and second broods of the Karner Blue in 1987 and 1988. The purpose of these visits was to document the occurrence, distribution, and abundance of lupine and the Karner Blue on the site, as well as that of the Buck Moth and other rare Pine Bush species; to examine the

existing vegetation on the site; and to assess the possibilities for full restoration of the pine barrens vegetation on the disturbed or previously cleared, sand mined, and excavated portions of the site.

Q. I show you six documents marked "Exhibit 16", "Exhibit 17", "Exhibit 18", "Exhibit 19", "Exhibit 20", and "Exhibit 21". Do you recognize these documents?

A. Yes. They are field notes made by me during visits to the proposed Landfill Expansion site in 1987 and 1988. Exhibit 16 records a visit to the site made by me on 30 May 1987. On that visit, I observed about 20 Karner Blues, including an ovipositing female, 2 Karner Blue eggs, and 2 full-grown larvae. I also counted about 800 lupine stems on site. Exhibit 17 records my site visit of 19 July 1987. On this visit, I covered the entire site and stayed until dusk. A total of 65 adult Karner Blue butterflies were observed on the site and moving over all parts of the site, feeding on a variety of wildflowers and drinking water from damp soil. Three butterflies were seen dispersing from the site to the rest of the northeast quad. Exhibit 18 records my site visit of 28 May 1988, during which I observed 17 Karner Blue adults, including two females ovipositing on lupine, and larval feeding damage on lupine leaves. I also found two Buck Moth egg masses and one larval cluster on the site. Exhibit 19 records my site visit of 10 July 1988, during which I observed seven adult Karner Blues and two full-grown Buck Moth larvae on the project site. The butterflies were feeding on Knapweed and New Jersey Tea growing on the site. Exhibit 20 records my site visit of 31 July 1988, during which I observed 9 Karner Blues feeding on the site, and

21 on the trail leading into the site from the northeast quad to the west. I also observed one Karner Blue female oviposit on dead grass near lupine, and found six more butterflies resting in grass near lupine at dusk. Exhibit 21 records my site visit of 1 October 1988, during which I set out Buck Moth females on the site and on the adjacent old landfill to the southwest, and lured 13 male Buck Moths from the site and immediate vicinity.

Q. In sum, what do your 1987 and 1988 site visits reveal about the Karner Blue?

A. My 1987 and 1988 site visits clearly show that the Karner Blue is actively using the site as a breeding area, as well as for feeding, resting, and as a dispersal corridor. Approximately 700 to 800 lupine stems have been counted on my recent visits to the site. A maximum of sixty-five (65) individuals of the Karner Blue have been observed on one day at the site. Karner Blue eggs, larvae, and adults have been observed on the site. Karner Blue adults have been observed by me feeding on a wide variety of plant species on the site, including Late Lowbush Blueberry (Vaccinium vacillans), Starry False Solomon-seal (Smilacina stellata), Wild Strawberry (Fragaria virginiana), Common Cinquefoil (Potentilla canadensis), New Jersey Tea (Ceanothus americanus), Butterflyweed (Asclepias tuberosa), Common Milkweed (Asclepias syriaca), Spotted Knapweed (Centaurea maculosa), Wild Black Cherry (Prunus serotina), Rue Anemone (Anemonella thalictroides), Wild Blue Lupine, and others.

Q. What do these same visits reveal about the Buck Moth?

A. The 1987 and 1988 field visits also clearly revealed the presence and current use of the site by the Buck Moth (Hemileuca maia). Buck Moth eggs, larvae, and later in the fall, adults, were found in various locations scattered across the entire site in both years. The presence of Scrub Oak (Quercus ilicifolia) and Dwarf Chestnut Oak (Quercus prinoides) on the existing duneforms and scattered over the remainder of the site (except the pond area) demonstrates that this site forms part of the essential breeding habitat of the Buck Moth at the Pine Bush. As a marginal area (meant in terms of its location near the eastern limits of the core vegetation of the Pine Bush), the proposed Landfill Expansion site is particularly important as one of the last areas in the eastern Pine Bush where female adults of the Buck Moth (and the Karner Blue) dispersing or flying eastward can return to successfully oviposit on their required hostplants in a pine barrens setting where the species' chances of reproductive success is high. This function of the site as a "last pine barrens outpost" is particularly important given the small, fragmented nature of the existing Pine Bush core, and the high probability that flying females, adapted for dispersing the relatively short distances that once existed among pine barrens areas of similar successional stages in the original, 25,000-acre Pine Bush, will accidentally leave the now much smaller, 2,000-acre Pine Bush core and be unable to find their way back to lay their eggs.

Q. Were there unusual weather conditions in 1987 or 1988 which could have affected Karner Blue population levels?

A. During both 1987 and 1988, extreme weather conditions affected the Pine Bush. The spring of 1987 was extremely cool and wet; the spring of 1988 only slightly less so. From the beginning of June to the middle of August 1988, a heat wave and drought affected much of the central North American continent, including the Albany area. These weather events most likely reduced the 1987 and 1988 population levels of the Karner Blue, as they occurred during critical seasonal periods during the life history of the butterfly. The occurrence of the Karner Blue in substantial numbers at the Landfill Expansion site despite the extreme weather events of 1987 and 1988 is a clear indication of the present importance of the site as part of the critical Karner Blue breeding habitat at the Pine Bush.

Q. What is critical habitat?

A. Critical habitat is the combination of physical, chemical, and biological components of the environment, contained within a discreet area, which is essential for the survival and perpetuation of a rare or endangered species or one or more of its populations.

Q. Is the Landfill Expansion site part of the critical habitat of the Karner Blue at the Pine Bush?

A. Yes.

Q. Why?

A. The Landfill Expansion site is part of the critical habitat of the Karner Blue Butterfly at the Pine Bush for the following reasons:

a) It contains significant numbers of both the Karner Blue Butterfly (observed in their various life stages), and of its host, Wild Blue Lupine. In addition, the Karner Blues on the site are functioning as a separate subpopulation of the Pine Bush Main population.

b) The site contains significant remnants of pine barrens vegetation which can be restored through the reintroduction of wildfires.

c) The site is a part of, and directly connected to, the pine barrens vegetation of the northeast quad, one of the most important parts of the Pine Bush Preserve.

In addition, the site is an important part of the essential habitat of the Buck Moth at the Pine Bush. Loss of this site would constitute a reduction in the essential habitat required for the Karner Blue at the Pine Bush core, and also of the Pine Bush Karner Blue population itself. This would represent an unacceptable increase in the risk of extirpation for the Karner Blue.

Q. In light of this, what should be done with the project site?

A. Because it is critical habitat for the Karner Blue, as well as an important component of the remaining Pine Bush core, the site should be added to the Pine Bush Preserve.

Q. What were the major findings of the panel report?

A. The panel of consultants to the City of Albany concluded that 2,000 acres was the minimum preserve size for the Pine Bush and Karner Blue Butterfly. The panel reached this conclusion using a different approach than the one I used (Exhibit 5). The panel used a figure of ten years as the average Pine Bush fire return rate, a figure of one hundred acres for the average wildfire burn size in the Pine Bush, and stated that two replicates of each vegetative successional year-class following fire should be maintained for each of the ten years in the average Pine Bush fire cycle, or 10 X 100 X 2 = 2,000 acres. The panel explicitly cautioned that 2,000 acres is a minimum for an intensively managed Pine Bush preserve, which would presumably be divided into approximately twenty 100-acre burn units, with two units control-burned each year. The panel also concluded that at least five Karner Blue population centers, each connected by corridors of natural vegetation to the others, should be maintained within the 2,000-acre minimum area of the Pine Bush preserve. Finally, the panel concluded that a minimum of 10,000 acres would be necessary for the long-term perpetuation of a pine barrens habitat island like the Pine Bush without human intervention or management.

Q. Has any member of the panel ever reached conclusions in conflict with those of the panel report?

A. In Appendix F of the Final Generic Environmental Impact Statement on Pine Bush development, one of the panel members, Thomas Givnish, suggests that the minimum area required to preserve the Pine Bush and the Karner Blue may be 1,500 acres instead of 2,000 acres. Givnish also ranked the 190-acre Karner Meadows site third, behind the 30-acre Anderson parcel and the 75-acre Pine Valley parcel, in importance for acquisition and preservation, when it is clear that the acquisition of all three parcels, and many more, is essential to the achievement of a contiguous, 2,000-acre Pine Bush core area preserve. Finally, Givnish disparages my call for more research on some of the same issues involving Pine Bush preservation and management that his panel later included in its own Pine Bush research proposal, tied to approval of the landfill expansion by the City of Albany's promise to fund such research from landfill receipts.

Q. Is the 2,000-acre minimum Pine Bush preserve size, as calculated by the panel, accurate?

A. The 2,000-acre minimum area size for the Pine Bush preserve, calculated using wildfire characteristics, is an underestimate. A more accurate figure would be much larger, perhaps 4,000 acres or more. The panel seriously underestimated the burn area of the average Pine Bush wildfire in making its calculation. Originally, the average Pine Bush fire burned a much greater area than one hundred acres; several thousand acres were probably consumed at a minimum, and historic Pine Bush fires recorded during the Seventeenth and Eighteenth Centuries burned from Schenectady to Albany, virtually the entire length of the Pine Bush. At present, wildfires set by careless

adults, children or lightning consume far more than one hundred acres in the Pine Bush regularly. In a Pine Bush preserve of any size, wildfires will remain a reality whether there exists a control-burn management plan or not. These fires will often consume more than one officially-declared burn unit, and may consume more than half of the preserve in some years. With the inevitability of some wildfires in the Pine Bush preserve in mind, a minimum preserve size calculated using average fire characteristics should be substantially larger than 2,000 acres to maintain examples of each year-class of pine barrens vegetative successional stages within the preserve boundaries.

Q. Did the panel properly consider the role of fire in making its minimum area calculations?

A. The panel did not properly consider other important fire characteristics in making a minimum area calculation based upon the need for fire to maintain a full array of successional stages in the Pine Bush preserve. A very important determinant of wildfire-induced plant and animal mortality rates and post-fire vegetative composition and physiognomy is fire temperature and speed. While partially determined by weather conditions, which cannot be controlled, these fire characteristics are also determined largely by the amount of pine barrens vegetation available to burn and the configuration, or layout, of areas containing such vegetation. In many situations, particularly those in the fire-suppressed Pine Bush, which has been extensively invaded by deciduous tree species with rapid growth rates, areas far larger than one hundred acres are necessary to generate fire temperatures high enough to kill the woody invaders and set the pine

barrens vegetation back to an early enough successional stage to support the natural re-establishment of extensive lupine stands. In many instances, this requires fires with temperatures hot enough to kill not only weedy invaders, but also a proportion of the Pitch Pines and Scrub Oaks in the burn area. To accommodate fires which generate the high killing temperatures needed, burn units far larger than one hundred acres each are required. A Pine Bush preserve that can fit twenty such large burn units within its boundaries would have to be far larger than 2,000 acres; in fact, it would approach the 10,000-acre minimum unmanipulated preserve size recommended by the panel.

Q. Have you observed pine barrens wildfires and measured their characteristics?

A. Yes. I have observed pine barrens fires on Long Island, at the Albany Pine Bush, and in other pine barrens regions, and have measured characteristics including fire temperature and speed. I have also collected data on pine barrens vegetation structure before and after fires, and compared such data with fire characteristics.

Q. Is the 10,000-acre minimum area for an unmanaged pine barrens preserve estimated by the panel realistic?

A. The panel's 10,000-acre minimum area recommendation for the perpetuation of a pine barrens habitat island without human intervention or management seems realistic to me, based on my extensive field research experience in over twenty other pine barrens

regions in the United States. Because the Pine Bush core area containing recognizable Pitch Pine/Scrub Oak-dominated vegetation covers a bit less than 2,000 acres, it is clear that an effort should be made to preserve not only all that remains of the pine barrens vegetation within the Pine Bush core area, but as much undeveloped land surrounding the pine barrens vegetation as possible, particularly if such land has soils dominated by Colonie sands which once supported pine barrens vegetation. These contiguous undeveloped areas could then be restored to pine barrens conditions using restoration burns and other techniques, and thus enlarge the core acreage supporting pine barrens vegetation suitable for the Karner Blue, Buck Moth, and other rare Pine Bush species.

Q. When should the three-year research proposal be done?

A. The three-year, intensive research proposal for the Pine Bush, first proposed by me in my 31 March 1988 letter to the City of Albany's consultants, and later echoed in the recommendations of the panel, should be completed before any more decisions are made by SEQR lead agencies or other governmental entities on pending development proposals in the Pine Bush, including the Landfill Expansion proposal. I have stated, and the panel has confirmed, that we need more baseline data and analysis on many issues vital to planning, management, and land-use decisionmaking in the Pine Bush, including the characteristics, behavior, and effects of natural wildfires, the effects of various control-burn and other fire management techniques, present Karner Blue population sizes, numbers, and distribution, present information on the status of the Buck Moth and other rare Pine

Bush species, and verification of the existence and magnitude of other potentially important factors affecting the Karner Blue and the Pine Bush natural community, including soil acidification by acid rain, soil enrichment by airborne nitrates and other compounds, and destruction of lupine by inadvertent human mismanagement and overgrazing by mammals. These important questions must be thoroughly researched and answered before any more Pine Bush lands are given over to non-preserve uses, such as the proposed landfill expansion.

Q. Was it ethical, and within the members' competence, for the panel to endorse the construction of the landfill expansion?

A. The panel's unqualified support and endorsement of the landfill expansion project (panel report, p. 70) is biased and lies far outside the areas of expertise of the panel members. None of the panel members have any expertise in the siting, design, and construction of landfills, and none of them have any expertise in the analysis of most of the potential non-ecological environmental impacts of landfills. In its endorsement, the panel cited the benefits of a permanent funding source for Pine Bush research which was proposed by the City of Albany to be created using all or part of the tipping fees from the proposed Landfill Expansion project. In addition, the city stated in its DEIS that money from the Crossgates fund may also be used to support the proposed Pine Bush research. As paid consultants to the City of Albany, the panel members have created a clear conflict of interest, and at least the appearance of ethical impropriety, in arguing for the creation of a funding source from which they may be the prime, if not the only, beneficiaries. One might conclude that

the only purpose of such a self-serving endorsement in a document purporting to be a scientific report is to "drum up new business".

Q. Which is more important, land acquisition or management in the Pine Bush?

A. Both are equally important, but fire management and other forms of Pine Bush restoration and management are useless if the minimum acreage required to form the Pine Bush core preserve is not in public hands first. Effective fire management cannot be accomplished on a hodge-podge of private and public lands. Acquisition of all the parcels needed to form a minimum 2,000-acre Pine Bush core preserve must therefore come first. This concept follows by logic from the decisions of the Supreme Court and Appellate Division ordering the City of Albany to answer the minimum area question. Implicit in these decisions is a mandate to the City -- not merely to conduct an academic exercise to answer the minimum area question, but to then do something about it -- to act to preserve the Pine Bush by acquiring the remaining pine barrens lands not in the preserve and as much buffer lands around the core area as possible. I am sure the courts did not envision that the City would try to answer the minimum area question and then shortchange acquisition by attempting to fund more studies and a management plan, through a scheme tantamount to bribery designed to gain approval of a project which will unnecessarily destroy essential Pine Bush habitat. It follows clearly from the court decisions that the minimum amount of acreage found necessary for the survival of the Karner Blue and the Pine Bush as an ecosystem MUST be acquired immediately.

Q. Are there better funding mechanisms for Pine Bush acquisition, research, and management than using landfill receipts?

A. There are many other Pine Bush land acquisition funding mechanisms which are much better than destroying part of the Pine Bush with a landfill project and using the proceeds from such a tainted enterprise to buy or manage Pine Bush land elsewhere. There is the City's Crossgates Fund, for instance, which was promised to be used to purchase land in the Pine Bush to add to the preserve. Almost ten years have passed and this money has not been spent by the City; it has lost most of its value from inflation and the rapid escalation of land prices in the Pine Bush. There is the 1986 Environmental Quality Bond Act fund, some of which has recently been used to acquire the Karner Meadows tract in the Pine Bush. There is the recently-formed Pine Bush Commission, which could press for state funds to complete the acquisition job, or for the power to issue bonds to acquire land. There is the City itself, which could also issue bonds or devote a percentage of its tax revenues to complete the acquisition of Pine Bush lands, as Suffolk County is doing to preserve the Long Island Pine Barrens. There is the Nature Conservancy, already a key player in the acquisition and preservation of Pine Bush land, which has worked closely with government at all levels. There is no reason why the panel should be arguing in favor of the landfill expansion; it is the least desirable funding source of all the many sources available, and will also not provide enough cash flow through tipping fees to finance the remaining land acquisitions needed.

Q. Do the City's mitigation proposals meet the 2,000-acre minimum preserve size suggested by the City's consultants?

A. The mitigation proposals do not meet the 2,000-acre minimum preserve area requirement set by the City's own consultants in the panel report. There are no specific proposals in the City's mitigation offer in the DEIS to acquire any of the identified tracts of privately-owned Pine Bush core area lands needed to assemble and complete a 2,000-acre core area preserve. The City's own figures show that only about 1,000 acres of Pitch Pine/Scrub Oak-dominated Pine Bush vegetation has been acquired and preserved in the Pine Bush; in reality, only about 800 acres of this contains more or less contiguous prime pine barrens vegetation at the Pine Bush core. Added to the pine barrens lands on the recently-purchased Karner Meadows site, only about 1,000 acres out of about 2,000 acres of existing pine barrens vegetation at the Pine Bush core have been acquired. The City's mitigation proposals must include detailed timetables for acquisition of each privately-owned parcel comprising the remaining 1,000 acres of pine barrens at the Pine Bush core, identifying each parcel to be acquired, cost, funding source to be used in acquisition, and when each parcel will be acquired. All acquisitions of remaining Pine Bush core area lands should be completed before any decisions are made to permit or deny any individual projects within the Pine Bush, including the Landfill Expansion proposal.

Q. Is preserve configuration also important?

A. Yes, just as important as preserve size. The configuration of a completed Pine Bush core area preserve is vital to the perpetuation of the Pine Bush ecosystem and its rare species like the Karner Blue Butterfly. The City mitigation proposal does nothing to close the gaps between and among the existing, unconnected or poorly connected segments of the Pine Bush preserve. Lands situated between and among the existing parts of the preserve must be acquired to create a single, contiguous preserve which can be successfully fire-managed without endangering neighboring developed areas. These parcels, whether they contain pine barrens vegetation or not, can and will be restored to pine barrens through the reintroduction of fire. They are vital to successful movements and natural recolonization of suitable habitats by the Karner Blue, Buck Moth, and many other rare Pine Bush species which are dependent upon particular successional stages of the post-fire pine barrens vegetation. It is particularly important that all Pine Bush lands which do not now contain pine barrens vegetation (and therefore were not included in the Natural Heritage Program's primary and secondary Pine Bush take lines), but which are located within or adjacent to pine barrens vegetation at the Pine Bush core be acquired. The lands within the primary preserve boundary line total only about 1,500 acres; only about 250 acres of secondary preserve was delineated. Additional, non-pine barrens, Pine Bush lands adjacent to the primary and secondary preserve boundaries must be acquired to create a contiguous core area preserve of over 2,000 acres. These contiguous Pine Bush lands can then be restored through cutting and restoration burns to their original pine barrens vegetation capable of supporting the Karner Blue, Buck Moth, and other rare species.

Q. Which parcels should the City acquire to form a truly contiguous, 2,000-acre Pine Bush core area preserve?

A. At the very least, the City should propose the acquisition of the following vital Pine Bush core area parcels to fulfill its mandate:

a) The remainder of the lands within the southeast quad, including lands now or formerly part of the BPS holdings located north, east, and west of the recently-acquired Karner Meadows site (approximately 200 acres);

b) The entirety of the Woodlands parcel in the northwestern corner of the southeast quad (80 acres);

c) The Pine Valley parcel in the southwest quad, which includes much valuable upland and wetland pine barrens vegetation (75 acres);

d) The Swyer parcel, fronting on Karner Road, needed as part of the connective link between the northern and southern sections of the Pine Bush (10 acres);

e) Those portions of the Karner Industrial Park in the western part of the southeast quad which are undeveloped, and contain transitional vegetation between the Kaikout Ravine and the pine barrens uplands (20 to 40 acres);

f) The remainder of the privately-owned lands in the City portion of the southwest quad (about 150 to 200 acres);

g) The pine barrens parcel located on either side of the power line right of way northeast of the Penn Central railroad tracks, opposite and northeast of Whitestone Trailer Park (about 50 acres);

h) Any naturally-vegetated Pine Bush core area parcel, whether covered with pine barrens vegetation or not, located between, among, or adjacent to the parcels recommended by me for acquisition, or to any existing preserved Pine Bush core area parcel.

In addition, the City and other governmental agencies with jurisdiction over the Pine Bush should begin to plan now to acquire developed properties within the Pine Bush core region when the developments or buildings reach the ends of their useful lives. The structures could then be removed, and the properties added to the Pine Bush preserve and restored to pine barrens conditions using fire management and other techniques. This would greatly facilitate the effectiveness and safety of fire management within the Pine Bush preserve by consolidating the core area preserve into one massive, compact shape unbroken by development. It could also increase the core area preserve to over 3,000 acres. Parcels which should be targeted for "undevelopment", acquisition, and restoration include the Point of Woods/Pinehurst complex northwest of Route 155, the Dunes subdivision southeast of Route 155 and southwest of Washington Avenue Extension, the warehouse complex northwest of Route 155 and northeast of Old State Road, and the commercial, industrial, and other parcels on both sides of Washington Avenue Extension.

Q. Can these acquisitions be considered mitigation for the landfill expansion project?

A. These acquisitions can not be considered mitigation for the landfill proposal because they are required by the Pine Bush court decisions mandating the determination of a minimum area for the Pine Bush preserve, and by the panel report produced by the City's own consultants, which recommended that a minimum of 2,000 acres be acquired to form the Pine Bush preserve. In other words, these acquisitions will have to be made anyway, whether there is a City Landfill Expansion proposal or not.

Q. What is your evaluation of lupine propagation on the landfill as mitigation?

A. The DEIS proposes the placement of lupine plants either within the existing pine barrens habitat on the Landfill Expansion site or on top of the old and new landfills after capping and covering with three feet of sand. Both proposals are ludicrous and doomed to fail. The landfill planting scheme does not even merit serious consideration as "mitigation". Lupine cannot grow unless some very strict and exacting soil and other requirements are met, some of which we do not fully understand. For example, lupine requires the presence of certain microbial soil fungi in the form of mycorrhizae, which interact with its roots and help it gather nutrients and moisture from the arid sands. If these fungi are not present in the soil, lupine will be severely hampered in its ability to grow or survive. Enough is certainly known now, however, to predict the ultimate failure of any

attempt to sow or plant lupine on only three feet of sand, probably from a non-Pine Bush source (obtaining it from the Pine Bush would destroy existing pine barrens vegetation) atop a landfill. The roots of mature lupine plants can extend downward over ten feet beneath the soil surface. Other Pine Bush species, such as Pitch Pine and Scrub Oak, require deeper deposits of sand. Covering the old landfill with clay and three feet of sand cannot be considered adequate soil restoration by any stretch of the imagination. Three feet of loose sand will rapidly erode in many places, re-exposing the heavy clay cap and the landfill sediments, which are very moisture-retentive, rich in fine particles (silts and clays), and nutrient-loaded from the decomposing garbage. The landfill will exist into the indefinite future as a strange mound set in the undulating dune topography of the sand plain, covered at first by aggressive, nutrient-loving, methane-tolerant plant species such as aspens, Black Locust, Black Cherry, blackberries, coarse Eurasian grasses, Wormwood, Ailanthus, and other weeds. The plant community will slowly change and mature over several hundred years if left alone, as the landfill molders down and releases its enormous stockpile of nutrients. The climax community on the landfill will almost surely be a closed-canopied, mixed deciduous forest dominated by the regionally common tree species: oaks, maples, hickories, Beech, birches, willows, and other non-pine barrens species, because the underlying soil and sediments have been forever altered and the dune topography forever removed. Any use of the landfills, old or new, in mitigation for the destruction of any existing Pine Bush or Karner Blue habitat, is a ridiculous idea not worth any serious consideration.

Q. What is your evaluation of lupine plantings in the Pine Bush as mitigation?

A. The same is true for lupine plantings within the Pine Bush. As any ecologist knows, introductions of individual plants and animals into a stressed ecological community in an attempt to bolster faltering species populations are generally failures. The reason is that the introductions do not fill any excess carrying capacity of the environment for more lupines, Karner Blues, or whatever species is being bolstered. Plantings or introductions fail because they do not address the underlying reasons why the species are declining or missing from certain areas in the first place. In the case of lupine and the Karner Blue, habitat losses, ecological island extirpations, fire suppression, habitat fragmentation, edge effects, and direct disturbance by off-road vehicles and past bulldozing are major causes of decline both on the landfill site and throughout the Pine Bush. These factors must be arrested and reversed before lupine or the Karner Blue can increase in numbers. Lupine plantings, therefore, are not mitigation for habitat losses, even if the habitat lost is less than pristine.

Q. Has the City, then, offered any real mitigation for its proposed destruction of Pine Bush habitat at the project site?

A. The City has offered no real mitigation for the destruction of essential Karner Blue, Buck Moth, and pine barrens habitat at the Landfill Expansion site, or for the permanent loss of this site as present or future Pine Bush preserve land. The present contribution

of the site to the remaining pine barrens habitats at the Pine Bush is real and significant; and the reintroduction of fire could restore the site to its full potential as prime habitat for the Karner Blue, Buck Moth, and the pine barrens community of the Pine Bush. None of the mitigation proposals of the City is in fact real mitigation for the losses of pine barrens habitat engendered by the Landfill Expansion project. Land acquisition to complete the Pine Bush preserve, more research, development and testing of fire management and other management techniques, and the activities of the Pine Barrens Commission are all actions which have occurred and will occur irregardless of the Landfill Expansion proposal. Some of these actions are court-mandated; others have been mandated by the New York State Legislature in forming the Pine Bush Commission. None can be considered mitigation in any respect for the damage done to the Pine Bush by the proposed Landfill Expansion project. Neither can the various proposals for attempting to establish lupine or pine barrens vegetation atop the landfills, nor the offers to plant lupine on the site or elsewhere in the Pine Bush, be considered mitigation because they will not work. The City is left without any mitigation for the harm caused by this project.

Q. What would constitute effective mitigation?

A. Genuine mitigation for the Landfill Expansion project would involve the acquisition, preservation, and restoration of additional Pine Bush acreage above and beyond the preservation of the entire Pine Bush core area, which must now be done regardless of the existence of the Landfill Expansion project. For example, if the City identified

one hundred or more acres of Pine Bush fragments marginal but contiguous to the core area which had been fire-suppressed or damaged, but which could be rehabilitated by acquisition, reintroduction of fire, and restoration of native Pine Bush species, this could constitute partial mitigation for the losses of Pine Bush habitat. There is no possible mitigation for the losses of Karner Blue breeding habitat on the Landfill Expansion site, however, because the Karner Blue populations throughout the Pine Bush and the Hudson Valley Sand Belt are at such critically low levels that every scrap of existing and potential habitat is needed for the survival of the butterfly. The same is true for the Buck Moth, which has critically low population levels at the Pine Bush and the Glens Falls Sand Plain, and is in imminent danger of extirpation there.

EXHIBIT 1

Affidavit of John F. Cryan, dated
3 March 1985, with attachments

EXHIBIT 1

JOHN F. CRYAN
413 WEST 47TH STREET
NEW YORK, NEW YORK 10036
(212) 246-5893

EXPERIENCE

Associate Environmental Analyst, New York State Dept. of Environmental Conservation, Region 2 Office (New York City), Fish & Wildlife Unit, June 1987 to Present: Coordination of a Freshwater Wetlands Management Study for Staten Island; Preparation of a Draft Generic Environmental Impact Statement on the conservation and development of Staten Island wetlands; Legal defense of wetland designations before the Freshwater Wetlands Appeals Board and the courts, including preparation of affidavits and expert testimony.

Associate Regional Permit Administrator, NYSDEC, Region 2 Office, Regulatory Affairs Unit, April 1986 to June 1987: Coordinated Review of permit applications for freshwater wetland, tidal wetland, water quality protection, solid waste, and other permits; data gathering and preparation of tentative freshwater wetland maps and classifications for Staten Island; supervision of environmental analysts in one of two sections in the unit reviewing natural resources permit applications.

Senior Environmental Analyst, NYSDEC, Region 2 Office, Regulatory Affairs Unit, August 1985 to April 1986: Natural resources compliance and enforcement, including investigations, expert testimony and affidavits, and negotiations of settlements, for violations of tidal and freshwater wetlands laws; coordinated review of natural resources permit applications.

Environmental Analyst, NYSDEC, Region 2 Office, Regulatory Affairs Unit, December 1983 to August 1985: Natural resources compliance and enforcement program; field inspections of permit application sites; expert witness testimony.

Environmental Analysis Assistant, NYSDEC, Region 2 Office, Regulatory Affairs Unit, September 1982 to December 1983: Natural resources compliance and enforcement program.

Consultant to Endangered Species Unit, NYSDEC, Albany, 1978 through 1984: Studies of endangered species, including the Karner Blue Butterfly, Buck Moth, and Tiger Salamander.

Curator of the Nature Center and Museum, Hoyt Farm Park Preserve, Commack, NY, 1980 to present: Making and curating biological collections; museum exhibit design and construction; planning and conducting education programs; publications and illustrations; grant requests; conservation programs.

Associate Curator, Earth & Space Sciences Museum, SUNY at Stony Brook, NY, 1978 through 1979: Similar duties to above; position supported by a short-term Federal grant.

Assistant Ranger-Naturalist, Smithtown Parks Dept., Smithtown, NY, 1973-1977, summers and midwinters: Park conservation and education programs; natural resource management and park maintenance; nature center exhibit design and construction.

EDUCATION

Cornell University, Ithaca, NY: Bachelor of Science, 1978
Major: Entomology Minor: Botany
Areas of Concentration: biology, ecology, insect biology, morphology, and taxonomy, plant population and community ecology

HONORS & AWARDS

National Merit Scholarship (Michigan State Univ.-declined)
New York State Regents Scholarship
Waldemar Medical Science Foundation Scholarship for Summer Science Study

COLLEGE ACTIVITIES

Graphic Editor of TIEG (Teen International Entomology Group), a quarterly magazine with main offices at Cornell
Co-founder of the Karner Blue Project, a Cornell group studying rare pine barrens organisms, 1974
Jordani (Cornell Natural History Society)
Jugatae (Cornell Entomology Club)

SOCIETIES AND ORGANIZATIONS

Associate Editor of Atala, Journal of the Xerces Society, an international insect conservation society, 1976-1977
Member, Board of Directors, Xerces Society, 1975-1978
Member, Scientific Advisory Board of Skenectada, Journal of the American Pine Barrens Society, a pine barrens research and conservation society, 1979-present
Member, Town of Smithtown Conservation Advisory Council (Appointed by town board), 1979-1984
Member, Long Island Pine Barrens Task Force (Appointed by the Commissioner of NYSDEC), 1978-present
Co-founder and Vice-President of the Long Island Pine Barrens Society, and Editor of the Society's journal, The Heath Hen, 1980-present
Member, The Lepidopterists Society
Member, Northeastern Field Naturalists' Society
Member, Torrey Botanical Club

PARTIAL LIST OF PUBLICATIONS

Cryan, John F. 1973. Protective coloration used for defense by a Polyphemus Moth, Telea polyphemus Cramer, in flight. Engelhardtia 6(1): 14.

Dirig, Robert, and John F. Cryan. 1975. Endangered Pine Bush Lepidoptera: The fragile ecology of the Karner Blue and Buck Moth. Revised edition. Ithaca, NY. 16 p.

Cryan, John F., and Robert Dirig. 1975. In pursuit of the Buck Moth. TIEG Magazine 9: 17-20, 40, covers.

Dirig, Robert, and John F. Cryan. 1977. The Karner Blue Project: January 1973 to December 1976. Atala 4: 22-26.

Cryan, John F., and Robert Dirig. 1977. The Moths of Autumn. Pine Bush Historic Preservation Project, Occ. Publication No. 1. 16 p.

Cryan, John F., and Robert Dirig. 1978. A report on the status of the Karner Blue Butterfly (Lycaeides melissa samuelis Nabokov) in New York State. Research report, Endangered Species Unit, NYSDEC. 18 p.

Olsvig, Linda S., John F. Cryan, and Robert H. Whittaker. 1979. Vegetational gradients of the Pine Plains and Barrens of Long Island, New York, p. 265-282. Chapter 15 in Forman, R. T. T., ed., Pine Barrens: Ecosystem and Landscape. Academic Press, NY. 601 p.

Rittner, Don, and John F. Cryan. 1979. Skenectada -- A pine barrens journal. Skenectada 1: 1-2.

Cryan, John F. 1980. The Karner Blue Butterfly (Lycaeides melissa samuelis Nabokov) in the Hudson Valley Sand Belt of New York State. Part II. An annotated list of Hudson Valley Sand Belt populations and their status. Research report, Endangered Species Unit, NYSDEC. 31 p.

Cryan, John F. 1980. An introduction to the Long Island Pine Barrens. The Heath Hen 1(1): 3-15.

Cryan, John F. and John L. Turner. 1981. A landscape imperiled: The Long Island Oak Brush Plains. The Heath Hen 1(2-3): 3-34.

Cryan, John F. 1982. The Long Island Dwarf Pine Plains: Pygmy forests of the Pine Barrens. The Heath Hen 1(4): 3-33.

Cryan, John F. 1985. Retreat in the Barrens. Defenders 60(1): 18-29, cover.

Cryan, John F., and John L. Turner. 1985. The Peconic: Pine Barrens river. The Heath Hen 2(1): 1-21.

F.C. Copy
EXHIBIT 2

STATE OF NEW YORK)
: SS.:
COUNTY OF SUFFOLK)

JOHN F. CRYAN, being duly sworn, deposes and says:

1. I hold a Bachelor of Science degree from Cornell University with majors in entomology and botany. Since 1973, I have engaged in numerous scientific studies of the plants and animals of the Albany Pine Bush and many other Pine Barrens areas. These studies have covered topics in zoology, botany, entomology, ecology, conservation, vegetation science, endangered species, and many other fields. A copy of my resume, which includes a partial list of publications, is attached to this affidavit as Attachment 1. I have been intimately involved in planning studies on the Pine Bush and have supplied information and comments for such studies on Pine Bush plants and animals, ecology, fire, and endangered species. I have also testified at or participated in over twenty hearings since 1973 involving projects or developments proposed in the Pine Bush.

2. Upon information and belief, I am aware of the following projects proposed in the Pine Bush which have either been approved by the City of Albany or which are under consideration by the City:

(A) The "Madison Avenue Office Park", located NE of Madison Avenue, SW of the NYS Thruway, NW of New Karner Road, and SE of the joint State of New York/Town of Guilderland/City of Albany Pine Bush Preserve (recently approved).

(B) A smaller office development located between the "Madison Avenue Office Park" and New Karner Road (recently approved).

(C) The "Karner Meadows" development, located SW of Washington Avenue, SE of New Karner Road, NW of Rapp Road, and NE of Friar Tuck Road, North Gate Drive, and Velina Drive (under consideration).

(D) The "Old Anderson Office Park", located NE of Washington Avenue, SE of New Karner Road, SW of the NYS Thruway, and NW of existing light industrial buildings and offices (recently approved).

(E) Property located NE of Washington Avenue, SW of the NYS Thruway, in the vicinity of the existing Italian-American and Polish-American Community Centers, proposed for rezoning by the Boy Scouts of America (under consideration).

(F) A project proposed on twelve (12) acres located SW of Washington Avenue and NE of the existing "Dunes" development.

3. In addition, upon information and belief, I am aware of a proposal by Alice H. W. Williamson and the Apollo Drive Bank to mine sand and gravel on approximately 43 acres located NE of old State Road about ½ mile NW of New Karner Road, in the Town of Guilderland, abutting the City of Albany line. This proposal is under consideration.

4. The Pine Bush is recognized worldwide as a unique pine barrens ecosystem. It is the only pine barrens developed on sand dunes. It contains over 300 species of vertebrate animals, over 1,500 species of vascular plants, and over 10,000 species of insects and other invertebrate animals, many of them rare and restricted to pine barrens areas. Hundreds of plants and animals were first described and made known to science from the Pine Bush.

5. The geology of the Pine Bush is likewise unique. It is the only region in the Northeast containing giant, inland sand dunes. The Pine Bush played an extremely important historical role in the development of Albany and Schenectady, the westward expansion of the country, and the early development of industry.

6. The biological, geological, and historical importance of the Pine Bush has been discussed and summarized in hundreds of scholarly papers and in one book, Pine Bush -- Albany's Last Frontier, edited by Don Rittner. State and local government agencies, recognizing the enormous cultural and natural values of the Pine Bush, have worked over the last ten years to acquire and protect about one thousand (1,000) of the remaining four thousand (4,000) acres of natural pine barrens vegetation left in the Pine Bush, which once covered over 25,000 acres.

7. The "core area" of the Pine Bush, where the only large, contiguous, and natural pine barrens vegetation is located, is bounded by Routes 5, 20, 146, and Fuller Road. All of the projects listed in paragraphs no. 2 and 3 supra are located in the heart of the core area.

8. The projects listed in paragraphs no. 2 and 3 supra, as well as any other projects proposed within the Pine Bush core area, will, if approved and constructed, have severe and deleterious cumulative effects on the Pine Bush as a whole, beyond the boundaries of individual project sites. These harmful environmental impacts are cumulative because they increase in magnitude and severity as the number of individual projects constructed increases.

9. A major cumulative impact is the island effect. The remaining natural pine barrens land in the Pine Bush core area can be considered a "habitat island" because it is very different in its species composition and underlying geology from the surrounding land, which is either developed or supports deciduous forests on rocky soils instead of pine barrens on sandy soils. The Pine Bush thus behaves ecologically like real, oceanic islands, which were studied by MacArthur and Wilson and used to arrive at their widely-accepted Theory of Island Biogeography. Attachment 2 is a brief synopsis of the major findings of this theory. Basically, the theory states that the farther an island is from the mainland and the smaller it is, the fewer species it can hold, and the rarer, more specialized species usually go extinct first if an island is reduced in size. The theory is directly applicable to the Pine Bush core area which is a "habitat island" that will shrink in size each time a development proposal like those listed supra is approved and built. Thus, species which live anywhere in the Pine Bush can be jeopardized if just a part of the Pine Bush is cleared and developed. The rarer species, such as the Karner Blue Butterfly, Buck Moth, Hognose Snake, Birdsfoot Violet, or Eastern Bluebird, are much more likely than the commoner species to disappear from the Pine Bush as its overall size is reduced by projects like the ones listed supra. Of course, some of these projects will destroy rare species habitat directly, but the net size reduction in the Pine Bush will be felt by all individuals and species, not just those on the project sites. Even species found in the preserved Pine Bush acreage will not be immune to extinction caused by island effects because in many cases, the preserve acreage is not great

enough to support species populations by itself. Many species, especially the rarer and more endangered ones, need more than the 1,000 Pine Bush acres currently preserved to insure their long-term survival and resistance to island effects.

10. A related cumulative impact caused by the projects listed supra will be the degrading of an ideal preserve shape for the Pine Bush. Attachment 3 is an application of the Theory of Island Biogeography to the design of nature preserves. Nature preserves, like the ones already existing in the Pine Bush, act as "habitat islands" because eventually they are finalized and become surrounded by developed or less natural land. Studies of actual preserves, coupled with island biogeography theory, have shown that one large, contiguous preserve is much better than many smaller, scattered ones for maintaining high species numbers and preserving unusual vegetation. Such studies have also shown that compact or massive preserves are much better than elongated or long, thin, or irregularly-shaped preserves because they can hold a greater diversity of habitats within their boundaries and are less subject to edge effects because they have greater surface area to edge ratios. Attachment 4 shows the existing Pine Bush preserves in the core area. As one can readily observe, these preserves do not even come close to being ideal for the protection of the Pine Bush because they are small, scattered, and form an elongated, fingerlike pattern. Each completed project like those listed supra insures that this unacceptable preserve pattern becomes finalized; i. e., that the preserves stay small, scattered, and elongated, instead of being assembled into one massive, compact-shaped central preserve. Pine Bush species extinctions and the

degeneration of the characteristic and unique open, sunlit pine barrens vegetation structure of the Pine Bush will result if the preserves stay separate, unconnected, elongated, and small.

11. Another related cumulative impact is the permanent destruction of connective corridors between existing preserves. As explained supra, these corridors are vital for the survival of Pine Bush plant and animal populations, particularly rare and endangered species, which need more land to support populations than one of the existing preserves can provide. Any development project which breaks the natural links between preserves, makes preserves more irregular or elongated in shape, or reduces the amount of natural land in a "habitat island" like the Pine Bush reduces the equilibrium number of species that can be held by the Pine Bush. All of the projects listed will have one or more of these three effects, and all will reduce the species equilibrium number of the Pine Bush through island effects. The "Madison Avenue Office Park" will have a particularly catastrophic effect because it will break the corridor of Pine Bush vegetation that now connects the City of Albany preserves to the joint state/ town/city preserve to the west.

12. Island effects and related cumulative impacts become more important when the distance from colonizing sources of the Pine Bush "habitat island" is considered. The nearest pine barrens to the Pine Bush are those of Long Island, over 150 miles away. Because of development and destruction of pine barrens in nearby Saratoga and Warren Counties, and the great distances to other major pine barrens regions, once a species is lost from the Pine Bush, especially if it is a rare pine barrens species, there

is almost no chance that it will ever be able to recolonize the Pine Bush from the nearest sources, especially since those sources, other pine barrens regions, are themselves being rapidly reduced by development and are suffering from the same island effects as the Pine Bush.

13. The creation of additional edge effects in the Pine Bush is another cumulative impact of each of the projects listed supra. Each project destroys natural Pine Bush vegetation and creates a long "edge line" between the development and its artificial landscapes and the remaining natural Pine Bush. This edge is a tension zone where weedy, aggressive, or introduced plant and animal species can readily invade and outcompete the delicate pine barrens community. Increased edges also promote increased human access to previously undisturbed natural Pine Bush land, resulting in destruction of vegetation, further weedy incursions by alien species, and losses of pine barrens species. Karner Blue Butterfly and Buck Moth populations in the Pine Bush have suffered from this process. Many Pine Bush areas show the devastation of edge effects -- where once Pitch Pine and Scrub Oak were dominant, now the pine barrens are choked by clumps of Black Locust and Aspen which invaded from newly-formed edges near developments.

14. One of the greatest cumulative impacts of the listed projects is the elimination, reduction, or alteration of natural wildfires. Unlike most northeastern ecosystems, the Pine Bush is totally dependent on frequent, natural fires for its survival. An average Pine Bush acre must burn once every ten to fifteen

years to kill the growth of invading trees and shrubs that would, if left unburned, shade out the low, sun-loving pine barrens plants and their dependent animals, turning the Pine Bush into a dense, gloomy northern hardwood forest indistinguishable from those surrounding the pine barrens. At present, natural wildfires still burn the large, contiguous natural tracts within the core area at approximately the required 10 to 15-year intervals because these areas are relatively inaccessible to fire departments, whose official policies are still to extinguish every Pine Bush fire. Each new development approved in the core area increases road access to the area, making wildfires easier to put out. Each also breaks the pine barrens into smaller parcels, decreasing the acreage burned per fire and reducing fire temperatures (high temperatures are required to kill invading plants, and several hundred acres at a minimum are needed to reach these fire temperatures). Each also increases the amount of human life and property situated in the pine barrens which must be protected from fire. Obviously, as more and more developments are allowed in the core area, there will come a time when no fires will be allowed and the fire departments will have the capability of completely suppressing wildfires in the small, scattered Pine Bush preserves. At that point, the Pine Bush and all of its rare and endangered life will be lost as the preserves turn into dense forests.

15. A little-known cumulative impact of the listed projects is <u>light pollution</u>. All projects require street and building lights, and these lights are often mercury vapor lamps or other sources of ultraviolet radiation. This radiation attracts night-

flying insects by the millions, especially moths, beetles, flies, mayflies, caddisflies, and other aquatic insects. In the Pine Bush, most of the species attracted are very rare and restricted to pine barrens; they do not occur in the surrounding countryside. Insects lured to lights do not reproduce because they are mesmerized by the lights and stay near them. As the Pine Bush night is turned to day by each additional development, hundreds, perhaps thousands, of populations of rare nocturnal insect species will be lost from light pollution. Besides the direct species losses, the effects of night lighting will be felt throughout the Pine Bush ecosystem, for these insects are at the base of a food pyramid upon which the larger mammals, birds, and other animals depend for survival. As night lighting spreads throughout the Pine Bush, larger species will disappear along with the nocturnal insects. This process has already begun -- the Imperial Moth, Pine Winter Moth, Precious Underwing Moth, and hundreds of other moth species recorded in the early 1900's are gone, and the insect-eating Whippoorwill is disappearing rapidly from the Pine Bush.

16. The tremendous physical, chemical, and biological changes resulting from the replacement of natural Pine Bush ecosystems with pavement, buildings, cars, lawns, and alien plant species is a vast cumulative impact which, by its insidious alterations of the natural forces driving the pine barrens, will change the character of these ecosystems with the ultimate loss of most of their specialized and unusual species. Attachment 5 is a discussion of how these cultural changes have endangered one pine barrens species, the Buck Moth, in the Pine Bush and elsewhere.

17. In conclusion, the proposed projects listed in paragraph no. 2 supra will have cumulative impacts upon the Albany Pine Bush, and these impacts could cause the loss of the unique pine barrens vegetation and rare and unusual plant and animal species which characterize the Pine Bush as a distinct natural region within New York State and the Northeast. The cumulative impacts discussed above, including disruption of wildfires, ecological island effects, elimination of connecting natural area links and corridors, edge effects, reduction of natural area size, introduction of alien or weedy species, light pollution, alteration of the physical environment by paving, building construction, introduction of chemicals and increased traffic, greater human presence and access, and other factors will be felt far beyond the boundaries of the individual projects themselves and will affect the entire Pine Bush. These cumulative impacts, and their multiplied effects from many individual projects, must be considered in the environmental review process before decisions are made about any individual project in the Pine Bush.

John F. Cryan

JOHN F. CRYAN

Sworn to before me this
3rd day of March, 1985

JEROME J. PINTO
Notary Public, State of New York
No. 52-3107950
Qualified in Suffolk County
Commission Expires March 30, 1985

EXHIBIT 2

Decision of State Supreme Court
Justice Edward S. Conway, dated
17 May 1985, in the matter of
Save the Pine Bush, Inc., et al,
vs. the City of Albany, et al

EXHIBIT 3

Letter of John F. Cryan to the City of Albany Planning Board, dated 21 March 1986

EXHIBIT 4

Distribution map of the Karner Blue Butterfly in the Albany Pine Bush, compiled from field data collected from 1981 to 1986 by John F. Cryan

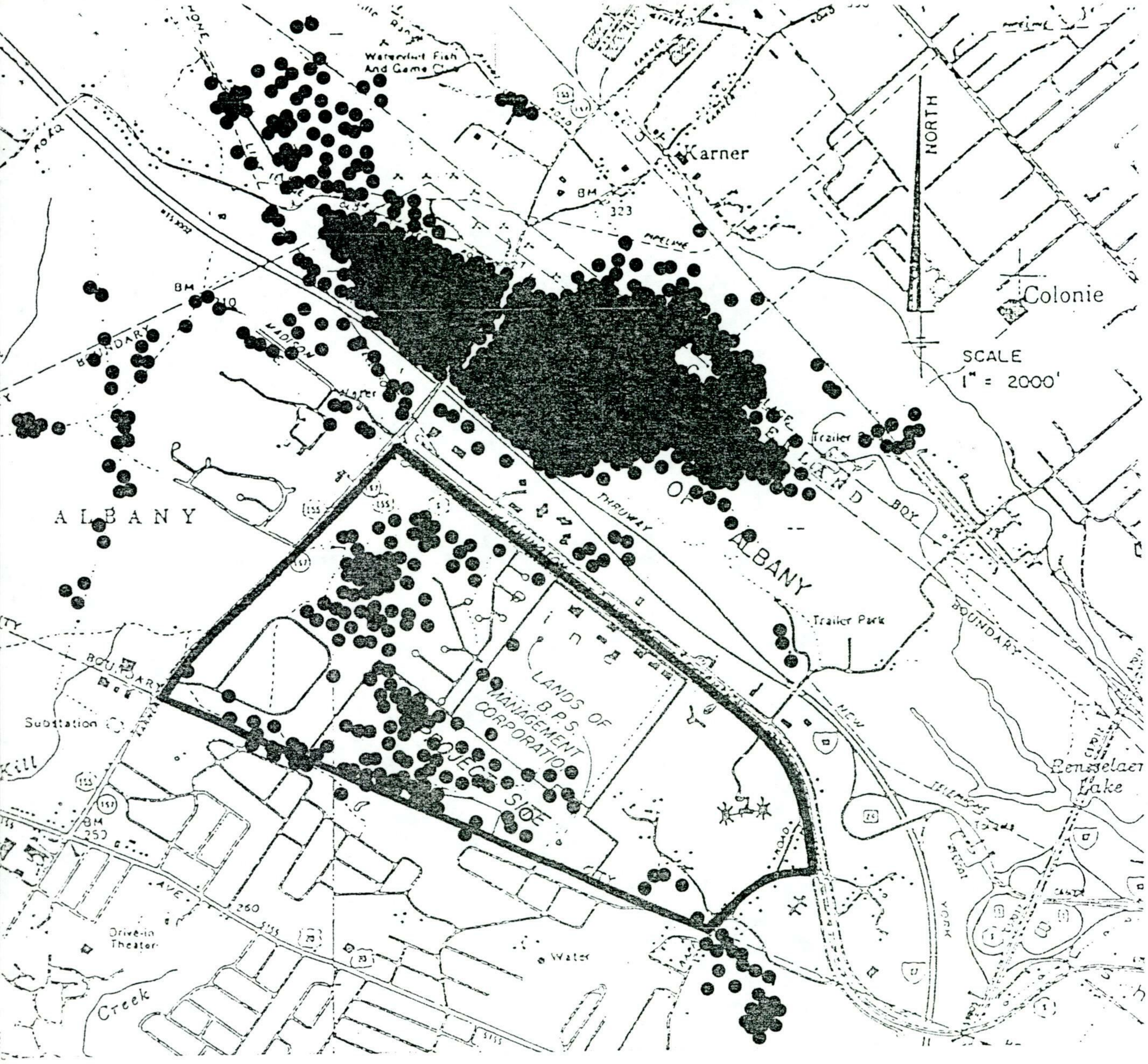


EXHIBIT 4: Distribution of the Karner Blue Butterfly in the Albany Pine Bush. Compiled from field data collected from 1981 to 1986 by John F. Cryan. Each dot represents one sighting; some dots represent many individuals. The southeast quadrant of the Pine Bush is heavily outlined.

EXHIBIT 5

Distribution Map of the Buck Moth in the Albany Pine Bush, compiled from field data collected from 1981 to 1986 by John F. Cryan



EXHIBIT 5: Distribution of the Buck Moth in the Albany Pine Bush. Compiled from field data collected from 1981 to 1986 by John F. Cryan. Each dot represents one sighting; some dots represent many individuals. The southeast quadrant of the Pine Bush is heavily outlined. Note: Because Buck Moths are powerful fliers, some recorded sightings were over unsuitable breeding habitat. However, collections of dots indicate prime breeding habitat in Pich Pine/Scrub Oak pine barrens.

EXHIBIT 6

STATE OF NEW YORK
SUPREME COURT

COUNTY OF ALBANY

In the Matter of the Application of

SAVE THE PINE BUSH, INC.; REZSIN ADAMS, President; JOHN WOLCOTT, GREGORY BELL, MARK PLAAT, LYNNE JACKSON and GENE DAMM, as Officers and Individuals and Taxpayers,

Plaintiff-Petitioners,

-against-

THE PLANNING BOARD and THE CITY OF ALBANY,

Defendant-Respondents.

RECEIVED
N.Y.S.D.E.C. REGION 2
DEC 22 1986
REGULATORY AFFAIRS

Supreme Court, Albany County Special Term, October 17, 1986

Justice Edward S. Conway, presiding

(Calendar #STO386)

APPEARANCES:

OLIVER & OLIVER, Esqs.
Attorneys for Plaintiff-Petitioners
Lewis B. Oliver, Esq., of Counsel
156 Madison Avenue
Albany, New York 12202

VINCENT J. McARDLE, JR., Esq.
Corporation Counsel, City of Albany
Attorney for Defendant-Respondents
John C. Egan, Jr., of Counsel
Department of Law
City Hall
Albany, New York 12207

RUTNIK & RUTNIK, Esqs.
Attorneys for Proposed Intervenor-Respondent
Peter A. Lynch, Esq., of Counsel
112 State Street, Suite 1320
Albany, New York 12207

CONWAY, J:

This is an Article 78 proceeding in which petitioners seek an order declaring that the approval of the Karner Meadows plat by the Planning Board of the City of Albany on August 12, 1986 is null and void, and also for an order permanently enjoining any land clearing, construction, or any other action as to the Karner Meadows Subdivision plat until the State Environmental Quality Review Act (hereinafter referred to as SEQRA), the State Endangered Species Act, and General City Law 33 have been complied with.

Benacquista, Polsinelli and Serafini Management Corp. (hereinafter referred to as BPS), proposed intervenor-respondent, opposes the motion and moves for an order granting it permission to intervene in the within proceeding on the ground that the petitioners seek to vacate the Planning Board's approval of the Karner Meadows Residential Subdivision, which is owned and developed by BPS, and that a judgment therefore will necessarily affect BPS's property interests. The motion of BPS to intervene is granted.

Petitioners, a not-for-profit corporation whose sole purpose is to promote the preservation of Albany's pine barrens, or pine bush, object to the approval of the Karner Meadows Residential Subdivision (hereinafter referred to as KMRS) by the City of Albany Planning Board on August 12, 1986.

The KMRS consists of 234 building lots on a 121 acre parcel. It is one part of a larger area of the Pine Bush located south of Washington Avenue Extension and east of Route 155 and which is owned by BPS.

On August 28, 1984, BPS submitted an application to the City of Albany Planning Board. As part of its application, BPS submitted a Draft Environmental Impact Statement (DEIS). On September 18, 1984, the City of Albany Planning Board passed a resolution designating itself as "Lead Agency" for the purposes of conducting a SEQRA review of the project. On October 9, 1984, the Planning Board approved the DEIS as to scope, form and content, and on November 15, 1984, the Planning Board conducted a public hearing to obtain comments on the DEIS. The final EIS was approved by the Planning Board on June 18, 1985 and accepted as complete.

During August of 1985, BPS submitted final plans for the subdivision, requesting approval at that time. The Planning Board however decided to withhold final action on KMRS as part of the moratorium on development (which the City of Albany had declared in July of 1985 until a Generic Environmental Impact Statement was prepared by Malcolm Pirnie Associates). From February of 1986 through June of 1986, the Planning Board as Lead Agency, with the approval of the New York State Department of Environmental Conservation, completed and approved a Draft Generic Environmental Impact Statement (DGEIS and a Final Generic Environmental Impact Statement (FGEIS).

On August 12, 1986, the Planning Board adopted a SEQRA Finding Statement and voted to approve the KMRS.

The petitioners contend that the Planning Board's decision is arbitrary and capricious and should be declared null and void because it did not take a hard look at the significant environmental impacts in that it failed to assess the cumulative environmental impacts of development proposals on the Pine Bush and it failed to consider the question of what is the minimum acreage that the Pine Bush ecology needs to survive. Further, petitioners contend that General City Law 33 requires that the owner shall install improvements or post a performance bond sufficient to cover the full cost of improvements prior to approval of a subdivision by the Planning Board and no performance bond for the full cost of the improvements was posted prior to the approval herein and, therefore, the approval by the Planning Board is null and void.

This Court must agree with the contentions of the petitioners. When the findings of the Planning Board fail to assess the cumulative environmental aspects of the development proposals on the Pine Bush, and when the effect of this proposal on the question of minimum acreage that the Pine Bush ecology needs to survive, or the number of acres that is a minimum habitat in order for the Karner Blue buttefly to survive is not considered, the decision is a nullity.

The Karner Blue butterfly is an endangered species and the question of the minimum preserve size for such an endangered species is an important environmental impact which must be considered in a cumulative impact statement and which was not considered herein. By failing to address the issue of the minimum Pine Bush preserve necessary for the survival of the Karner Blue butterfly, and the unique Pine Bush ecology, the FGEIS and the FEIS failed to consider an important environmental impact and failed to take a hard look at the environmental impact which is a requirement of the Rules (6 NYCRR 617.14(f)(3)) and the previous decisions of this Court and of the Appellate Division.

Further, the procedure by the Planning Bpoard in not requiring a performance bond by BPS before the approval, was a violation of Section 33 of the General City Law and renders the decision a nullity (see Matter of Friends of the Pine Bush, et al. v. Planning Board of the City of Albany, et al., 86 AD2d 246).

The petition is in all respects granted.

Petitioners to submit order.

All papers to the Attorneys for Petitioners for filing upon entry of the order hereon. Decision mailed 11/19/86.

EXHIBIT 7

Supreme Court—Appellate Division
Third Judicial Department

July 30, 1987 53980

In the Matter of SAVE THE PINE BUSH, INC., et al.,
Respondents,
v
PLANNING BOARD OF THE CITY OF ALBANY et al.,
Appellants,
and
BENACQUISTA, POLSINELLI AND SERAFINI MANAGEMENT CORPORATION,
Intervenor-Appellant.

OPINION

Argued, May 12, 1987.

Before:
HON. A. FRANKLIN MAHONEY,
Presiding Justice,
HON. JOHN T. CASEY,
HON. PAUL J. YESAWICH, JR.,
HON. HOWARD A. LEVINE,
HON. NORMAN L. HARVEY,
Associate Justices.

APPEAL from that part of an order and judgment of the Supreme Court (EDWARD S. CONWAY, J.), entered December 9, 1986 in Albany County, which granted petitioners' application, in a combined action and proceeding pursuant to CPLR article 78, to annul a determination of respondent Planning Board of the City of Albany approving intervenor's residential site development plan.

VINCENT J. MC ARDLE, JR., (John C. Egan, Jr., of counsel), City Hall, Albany, New York 12207, for appellants.

OLIVER & OLIVER (Lewis B. Oliver, Jr., of counsel), 156 Madison Avenue, Albany, New York 12202, for respondents.

RUTNIK & RUTNIK (Peter A. Lynch of counsel), 112 State Street, Suite 1320, Albany, New York 12207, for intervenor-appellant.

YESAWICH, JR., J.

This appeal is another growing out of proposed commercial and residential development of the Pine Bush area located within respondent City of Albany (see, Matter of Save the Pine Bush v City of Albany, 117 AD2d 267, mod ___ NY2d ___ [June 11, 1987]; Matter of Save the Pine Bush v Planning Bd. of City of Albany, 96 AD2d 986, lv denied 61 NY2d 668). The Pine Bush, a unique inland sand dune and habitat of rare plants and animal species such as the endangered Karner Blue butterfly, is recognized as having "a number of distinct environmental characteristics worthy of protecting" (Matter of Save the Pine Bush v City of Albany, ___ NY2d ___ [June 11, 1987], slip opn p 2).

In the early 1960s intervenor, Benacquista, Polsinelli and Serafini Management Corporation (BPS), purchased 250 acres of land in the Pine Bush and in 1978 presented a conceptual plan for its development in three phases. The first phase called for residential development of 121 acres referred to as the Karner Meadows Residential Subdivision (KMRS). Phases two and three envisioned developing the remaining acreage for commercial and multifamily purposes. This plan, though initially approved by respondent Planning Board of the City of Albany (Board), was subsequently found not to have been in compliance with the State Environmental Quality Review Act regulations (ECL art 8 [SEQRA]) and was annulled (Matter of Save the Pine Bush v Planning Bd. of City of Albany, 96 AD2d 986, supra).

In August 1984, BPS submitted a new proposal for approval of only the 121-acre KMRS development. After several draft environmental impact statements were prepared and public comment was had thereon, a final generic environmental impact statement (FGEIS) was submitted to the Board in June 1986. The Board granted BPS conditional approval for the KMRS development in August 1986, after which petitioners instituted this suit seeking review of the Board's determination. Supreme Court annulled the Board's decision, prompting this appeal by respondents and BPS. We affirm.

The standard of judicial review of a SEQRA determination is whether the reviewing agency identified the relevant areas of environmental concern, took a "hard look" at them (H.O.M.E.S. v New York State Urban Dev. Corp., 69 AD2d 222, 232), and made a reasoned elaboration of the basis for its determination (see, Chinese Staff & Workers Assn. v City of New York, 68 NY2d 359, 363-365; Matter of Jackson v New York State Urban Dev. Corp., 67 NY2d 400, 417). Though easily articulated, this standard is often difficult to apply.

Here, Supreme Court concluded that a "hard look" cannot be said to have occurred without "consider[ing] the question of what is the minimum acreage that the Pine Bush ecology needs to survive" or "the number of acres that is a minimum habitat in order for the Karner Blue butterfly to survive". We agree.

While respondents and BPS suggest that resolution of this issue is "outside the scope of a generic EIS [environmental impact statement]", we deem it precisely the kind of environmental issue that needs to be evaluated when, as here, the habitat of an endangered species is at risk (6 NYCRR 182.6 [a] [2]) and the municipality has opted for maximum development of the land area involved without proposing any substantively salutary mitigating measures which would minimize the adverse environmental effect of its decision; to allow the Board to do otherwise would frustrate the objectives of SEQRA.

Admittedly, an environmental impact statement need not identify and address every conceivable environmental impact, mitigating measure or alternative to satisfy SEQRA (Matter of Jackson v New York State Urban Dev. Corp., supra, p 417; Aldrich v Pattison, 107 AD2d 258, 266), but here the Legislature has taken pains to express heightened environmental concern for the Karner Blue butterfly, whose continued existence depends upon the preservation of its singular habitat, by according it endangered species status. If the Legislature's concern is to be respected, as it must be, then the question of minimum acreage needed to ensure the survival of the endangered species and its habitat is to be resolved. In the light of this, the Board's authorization of maximum development of the land involved, without offering any empirical data or other satisfactory documentation to resolve the minimum acreage issue, was an arbitrary and capricious act.

Additionally, we have considerable doubt as to the quantitative validity of an underlying assumption upon which the entire FGEIS is based. Throughout its entire environmental analysis, the Board observed that a minimum of approximately 1,700 acres of preserve lands were to be set aside for the habitat. However, of this land, only 421 acres then existed within the municipality's borders. Even assuming that the proposed purchase of an additional 160 acres by the City will be consummated, the lion's share of the proposed 1,700 acres remains 616 acres of land which are presumably to be purchased in the Town of Colonie, Albany County, another municipality. Thus, the Board's approval of BPS' plan presupposed land purchases which the record does not disclose have indeed been consummated. The reality appears to be that the Board's approval was given on substantially less than a 1,700-acre preserve.

Additionally, we are in agreement with Supreme Court's conclusion that the Board's decision not to require a bond for the full amount of the projected costs of improvements and instead to allow for bonding in stages over the four-phase 10-year period that the KMRS development will be under construction violated General City Law § 33. General City Law § 33, inter alia, permits the Board to adjust the value of a performance bond "at any time during the term of the performance bond" (emphasis supplied). This language contemplates adjustments in the bond once performance is underway. An "anticipatory adjustment" is not countenanced by the statute (see, Matter of Friends of Pine Bush v Planning Bd. of City of Albany, 86 AD2d 246, 249, affd on opn below 59 NY2d 849). As a condition of approval of an entire subdivision, the owner must install the improvements or furnish a bond for improvement costs occasioned by the development of the entire site before commencing construction (see, id.).

Opinion by YESAWICH, JR., J., in which MAHONEY, P.J., CASEY, LEVINE and HARVEY, JJ., concur.

Order and judgment affirmed, without costs.

EXHIBIT 8

413 West 47th Street
New York, N. Y. 10036
31 March 1988

Mr. Lawrence G. Rogers
Malcolm Pirnie, Inc.
4 Corporate Plaza
Washington Avenue Extension
Albany, New York 12203

Re: Scope of work needed to answer minimum acreage question in Albany Pine Bush

Dear Mr. Rogers:

This letter is in response to your letter of 8 December 1987 and several recent telephone requests from consultants in your employ, Dale F. Schweitzer and Thomas Givinish, for information from me regarding the court-ordered study of the Pine Bush minimum acreage question.

After careful consideration of your requests, I have decided not to release any additional unpublished data to your company at this time. My primary reasons for this decision are threefold. First, I am organizing the population, floristic, and faunistic data collected at the Pine Bush over the past fifteen years for submission to scientific journals for publication in the form of several scientific papers dealing with Karner Blue Butterfly autecology, population dynamics, hostplant and nectar source interactions, distribution, and other topics, as well as papers on the Buck Moth, Pine Bush butterflies, other pine barrens insects, gradient analyses of Pine Bush vegetation, and fire ecology of the Pine Bush, among other subjects. It would take me a great deal of time and effort to sort, cull, organize and present to you the data you seek relevant to the minimum acreage question from this mass of information, time which I do not have now.

Second, I feel it is more important to get my data and conclusions on the Karner Blue and Pine Bush reviewed and published in respected, refereed scientific journals so that the work will be generally available and useful, and I am endeavoring to do this in as reasonably short a time as possible.

Third, I feel that any unpublished data that I submit to you now will probably meet the same fate as my previous submittals to you. Those submittals, made over the telephone, in an interview with members of your firm, and in written comments before, during, and after the preparation and public review of the Pine Bush Generic EIS, were either ignored in whole or in part, selectively quoted where my comments apparently fit the "politically correct" conclusions of the City of Albany regarding Pine Bush development, and the remainder

(evidently in conflict with the development goals of the City) selectively quoted and rebutted in the appendices of the Final Generic EIS. Nowhere was my data or comments presented whole, as I gave them to you.

In addition, on several occasions I have been grossly misquoted or my data or conclusions taken out of context. (For example, see the Pine Bush Final Generic EIS, p. III-41; I actually said Pine Bush Buck Moth population density averages about 1 adult/acre/year, New Jersey Pine Barrens population density averages about 1-2 moths/acre/year, Long Island populations vary in population density from an average of 10-50 adults/acre/year in some locations, to 100 adults/acre/year in others, with a peak of 1000 adults/acre/year in the Long Island Dwarf Pine Plains, NOT the New Jersey Pine Barrens. Other instances of misquotation or my comments taken out of context and misinterpreted occur in the September, 1988 Rapp Road Landfill Expansion Draft EIS, pp. VII-22 and VII-37.)

Given these circumstances, I cannot entrust any more unpublished data to you and risk such treatment, and will instead publish my research as I stated previously. This will protect the integrity of my work while allowing it to be reviewed in an unbiased, scientific manner, and making it generally available in a reasonably short time to help answer some of these pressing questions concerning Pine Bush preservation and management.

I do believe, however, that I can be of some use to you in attempting to outline the questions which need to be asked and the scope of work needed to answer these questions regarding the minimum acreage required to support the Pine Bush ecosystem and, in particular, the Karner Blue Butterfly. I therefore offer the following scope of work which I believe, from my fifteen years of experience in the Pine Bush, is necessary to answer the minimum acreage question.

First, one must ask the proper questions. The Supreme Court has ordered that two separate but related questions be answered, to wit: 1. What is the minimum acreage necessary to support the Pine Bush population of the Karner Blue? 2. What is the minimum acreage necessary to preserve the Pine Bush as an ecosystem? These two questions differ, in that the first focuses on the requirements of a population of a single, endangered species, and the second seeks to address the needs of an entire ecosystem, composed of thousands of species, some of them as rare and endangered as the Karner Blue, but not officially listed yet. Intuitively, one may conclude that whatever amount of acreage will preserve the ecosystem will also preserve the single endangered species which is part of the ecosystem, but the reverse is not necessarily true. It is likely, then, that the answer to question no. 2 will be a larger acreage figure than that to question number 1.

It is also clear that another factor must be added to each question to ask the minimum acreage questions properly -- the factor of time. Are we interested in preserving the Karner Blue and Pine

Bush indefinitely? Or until some other overriding factor, such as climate, changes sufficiently to affect the survival of the Pine Bush and Karner Blue, a process which could take thousands of years naturally? Or for some shorter, determinant period, such as 100 years, 50 years, or until the year 2000? It is probably true that the shorter the time period specified, the smaller the minimum acreage needed, so the period of preservation needs to be specified. I believe we should ask the questions in this manner: How much acreage is needed to preserve the Karner Blue and Pine Bush until the next natural, deleterious shift in climate, a period of time which is probably 5,000 or more years in length?

Under each of the two major questions, a short list of related questions may be assembled. These questions must be answered to provide part of the answer to each major question. The list of related questions is presented below:

MAJOR QUESTION NO. I: What is the minimum acreage needed to support the Karner Blue?

A. What was the original distribution , extent, population size, and population density of the Karner Blue and its host plant, Wild Blue Lupine, in:

1. The Pine Bush?
2. The Saratoga County Sand Belt?
3. The Glens Falls Sand Plain?
4. All three areas taken together as the Hudson Valley Sand Belt?
5. Other locations in the U. S. where the Karner Blue occurred or still exists?

B. What is the current distribution, extent, population size, and population density of the Karner Blue and its host plant within the areas named above?

C. What are the population sizes of the smallest known Karner Blue populations? What are the sizes of the smallest known Lupine stands supporting Karner Blue colonies? What are the acreage sizes of these smallest Karner Blue colonies?

D. At what rate do such small populations of the Karner Blue become extinct? What causes them to disappear? How does the extinction rate differ when there is a center-periphery type distribution (as at the Pine Bush) as opposed to scattered small populations with no large central population (as in Saratoga County)? How does the population extinction rate compare with that among isolated, small populations (the pattern in the Glens Falls Sand Plain)? What is the rate of founding of new populations, if any?

E. What were the original fire or disturbance regimes which perpetuated lupine?

F. What are the Pine Bush fire and disturbance regimes now? Are these current regimes perpetuating or harming lupine?

G. How far can Karner Blues disperse, especially the females, to mate, lay eggs, and found new colonies?

H. What are lupine's exact soil property ranges, tolerances, and requirements (texture, nutrient levels, moisture levels, and pH range)? Does lupine require certain mycorrhizal fungus species for optimum root growth or even for survival? If so, which species? How long does it take to establish a healthy lupine stand? Does it take ten, twenty, thirty or more years?

I. What is the effect of acid rain in the East upon the soils favorable to lupine growth, especially eastern U. S. sands like those of the Pine Bush, with some mineral content, moderate soil acidity, and some acid buffering capacity? Is the soil pH lowered, or made more acidic? How is lupine affected? How are lupine root fungi, or mycorrhizae, affected by acid rain? Are other plant competitors of lupine, which thrive in more acidic, harsher sands, especially heath plants (blueberries and huckleberries in the Pine Bush), favored over lupines under acid rain conditions?

J. How do lupine stands and Karner Blue colonies shift over time within the Pine Bush vegetative matrix under the influence of fires, the dune topography, and plant succession? How much acreage is necessary to preserve such naturally shifting populations given their metapopulation and microhabitat dynamics?

MAJOR QUESTION NO. II: What is the minimum acreage necessary to support the Pine Bush ecosystem?

A. What was the original acreage size of the Pine Bush? What is it now?

B. What was the original floristic and faunistic composition of the Pine Bush (a complete list of Pine Bush plant and animal species must be assembled through field sampling to answer this question)? What is it now? Which species have already been lost? Can a Pine Bush species-area curve be constructed to describe the relationship between the loss of Pine Bush acreage and the loss of resident Pine Bush species?

C. What were the original vegetative composition, types, and gradients of the Pine Bush? What are they now? Which vegetation types and gradients have been lost (we know, for example, that the Pine Bush has lost many freshwater wetland vegetation types, including acidic marshes and classic Sphagnum-Leatherleaf bogs, which contained hundreds of species or rare bog plants and animals)? Have any vegetation types been completely lost or drastically altered by past human activity, development, habitat destruction, or the reduction in size of the Pine Bush? What are predicted future vegetative losses and alterations caused by these factors?

D. How does the Pine Bush vegetation and animal life shift over time and space (acreage) in relation to the dune structure of the Pine Bush, to Pine Bush wildfires, and to post-fire succession? How much acreage is needed to maintain the full pattern of vegetative shifts?

E. What are the minimum acreage requirements for the other rare and endangered or disappearing species found in the Pine Bush ecosystem, including, but not limited to, the following examples:

1. The Buck Moth
2. Perseus Dusky Wing
3. Dion Skipper
4. Many other rare Pine Bush insects
5. Hognose Snake
6. Spadefoot Toad
7. Worm Snake
8. Tiger Salamander (if still extant)
9. Prairie Warbler
10. Pine Warbler
11. Whippoorwill
12. Eastern Bluebird
13. Birdsfoot Violet
14. Albany Beechdrops
15. Yellow Swallowwort
16. Many other rare Pine Bush plants

The answers to the questions of minimum habitat requirements for other rare Pine Bush species must be known before the minimum area for preservation of the entire ecosystem can be known.

F. What was the original average size, intensity, frequency, type, and acreage covered by Pine Bush wildfires? What is it today? How many acres are required for a Pine Bush fire to burn properly, at high enough temperatures and the proper speed, flame height, fire formation, and other fire characteristics to destroy invading plant species and renew the Pine Bush vegetation?

G. What are the acreage sizes and complete species lists for other comparable pine barrens habitat islands ranging from 100 acres up to over 750,000 acres in size? If a species-area curve is constructed plotting each pine barrens island's species numbers against its acreage, where is the break point (the point at which species loss accelerates as acreage decreases)? If there is no break point, where does the loss of species become too severe and a threat to the future of the pine barrens ecosystem? Are rare or specialized species lost early or late in the reduction of pine barrens habitat island acreage?

H. How does fire suppression affect vegetation composition, structure, and succession? Which species are lost first? Are specialized or rare species lost first? How are "island effects" affected by fire suppression or other changes in fire regimes?

I. How are ecological island extinctions felt over time? How long does it take for a new, lower, equilibrium species number to be

reached after a pine barrens habitat island is reduced in size? (One study done on mammal species present in western U. S. reserves suggests that it may take over fifty years; in other words, over fifty years after habitat acreage reduction, species present inside the reduced preserves may still be going extinct, just from the "island effect" caused by the reduction in acreage.) Which types of species will continue to disappear long after natural habitat islands are reduced in size by development? How should existing estimates of species losses caused by "island effects", as well as the figures for species presently extant within the Pine Bush and other habitat islands, be revised downward to account for delayed species extinctions which may occur decades into the future?

With the questions framed above, all of which need to be answered to answer the minimum acreage question, in mind, I offer below a proposed scope of work necessary to gather, analyze, and present the data required to adequately answer the Pine Bush minimum acreage question. Many of the elements of this scope of work were presented by me to your firm or the City of Albany in my comments upon the Pine Bush Generic EIS in March 1986.

1. A three-year minimum study of all existing Karner Blue populations and subpopulations (colonies) must be undertaken in the Pine Bush and the Hudson Valley Sand Belt including Saratoga and Warren Counties. This study should have as its goals the same purposes as my 1980 report on the Karner Blue in the Hudson Valley Sand Belt: a) to identify all existing colonies, b) estimate their sizes in numbers of spring and summer brood individuals, c) obtain some idea of the natural fluctuations in population sizes which are presently occurring in these populations, d) estimate the numbers, distribution, and associated vegetation of the lupine plants supporting the Karner Blue populations, e) investigate the fire and disturbance history of the sites supporting Karner Blue populations, f) report on any threats to the integrity of each population, including development, fire suppression, plant succession, invasion by weedy plant species, off-road vehicles, lack of adult nectar sources, or other vegetative changes deleterious to lupine survival, and g) to compare the size and status of each surviving population with my assessment of the population made in my 1980 report. The three-year coverage is needed to detect natural patterns of fluctuation in population sizes, lupine numbers, and location which are occurring now, and to be sure that all existing populations are found and documented. This three-year resurvey of the status of the Karner Blue in the Pine Bush and the remainder of the Hudson Valley Sand Belt is vitally needed if we are to answer the question of minimum acreage required by the Karner Blue.

2. A complete inventory of Pine Bush plants and animals must be assembled from existing field data, publications, and new field work over the next three years. The species lists should include mammals, birds, reptiles and amphibians, fishes, insects, other invertebrates, vascular plants, mosses, lichens, and fungi. The species lists should be divided into those species formerly present at the Pine Bush and

now extinct there, and species still in existence at the Pine Bush. These complete lists are needed to produce species-area curves relating Pine Bush species diversity to the former 25,000-acre original size of the Pine Bush, through various reductions in Pine Bush acreage which can be calculated for various years from colonial times to the present, down to the 2,000-acre Pine Bush area size of today. If the lists are not complete, the species-area curves will not be useful.

3. Similar complete surveys and species lists should be compiled from other pine barrens habitat islands scattered around the northeastern United States, including the New Jersey Pine Barrens, Long Island Pine Barrens, Cape Cod/Plymouth Co. Pine Barrens, Marthas Vineyard, Nantucket, Rhode Island Pine Barrens, the Merrimack Valley Barrens, Montague (MA), Shapleigh, Freiburg, and Ossipee Pine Barrens (ME), the Saratoga Sand Belt, Glens Falls Sand Plain, Rome Sand Plain, Centre Co. Barrens (PA), Pocono Pine Barrens (PA), and the Nottingham Serpentine Barrens (PA). Because these pine barrens areas are of different sizes, they can be compared in their species composition and diversity with the Pine Bush and species-area curves can be constructed using pine barrens islands of different sizes to get a good idea of how the ecological island effect operates among pine barrens islands. This will help to clarify where the Pine Bush, at 2,000 acres, stands in terms of potential species losses from the island effect and also help answer the question of whether certain types of species, like the Karner Blue, are more extinction-prone from island effects as their habitats are reduced in size.

4. A complete vegetative inventory by vegetation types and major vegetative gradients should be made for the Pine Bush, and the results reported in the form of maps, aerial photographs, charts, and vegetative gradient analyses. The current picture of the Pine Bush vegetation should be compared to data from the past, including aerial photographs, previous vegetative studies (I know of four), floristic lists and studies, and historical accounts of Pine Bush vegetation. The present vegetative inventory and comparison with what is known about past Pine Bush vegetation will help answer questions of the relationship between habitat size reduction and changes in vegetation, fire frequencies or patterns, shifts in lupine habitats (open areas in the vegetation), and losses of certain vegetation types, gradients, or patterns vital to the survival of lupine, the Karner Blue, the Buck Moth, and other rare and endangered Pine Bush species of plants and animals.

5. All existing data on the fire history of the Pine Bush, including the numbers and frequencies of fires, areas burned each year, fire intensities and heat levels, fire kill ratios of major Pine Bush plant species, post-fire regrowth patterns and timing, effects of fires on lupine regrowth, propagation, and spread, effects of fires on Karner Blue survival and recolonization, effects of fires on other rare Pine Bush species like the Buck Moth, and long-term patterns of shifts in Pine Bush vegetation caused by fires acting upon the dune structure underlying the Pine Bush vegetation, should be collected and analyzed, and augmented with new data collected over the next three years to

compare original fire conditions and effects on the vegetation with those of today. The fire studies are a necessary component of the minimum area studies because we need to know how much acreage must be saved to allow for the play of wildfires across the Pine Bush landscape, renewing the vegetation and opening up new areas for lupine, the Karner Blue, and other rare species as the older colonies become overgrown by post-fire plant succession.

6. A three-year program of in-depth studies of other rare and declining Pine Bush species should be undertaken to provide current, up-to-date information on the distribution, status, and fire-related and plant succession-related population shifts of these species. Previously collected data on these species should be incorporated into the studies to enable comparisons of past distribution and abundance with present conditions to be made. Other rare species besides the Karner Blue should be studied to provide comparative data on the declines in distribution and abundance with that for the Karner Blue over the past several decades, so that common causes of such declines can be identified, and the effects of habitat loss and reduction can be described for the rarest component species of the Pine Bush ecosystem. Studies of other species besides the Karner Blue will also provide estimates of the minimum acreage requirements of a variety of other Pine Bush species, and so help to confirm minimum acreage estimates made for the Karner Blue, and provide some of the data needed to make a minimum acreage estimate for the Pine Bush as a whole. Studies of other rare species will also help answer the question of which sorts of species are most in danger of going extinct at the Pine Bush from island effects caused by habitat reduction.

7. The effects of acidic precipitation upon Pine Bush soils and vegetation, and particularly upon lupine and its ability to compete with other plant species, must be studied and assessed. Soil samples should be taken and analyzed throughout the Pine Bush, and the effects of acidic precipitation upon the buffering capacity, pH, and nutrient-supplying capability of Pine Bush soils should be quantified. Tests should be done to ascertain whether other plant species, especially members of the heath family (blueberries and huckleberries) and certain grasses and weeds, gain a competitive advantage over lupine if the surface layers of Pine Bush sands, which contain an alkaline component derived from limestone, are progressively acidified by decades of acid rain. (My field observations indicate that this is happening throughout the Pine Bush, where open patches of lupine and prairie grasses among the scrub oaks have, over the past fifteen years, become slowly overgrown with huckleberries, blueberries, and scrub oaks. Some of these vegetative shifts may be caused by plant succession in the absence of fire, but my soil tests have indicated a progressive, subtle acidifying of the upper soil layers.) Other studies should be done to determine the growth requirements of lupine (soil texture, pH, nutrient levels, water-supplying capacity, sunlight, competition from other species), which fungus species lupine require for mycorrhizal symbiosis, and whether these fungus species are deleteriously affected by acid rain acting upon Pine Bush sands. If the action of acid rain over the decades on Pine Bush soils, and upon the soils of other eastern U. S. pine barrens, has reduced the

buffering capacity or pH of these soils, this would have grave effects on the ability of lupine to survive and produce the large, thriving stands required by the Karner Blue for the caterpillars. The effects of acid rain, in turn, would drastically increase the estimates of acreage required to perpetuate the Karner Blue at the Pine Bush, as the butterfly colonies would become smaller, more isolated, and more extinction-prone as the lupine stands thinned out or as lupine became a less important component of the Pine Bush vegetation.

8. A three-year study should be done to determine the best and safest fire management techniques to use in the Pine Bush. We know very little about practical fire management techniques, especially controlled burning or the simulation of natural wildfires in the Pine Bush, through practical experience. Techniques must be found which can duplicate the fire intensity, temperature levels, speed, and killing effects of natural Pine Bush wildfires, without resorting to windrowing, the plowing of new fire lines or fire lanes, or any other aesthetically obnoxious approach which will destroy the natural beauty of the Pine Bush vegetation. Many roads, trails, and human-made fire breaks exist already in the Pine Bush; fire management and controlled burning techniques must be developed which use these existing boundaries. Most controlled burning research has been done in the West and Deep South in planted monocultures of pine and other evergreens; the purpose of such research has been to learn how to manipulate the vegetation by eliminating the understory and promoting pine growth. New fire research is needed in the Pine Bush and other northeastern pine barrens to find techniques which simulate natural wildfires, yet which are controllable, for the purposes of perpetuating the full array of natural pine barrens vegetation in the proper species mixes and proportions. Part of the development of fire management techniques for the Pine Bush must be the estimation of minimum areas needed for safe and effective pine barrens controlled burns, and how many burn areas are needed to prevent accidental species losses through the burning of too much of the pine barrens habitat island at one time. These estimates of controlled burn minimum acreage sizes are directly related to the estimate of an overall minimum acreage size for the Pine Bush preserve because the preserve cannot successfully persist without sound fire management theory, techniques, and practices.

9. Vegetative and faunistic studies must be done to determine the effects of existing and future disturbance patterns caused by human activities and development upon the Pine Bush. These disturbance patterns include those caused by edge effects, off-road vehicles, utility and other construction, various development practices, illegal dumping, passing vehicles on highways and roads, artificial night lighting, and any other disturbance which damages vegetation or scarifies the soil. The effects of such disturbance patterns often include the establishment and spread of undesirable invading plant species, especially weedy tree species such as Black Locust, Trembling Aspen, Black Cherry, and others. The penetration of such invaders under various disturbance regimes into Pine Bush preserve sections of various sizes should be estimated, and corresponding shifts in vegetation and animal species, including losses of rare plant and

insect species dependent upon pine barrens vegetation, should be described and mapped. The effects such disturbance patterns, both existing and anticipated, have upon the viability of pine barrens habitat islands of varying sizes is an important determiner of the minimum acreage requirements for preservation of the Pine Bush, and the size of individual blocks or tracts of land which must be kept free of such disturbances.

10. Finally, when enough data have been collected in all of the subject areas of study described above, the synergistic, or multiplied, effects of factors which have been analyzed separately should be described for all of the factors influencing the island effect acting together. These factors include habitat size; vegetative and faunistic diversity and distribution; location, distribution, and size of lupine and Karner Blue colonies; the action of wildfires and post-fire plant succession; location, distribution and size of populations of other rare Pine Bush plants and animals; disturbance factors such as edge effects, land clearing, scarification, and invasion by weedy plant species; fragmentation of pine barrens habitat by roads and developments into small "islands within islands"; topography and soils of the Pine Bush dunes; acid rain; and others. Mathematical modelling may have to be used to simulate the actions of multiple factors upon the species diversity, Karner Blue colony movement and survival patterns, and vegetative shifts of the Pine Bush under the assumptions of various minimum acreage sizes, preserve shapes, and habitat fragmentation patterns. Multivariate analysis of many factors acting together should provide ideas about how these factors work together to influence minimum viable preserve size, and how the minimum acreage figures for the Pine Bush and the Karner Blue should be revised or modified to account for synergistic effects. In addition, the factor of time, particularly the anticipated delayed reaction of the Pine Bush vegetation and rare species to the habitat reduction which has already taken place, as well as local species extinctions which will occur if the habitat island is further reduced in size by development, must be taken into account, using modelling based on the results of the few studies of delayed extinction rates caused by island effects which have been done to date.

The choice of three years as the minimum duration for the required studies of Karner Blue populations, Pine Bush flora and fauna, Pine Bush fire history and fire ecology, autecology of other rare Pine Bush species, and the development of Pine Bush fire management techniques was made for several reasons. First, in the cases of the population studies, three years is needed at a minimum to acquire enough data to cancel many of the effects of annual variations in climate, weather, population levels, population levels of other species important to the one being studied, and other ecological factors, and thus get a more accurate picture of average population sizes, movements, and interactions with other species necessary for survival. Second, three years is needed at a minimum to obtain meaningful data on short-term population movements or shifts, vegetative shifts, and to detect long-term trends in population numbers which can be related to habitat size and thus be used to help

answer the minimum acreage question. Third, for compiling complete floral and faunal lists, three years is the minimum time required for surveys to pick up most species which are difficult to detect, dormant or inactive for one or two years, fluctuate greatly in numbers from year to year, or species which are present some years but absent in others; three years is also the minimum amount of time, from my experience doing floral and faunal surveys, necessary to overcome human factors such as limited amounts of time, time needed to collect specimens and make identifications, and human error. Fourth, for the fire history, fire ecology, and fire management studies, three years is a bare minimum amount of time within which one may have the opportunity to study several natural Pine Bush wildfires and the preliminary stages of elimination of invading species and post-fire succession. It is also a bare minimum of time needed to conduct several experimental controlled burns in the Pine Bush to find out which fire management techniques will produce a fire that is controllable, yet will simulate the effects of natural Pine Bush fires by eliminating invading species without destroying native Pine Bush species or altering the natural vegetation patterns of the Pine Bush. In most of these areas of study required to answer the minimum acreage question, more than three years of study would be preferable because it would allow more complete and thorough data to be gathered, and the conclusions reached would thus be more reliable and scientifically sound. I chose three years in consideration of the economic factors involved, as the minimum time period needed to obtain answers with some degree of reliability, and as a time period during which field studies could be conducted at reasonable costs compared to the total overall economic values of the projects being proposed, the Pine Bush lands already acquired (this money will have been wasted if enough of the Pine Bush is not acquired and properly managed), and the budgets of the government entities active in the Pine Bush region.

I would like to end this letter by briefly reiterating where the relevant data which I have collected over the past fifteen years point on the issues of minimum acreage requirements for the Karner Blue and the Pine Bush as a whole. My species-area data show a "break point" in acreage size of about 2,000 acres for pine barrens habitat islands -- those pine barrens areas, like the Pine Bush, which are surrounded by other types of vegetation or by developed areas and which are essentially unable to replace rare pine barrens species or vegetation types lost through development or habitat destruction. The "break point" represents the portion of the species-area curve where species losses begin to sharply increase as a result of acreage reduction. It is obviously critical to avoid reducing habitat islands like the Pine Bush to their "break points" because when they reach this size, species begin to become extinct in large numbers. If the rarest and most specialized pine barrens species, like the Karner Blue, are more vulnerable to early extinctions as a result of habitat area reductions than other species, it is vital to preserve not only the "break point" amount of land, but more acreage, to avoid long-term species losses. In addition, the studies which I have suggested, if done properly, may produce species-area curves from a larger variety of pine barrens areas than the ones I was able to sample. These species-area curves

may show that the Pine Bush in fact requires more than 2,000 acres as a minimum acreage size for long-term survival of the pine barrens ecosystem.

My data on the Karner Blue, collected throughout the range of this species in New York State and elsewhere in the U. S., indicate that the butterfly has suffered a catastrophic decline in numbers of upwards of 95% in the central Pine Bush population, and that as many as one-half of the small, peripheral colonies in the Pine Bush, Saratoga County, and the Glens Falls Sand Plain have disappeared due to habitat destruction, fire suppression, plant succession, and a disturbing reduction in the number, density, and viability of lupine stands throughout the entire upper Hudson Valley Sand Belt which includes the Pine Bush. Other rare pine barrens species which I have studied intensively during this period, such as the Buck Moth, have also suffered alarming population reductions in the Pine Bush corresponding to habitat reductions caused by development over the past fifteen years.

Given these findings, I must also reiterate my conclusion expressed in my letter of 21 March 1986 to the City of Albany, commenting upon the Pine Bush Generic EIS: The Pine Bush is now at or below the minimum acreage it needs to survive. Because of the action of certain factors upon the Karner Blue at the Pine Bush, most notably fire suppression, deleterious vegetative shifts, invasion and spread of weedy plant species, and, most importantly, an alarming loss of lupine stands in both numbers and density of plants (perhaps caused in part by acid rain acting over many decades on poorly-buffered Pine Bush soils), compounded with habitat reduction and fragmentation of the remaining good pine barrens habitat by development, I must also conclude that the Karner Blue is now at or below the minimum acreage it needs to survive in the Pine Bush.

I therefore urge you as responsible consultants, acting together with the City of Albany and the State of New York, to stop this wasteful exercise of time and taxpayers money and to put all possible resources to work immediately to acquire every last acre of natural Pine Bush land remaining in private hands, to add these pine barrens lands to the existing, fragmentary Pine Bush preserve, and help focus research efforts on developing practical techniques for controlled burning of the Pine Bush vegetation and the management of its rare and endangered species, including the Karner Blue. Ethical leadership needs to be shown by your company, the City, and the State to end this wasteful legal morass and redirect efforts toward true preservation and management of the priceless natural landscapes, rare species, and historical and cultural resources of this truly unique region of New York State.

Very truly yours,

John F. Cryan

John F. Cryan

cc:
A. Breisch
L. Brown
M. Fitzsimmons
K. Freid
A. Hicks
T. McCabe
M. Platt
C. Reschke
D. Rittner
M. Stewart
W. Bruce
T. Glvinish
V. McArdle
E. Menges
D. Schweitzer
L. Oliver
P. Nye
R. Dirig
A. Williams

SCALE: 1" = 2000'

PINE BUSH ENVIRONMENTAL PARK

PROJECT SITE

3 WILLIAMSON PROPERTY

"KARNER MEADOWS"

LANDFILL

COOK PARK

ALBANY

ELDERLAND

Prospect Hill Cemetery

Drive-in Theater

Westmere

Karner

Colonie

Trailer Park

Trailer Park

Water

Station

KARNER ROAD

WASHINGTON AVENUE EXTENSION

NEW KARNER ROAD

RAPP ROAD

PENN CENTRAL

CITY BOUNDARY

PIPELINE

TELEPHONE

LEGEND

- Preserved Pine Bush
- Developed Parkland
- Development Proposals

OPEN SPACE PRESERVATION AREAS

Attachment 2

Excerpt from:

A Primer of Population Biology

by Edward O. Wilson and

William H. Bossert, Chapter 4

Sinauer Associates, Sunderland, MA

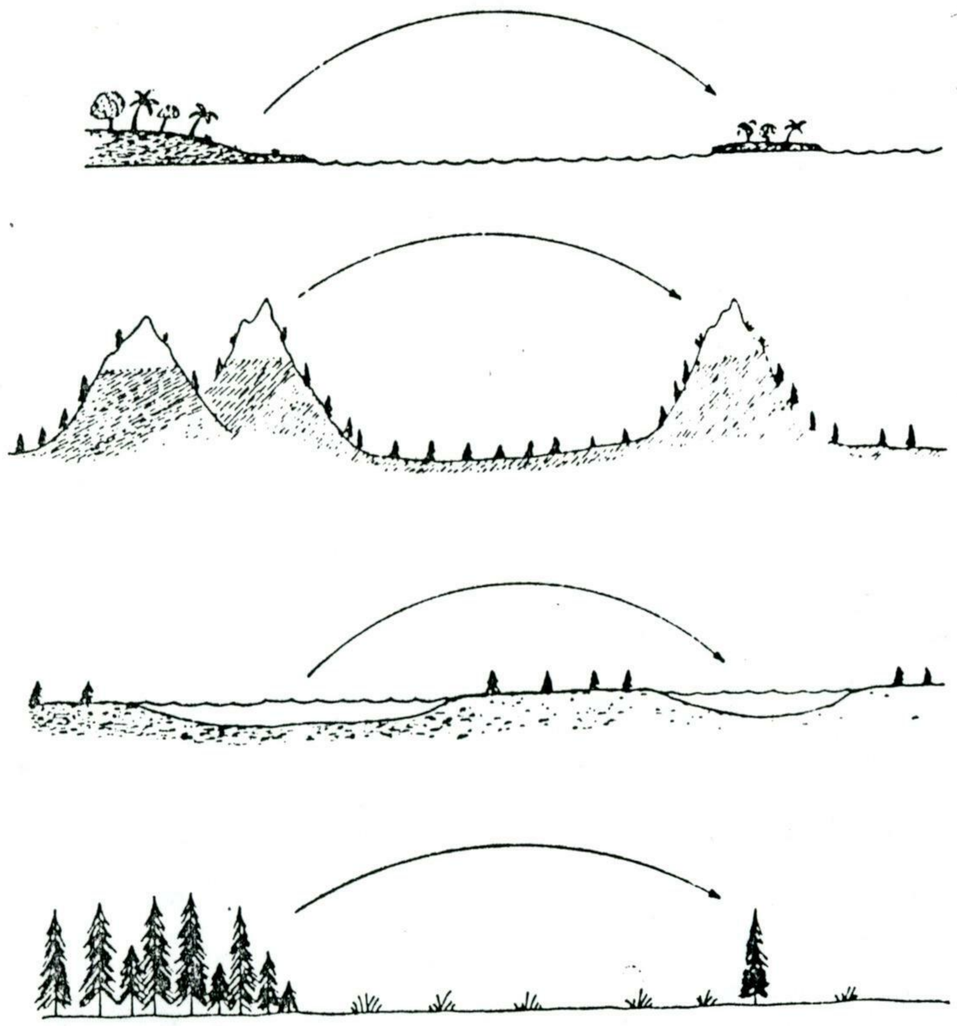
1971

4 Biogeography: Species Equilibrium Theory

The living world is broken into patches. It exists to a large extent either on "real" islands, such as bodies of land projecting from the sea, or "habitat islands," which are fragments of habitats surrounded by other habitats of markedly different nature. Figure 1 provides an intuitive aid to this view of nature. Notice that whereas only a geographic unit of the magnitude of Bermuda or Cuba is an island to a bird, a single spruce tree in the middle of a field can be an island to an insect, and a teaspoon of water serves as one to a microorganism. The islands contain sets of species that can be demarcated as more or less discrete communities. In analyzing such units, ecologists and biogeographers wish to learn the principles and laws that govern the buildup of species during the colonization period, the final equilibrium level attained, and the immigration and extinction rates of species throughout the process. The section to follow will familiarize you with the basic theory of this subject, which has only recently been put into mathematical form and is now in the process of being tested and extended.

THE AREA-SPECIES CURVE

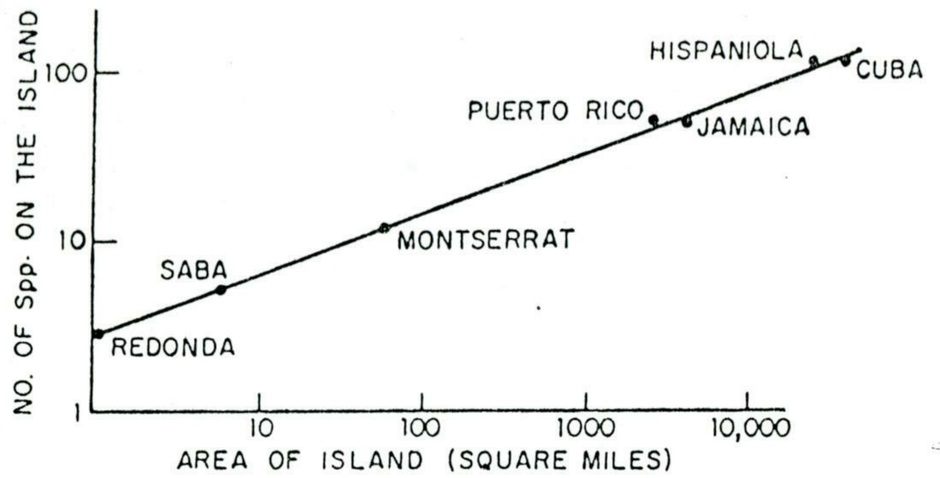
Very roughly, the number of species belonging to a given taxon increases as approximately the cube root to the fourth root of the area of the island. An example can be taken from the reptile-and-amphibian faunas of the West Indies (Figure 2). Here $S = CA^{0.301}$, where S is the number of species, A is the area of the island, and C is the value of S at $A = 1$ (its value is not important for our purposes). Notice that the scale used in the graph is doubly logarithmic, giving a straight-line area-



1 "TRUE ISLANDS" (*top*) and "habitat islands" (*bottom three*) are analyzed by the same quantitative theory.

species curve; and since $\log S = \log C + 0.301 \log A$, the slope of this curve is 0.301.

PROBLEM. Suppose you are an entomologist exploring the ant fauna of southeastern Asia. You have just completed a thorough study of a small island (area: 100 square miles) and found it to hold 10 ant species. Previous studies have shown that the slopes of ant area-species curves in a log-log plot are about 0.30. Now you are about to explore a much larger island (area: 10,000 square miles). Predict the number of ant species on this larger, unstudied island.



2 AREA-SPECIES CURVE of reptiles and amphibians in the West Indies.

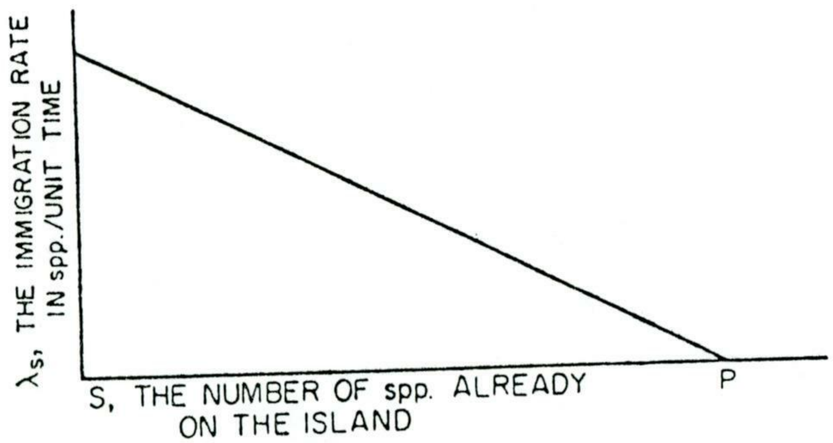
ANSWER. From the information just given we predict that for most cases $S = CA^{0.30}$. We know from our explored island that $10 = C \times 100^{0.30}$. We could determine C at this point and then solve for 10,000, but it is better to take a short cut by simply dividing the two equations, canceling out C and solving directly for the unknown S, as follows:

$$\frac{S}{10} = \frac{C \times 10{,}000^{0.30}}{C \times 100^{0.30}}$$

$$S = 40 \text{ ant species}$$

THE EQUILIBRIUM MODEL

The regularity of the area-species relation and certain correlations observed between the slope of the area-species curve and the degree of isolation of the islands prompted MacArthur and Wilson (1967) to construct the following basic equilibrium model. First, note that as an island fills up with species, the total IMMIGRATION RATE (λ_S), defined as the number of new species arriving per unit time, should drop, as in Figure 3.



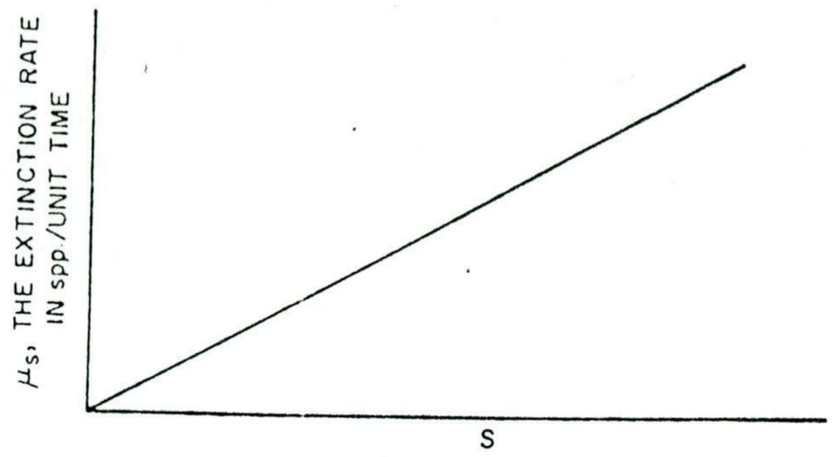
3 IMMIGRATION CURVE. As species fill the island, the rate of arrival of new species drops.

P represents the number of species in the "pool," that is, the number found in the surrounding source areas. Note that if, by some unlikely circumstance, there already exist P species on our island, the immigration rate is zero by definition.

Now, similarly, we should expect the TOTAL EXTINCTION RATE (μ_S), defined as the rate at which species *already on the island* go extinct, to rise as shown in Figure 4. In order to simplify matters, we are employing here the linear model, where the rate curves are given as straight. A great many reasonable modifications in the shape of the rate curves could be postulated, without, however, altering the qualitative conclusions drawn by the linear model.

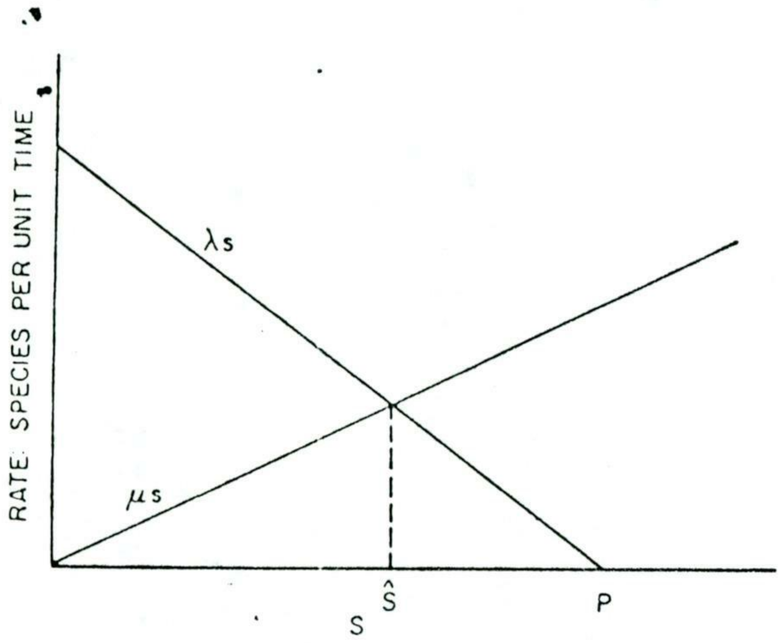
When $\lambda_S = \mu_S$, the number of species will be at equilibrium, a species number designated by S (see Figure 5).

Now, what is the total immigration rate (λ_S) in number of species per unit time when S species are present? First, take the average immigration rate of new species, per species, onto the island when S species are present; let us label it λ_A. The



4 EXTINCTION CURVE. As species fill up the island, the rate at which they become extinct increases.

total immigration rate is this number λ_A (which is a constant in the linear equilibrium model) times the number not yet on the island, or $\lambda_A\ (P - S)$. Next, what is the total extinction rate in species per unit time? It is the average extinction rate per species μ_A, also a constant in our simple model, times the number of species already on the island, or $\mu_A S$. Finally, what is the rate of increase with time (dS/dt) in the number of



5 BASIC MODEL of species equilibrium. At $\hat{S}$, enough species are present so that the extinction rate equals the immigration rate.

species on the island? It is the total immigration rate minus the total extinction rate:

$$\frac{dS}{dt} = \lambda_S - \mu_S \qquad [1]$$
$$= \lambda_A(P - S) - \mu_A S$$

At equilibrium, $dS/dt = 0$ by definition, so that

$$\left.\frac{dS}{dt}\right|_{S=\hat{S}} = \lambda_A(P - \hat{S}) - \mu_A \hat{S} = 0$$

(Note that at equilibrium the number of species is labeled $\hat{S}$.) By rearrangement,

$$\hat{S} = \frac{\lambda_A P}{\lambda_A + \mu_A} \qquad [2]$$

PROBLEM. A small offshore island was defaunated near a larger, source island containing 210 species of arthropods. After a short period of time the small island was found to contain 10 arthropod species, the total immigration rate was estimated to be one species every 5 days and the total extinction rate was estimated to be one species every 10 days. Predict the equilibrium number of species from the linear model.

ANSWER. The linear model predicts that $\hat{S} = \lambda_A P/(\lambda_A + \mu_A)$. P is given as 210 species. λ_A (the average immigration rate) is the total immigration rate divided by the number of species not yet on the island, or $(1/5)/(210 - 10) = 0.001$. μ_A (the average extinction rate) is the total extinction rate divided by the number of species already on the island, or $(1/10)/10 = 0.01$. Inserting these numbers in the equation, we get $\hat{S} \doteq 19$ species.

We have just shown how the linear equilibrium model can be used in an attempt to predict the ultimate equilibrium species number from a knowledge of the immigration and extinction rates. Let us now turn the prediction process around. We reasoned that

$$\frac{dS}{dt} = \lambda_A(P - S) - \mu_A S$$

If you have had enough calculus, try to confirm the following solution of this differential equation (if you haven't, inspect the result closely just the same):

$$S = \frac{\lambda_A P}{\lambda_A + \mu_A}(1 - e^{-(\lambda_A + \mu_A)t}) \qquad [3]$$

As t becomes very large, $e^{-(\lambda_A + \mu_A)t}$ approaches zero, and S approaches $\hat{S}$ $[= \lambda_A P/(\lambda_A + \mu_A)]$, as we observed already in Equation 2. We use the rate of approach to equilibrium to derive the TURNOVER EQUATION that predicts the rate of turnover (= extinction rate = immigration rate) at equilibrium. We first select some arbitrary fraction of $\hat{S}$, say 90 percent of $\hat{S}$, or $0.9\hat{S}$. Now multiply both sides of Equation 2 by 0.9 to obtain

$$0.9\hat{S} = \frac{\lambda_A P}{\lambda_A + \mu_A} \times 0.9 \qquad [4]$$

Bear in mind that $S = 0.9\hat{S}$ by our arbitrary selection; next we apply Equation 3 and note that

$$S = 0.9\hat{S} = \frac{\lambda_A P}{\lambda_A + \mu_A}(1 - e^{-(\lambda_A + \mu_A)t_{0.9}}) \qquad [5]$$

Compare Equations 4 and 5 to see that

$$1 - e^{-(\lambda_A + \mu_A)t_{0.9}} = 0.9$$

where $t_{0.9}$ is the time required for the island to fill up to 90 percent of its equilibrium number. By rearranging and taking natural logarithms (you should try this yourself for practice) we get

$$t_{0.9} = \frac{2.3}{\lambda_A + \mu_A} \qquad [6]$$

where (don't forget!) λ_A and μ_A are the *average* immigration and extinction rates respectively. We could stop here and put this equation to immediate use, but let's first get it into a more useful form by converting to the total rates λ_S and μ_S. MacArthur and Wilson (1967:38), for purposes of illustration, took the simplifying step of letting $\lambda_A = \mu_A$, so that

$$t_{0.9} = \frac{2.3}{2\mu_A} = \frac{1.2}{\mu_A}$$

If you now multiply the right-hand side of the equation by $\hat{S}/\hat{S} = 1$, you get (for this special case)

$$t_{0.9} = \frac{1.2\hat{S}}{\mu_{\hat{S}}} \qquad [7]$$

where $\mu_{\hat{S}}$ is the total extinction rate at equilibrium.

PROBLEM. A series of small, undisturbed islands have about 30 plant species each; floristic surveys over a period of several years have indicated that average immigration rates are about equal to average extinction rates; and the total extinction rate is shown to be one species per year per island. A severe hurricane one September day completely destroys the vegetation of one of the islands. About how long will it take for the flora to return to, say, 90 percent of its original number?

ANSWER.

$$t_{0.9} = \frac{1.2 \times 30 \text{ species}}{1 \text{ species/year}} = 36 \text{ years}$$

PROBLEM. Here is a real example. The island of Krakatau (or Krakatoa), located in the Sunda Strait between Sumatra and Java, suffered a huge volcanic eruption in 1883 that destroyed its entire fauna. Birds later recolonized the island (along with almost all other important elements of the fauna and flora), reaching an apparent equilibrium of approximately 27 species in a period of 36 years. Using the elementary equilibrium model, predict the turnover rate at equilibrium.

ANSWER.

$$\mu_S = \frac{1.2 \times 27}{36} = 0.9 \text{ species/year}$$

From the data of K. W. Dammerman, MacArthur and Wilson obtained an estimated minimal turnover rate of 0.4 species/year. Similar approximations, correct to the nearest order of magnitude, have since been obtained from the

elementary model applied to colonization data of freshwater benthic organisms and island-dwelling insects and other arthropods.

PROBLEM. Let us now try for a little more flexibility by making λ_A *not* equal to μ_A. Suppose the little islands had their 30 species drawn from a nearby mainland containing 130 species. Again, we measure a total immigration rate for each island of one new species per year. Before going on, what are λ_A and μ_A?

ANSWER. λ_A by definition is the average immigration rate, equal to the total immigration rate (1 species per year) divided by the number of species in the pool *not* on the island ($P - \hat{S} = 130 - 30 = 100$). So $\lambda_A = 1/100$. What is μ_A? We know that since the islands are at equilibrium, the total extinction rate is equal to the total immigration rate, or 1 species per year. μ_A by definition is this total extinction rate divided by the number of species already on the island, or 1/30.

PROBLEM. One of the islands is completely denuded by a storm. How long will it take this island to regain 90 percent of the original species number?

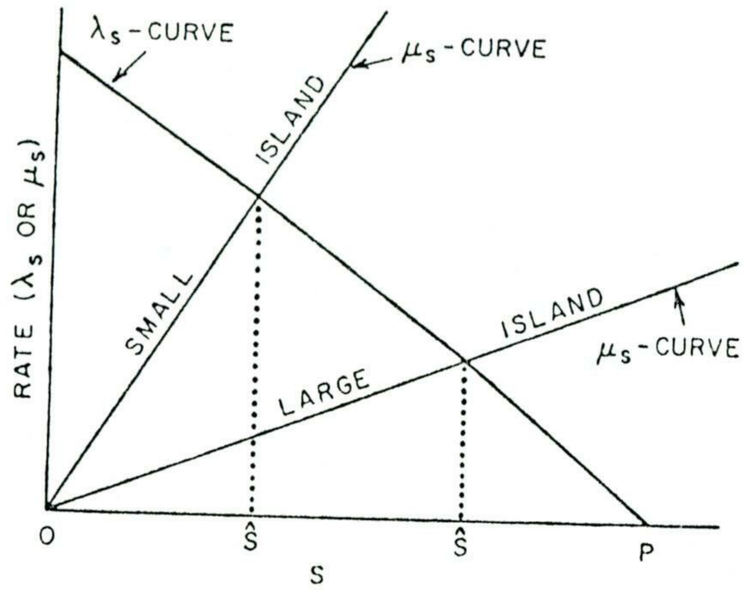
ANSWER. From Equation 6, $t_{0.9} = 2.3/(1/100 + 1/30) = 53$ years. Notice that to solve this problem, in which we did not take it for granted that $\lambda_A = \mu_A$, we needed to know P in order to calculate λ_A. Also, it should always be kept in mind that the purpose in obtaining exact numerical solutions to this and the previous problems was to gain a firm grasp of the theory. Experimental work has not yet advanced to the stage where the precision of the formulas based on the linear model can be adequately evaluated, although enough studies have been finished to indicate that they are at least approximately correct in the cases where colonization occurs rapidly.

PROBLEM. How long would it take for the denuded island to regain 90 percent of its original species *composition*? (Think a bit about the wording of this question and attempt some response before going on.)

ANSWER. The theory simply does not cover this question. Only the *number* of species is covered, not the actual identity, i.e., the composition, of the species. Do you see the difference? It would be possible to answer the composition question by an elaboration of the linear model, but complex probability theory would be involved, and no one has tried to do it yet. Surely a very long time would pass, on the average, before the new flora would hold 90 percent of its species in common with the old, and this would be only a temporary condition. Do you understand why?

AREA AND DISTANCE EFFECTS

It is easy to see that a larger island should have more species at equilibrium than a smaller island which is at the same distance from the same source area (Figure 6). This AREA EFFECT (which we have already seen exemplified in the area-species curves) is due to the fact that the small island holds smaller populations, which are subject to more frequent extinction. The λ_S curve is about the same for both islands, because they are equally distant to the source area and receive about the same number of colonists from it; also the number of species in the source area, P, is the same for both islands.

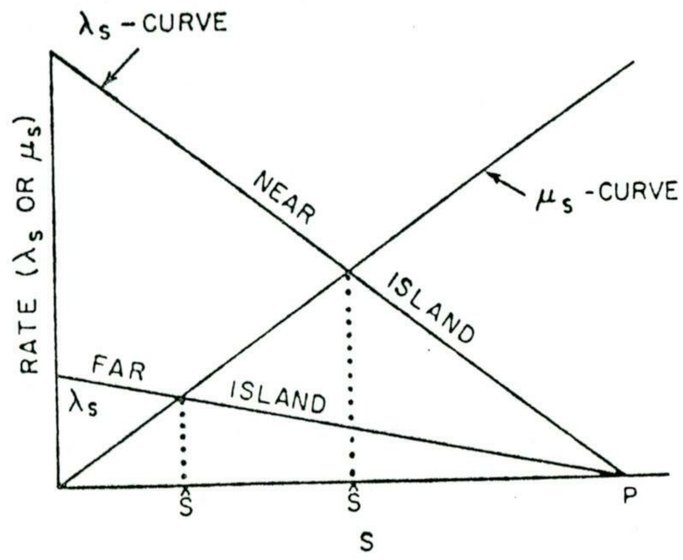


6 AREA EFFECT. An increase in land area lowers the extinction curve and, therefore, raises the number of species at equilibrium.

Next, we can deduce the result of the reverse situation, where the area of the two islands is the same, but one island is closer to the source island than the other. In this case the closer island should have a larger number of species at equilibrium (Figure 7). The a priori basis for predicting this DISTANCE EFFECT is the expected smaller rate of immigration onto the more distant island.

If you now understand all the reasoning behind the turnover equation and the prediction of the area and distance effects, you are prepared to employ equilibrium theory in a more flexible way. For example, try the following two problems.

PROBLEM. In a real experiment, a series of very small mangrove islands in the Florida Keys were denuded of their insect faunas by fumigation with methyl bromide, and the recolonization was then closely observed. The fauna of the most distant island regained its old equilibrium number more slowly than was the case for several other faunas located nearer the source areas. By studying the equations based on the linear equilibrium model, how could you have predicted this effect? (*Hint:* you won't be able to deduce it from the graphical models alone.)



7 DISTANCE EFFECT. An increase in distance from the source of immigrant species lowers the immigration curve and, therefore, decreases the number of species at equilibrium.

ANSWER. Look at Equation 3. Distant islands should have a smaller λ_A, simply because fewer propagules are able to

reach them. According to the strict terms of the linear model, μ_A should not vary with distance. This means that the term $e^{-(\lambda_A + \mu_A)t}$ approaches zero more slowly as t increases, and consequently S approaches $\hat{S}$ [$= \lambda_A P/(\lambda_A + \mu_A)$] more slowly on the more distant island.

PROBLEM. Suppose a large island and a small island are equidistant from the source area. Would they reach equilibrium at the same time? If not, which would reach equilibrium first?

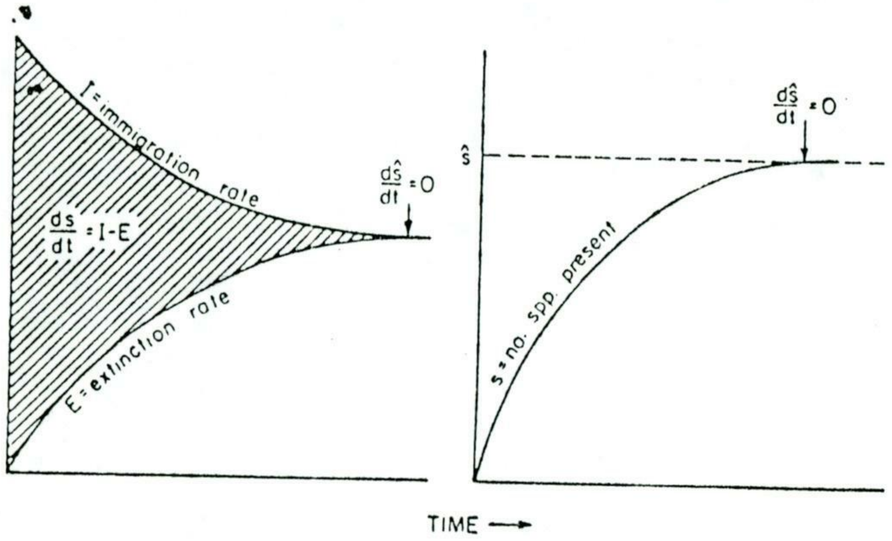
ANSWER. Look at Equation 3 again and think about the relation of μ_A to area. The smaller island should have a larger μ_A and hence should approach equilibrium faster.

PROBLEM. Two islands, one large and one small, are otherwise similar; in particular they have similar environments and are located the same distance from the same source region. A bird species colonizes both islands in the same year. On which island are the colonists more likely to evolve to endemic status?

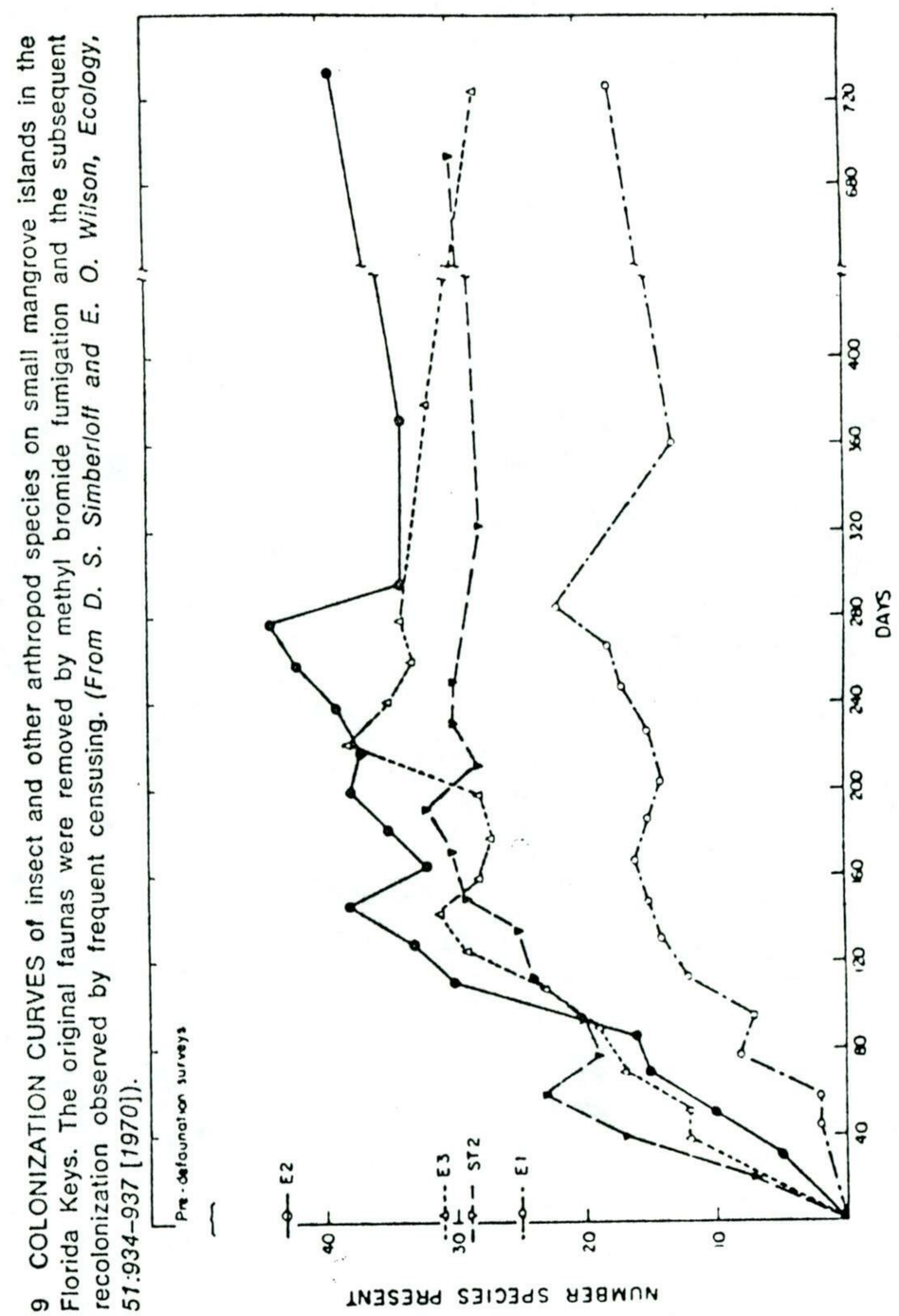
ANSWER. The equilibrium theory predicts that the colonists are more likely to reach endemic status on the larger island. The reason for this result may not have been immediately obvious to you. An examination of the graphical analysis that led to the "area effect" will show that the larger island, with its higher $\hat{S}$, has a lower μ_A, that is, a lower average extinction rate (= slope of the μ_S curve). A lower average extinction rate means a longer average survival time per species, and hence a greater chance that any given population will persist long enough to evolve into an endemic species. In fact, it turns out to be generally true that within a single archipelago the percentage of endemic species on a given island, and not just the absolute number of endemic species, increases with the area of the island.

PROBLEM. This exercise is directed at students with a particular interest in graphical analysis. Even if you cannot solve it, study the answer supplied afterward to understand this kind of approach. The problem is to predict the shape of the colonization curve through time, from the beginning of immigration to the attainment of equilibrium.

ANSWER. The graphs in Figure 8 are nearly self-explanatory. The rate at which the number of species (S) present is increasing (dS/dt) is simply the difference between the rates at which new species are arriving (I) and old ones are going extinct (E). When $E = I$, dS/dt is equal to zero, and equilibrium exists by definition. The number of species present follows a rising curve, as shown in the right-hand figure. The rate at which this curve ascends, however, is continually decreasing, because I and E converge toward each other from the beginning, and their difference (dS/dt



8 SHAPE OF COLONIZATION CURVE. As an empty island is colonized, the immigration rate decreases and the extinction rate increases until the two are equal, producing species equilibrium (*left*). The colonization curve is obtained as the summed difference, through time, between immigration and extinction (*right*).



9 COLONIZATION CURVES of insect and other arthropod species on small mangrove islands in the Florida Keys. The original faunas were removed by methyl bromide fumigation and the subsequent recolonization observed by frequent censusing. (*From D. S. Simberloff and E. O. Wilson, Ecology, 51:934–937 [1970]*).

$= I - E$) is therefore always decreasing. To be more precise, the number of species present on the island is the integral through time of $I - E$, a value whose rate of increase is always decreasing with time. Some actual examples of colonization curves are shown in Figure 9.

Suggested Additional Reading

Darlington, P. J. 1957. ZOOGEOGRAPHY: THE GEOGRAPHICAL DISTRIBUTION OF ANIMALS. John Wiley & Sons, Inc., New York. *xi* + 675 pp. (The classic empirical study of vertebrate zoogeography, containing discussions of faunal balance and turnover on the global scale.)

MacArthur, R. H. and E. O. Wilson. 1967. THE THEORY OF ISLAND BIOGEOGRAPHY. Princeton University Press, Princeton, N.J. *xi* + 203 pp. (A theoretical study that derives many of the results of biogeography, and in particular the species equilibrium, from first principles in population and community ecology.)

Pielou, E. C. 1969. AN INTRODUCTION TO MATHEMATICAL ECOLOGY. Interscience Publishers, New York. *viii* + 286 pp. (Although primarily devoted to ecology, Pielou's textbook covers several topics in dispersal and patterns of distribution of organisms not adequately treated in the other two books cited above.)

Glossary

$a_1, a_2, a_3, \ldots, a_n$ symbols designating alleles that occur on the same locus in the population.

A in population genetics, a symbol designating a particular allele; in species equilibrium theory, the area of an island.

α competition coefficient; the amount by which each individual diminishes the growth of the competing species.

b the individual birth rate, the number of female offspring one female will have per unit of time.

β competition coefficient; same as α.

d the individual death rate, the average number of deaths per individual per unit of time (if one in ten die in a day, for example, $d = 0.1$ individuals per individual per day).

Δq the amount of change, from 0 to 1, that occurs in q, the frequency of an allele, in one generation.

e the base of natural logarithms, a constant with a value of 2.71828. . . .

H the entropy measure of diversity; the negative sum of the frequencies of each category multiplied by the logarithms of the frequencies.

H_S the entropy measure of species diversity; based on the number of organisms found in each species for all species in the sample.

h^2 heritability; the fraction of the variance in a given characteristic of a population that is due to genetic variation in the population.

l_x survivorship; the proportion of females surviving to age x.

λ_A the average immigration rate of species; in other words, λ_S (see below) divided by S, the number of species present.

λ_S the immigration rate of species; the rate at which new species

Diamond, Jared M. 1975. The island dilemma: Lessons of modern biogeographic studies for the design of natural reserves. Biol. Conserv. 7: 129-146.

Attachment 3

[illegible] it is still possible that the butterfly may exist in localities further [illegible] where apparently it has never been sought.

ACKNOWLEDGEMENTS

[illegible] of this work was undertaken while one of the authors (J.M.) was in receipt [illegible] from the Gloucestershire Trust for Nature Conservation, the Natural [illegible] Research Council and the World Wildlife Fund.

REFERENCES

[illegible] B. R. (1973). The decline (and fall?) of the Large Blue butterfly. *Bull. amat. Ent. Soc.*, [illegible]

[illegible], R. J. (1971). Conservation aspects of the genetical constitution of populations. In *The [illegible] management of animal and plant communities for conservation*, ed. by E. Duffey and [illegible] A. S. Watt, 177–206. Oxford, Blackwell.

[illegible], E., Morris, M. G., Sheail, J., Ward, L. K., Wells, D. A. & Wells, T. C. E. (1974). *[illegible] ecology and wildlife management*. London, Chapman and Hall.

[illegible], E. B. (1965). *Ecological genetics*, 2nd edition. London, Methuen.

[illegible], H. (1884). On the probable early extinction of *Lycaena arion* in Britain. *Entomologist's [illegible] Mag.*, 21, 107–9.

[illegible], N. D. (1971). The size and surroundings of nature reserves. In *The scientific management [illegible] of animal and plant communities for conservation*, ed. by E. Duffey and A. S. Watt, 555–61. [illegible], Blackwell.

[illegible], T. G. (1973a). The conservation of the Large Blue butterfly (*Maculinea arion* L.) in [illegible] Devon and Cornwall. *Proc. Brit. ent. nat. Hist. Soc.*, **5**, 121–6.

[illegible], T. G. (1973b). *South's British butterflies*. London, Warne.

[illegible], H. (1884). On the probable extinction of *Lycaena arion* in England. *Entomologist's [illegible] Mag.*, 21, 186–9.

[illegible], E. (1966). *Animal species and evolution*. Cambridge, Mass., Harvard University Press.

[illegible], J. (1973). Some aspects of the history and ecology of Blue butterflies in the Cotswolds. *Proc. Brit. ent. nat. Hist. Soc.*, 6, 77–84.

[illegible], J. (1974). *A survey of the breeding sites of Blue butterflies in Gloucestershire*. M.Sc. [illegible] University of Bristol.

[illegible], F. H. & Walters, S. M. (1962). *Atlas of the British flora*. London, Nelson.

[illegible], R. (1884). On the probable extinction of *Lycaena arion* in England. *Entomologist's mon. Mag.*, 21, 133–4.

[illegible], G. M. (1963). On causes of the decline of *Maculinea arion* L. (Lep., Lycaenidae) in Britain. *Entomologist*, 96, 199–210.

[illegible], T. C. E. (1968). Land-use changes affecting *Pulsatilla vulgaris* in England. *Biol. Conserv.*, 1, 37–43.

[illegible], S. (1948). On the roles of directed and random changes in gene frequency on the genetics of populations. *Evolution*, 2, 279–95.

THE ISLAND DILEMMA: LESSONS OF MODERN BIOGEOGRAPHIC STUDIES FOR THE DESIGN OF NATURAL RESERVES

JARED M. DIAMOND

Physiology Department, University of California Medical Center, Los Angeles, California 90024, USA

ABSTRACT

A system of natural reserves, each surrounded by altered habitat, resembles a system of islands from the point of view of species restricted to natural habitats. Recent advances in island biogeography may provide a detailed basis for understanding what to expect of such a system of reserves. The main conclusions are as follows:

The number of species that a reserve can hold at equilibrium is a function of its area and its isolation. Larger reserves, and reserves located close to other reserves, can hold more species.

If most of the area of a habitat is destroyed, and a fraction of the area is saved as a reserve, the reserve will initially contain more species than it can hold at equilibrium. The excess will gradually go extinct. The smaller the reserve, the higher will be the extinction rates. Estimates of these extinction rates for bird and mammal species have recently become available in a few cases.

Different species require different minimum areas to have a reasonable chance of survival.

Some geometric design principles are suggested in order to optimise the function of reserves in saving species.

INTRODUCTION

For terrestrial and freshwater plant and animal species, oceanic islands represent areas where the species can exist, surrounded by an area in which the species can survive poorly or not at all and which consequently represents a distributional barrier. Many situations that do not actually involve oceanic islands nevertheless possess the same distributional significance for many species. Thus, for alpine species a mountain top is a distributional 'island' surrounded by a 'sea' of lowlands;

for an aquatic species a lake or river is a distributional island surrounded by a sea of land: for a forest species a wooded tract is a distributional island surrounded by a sea of non-forest habitat; and for a species of the intertidal or shallow-water zones, these zones represent distributional islands compressed between seas of land and of deep water.

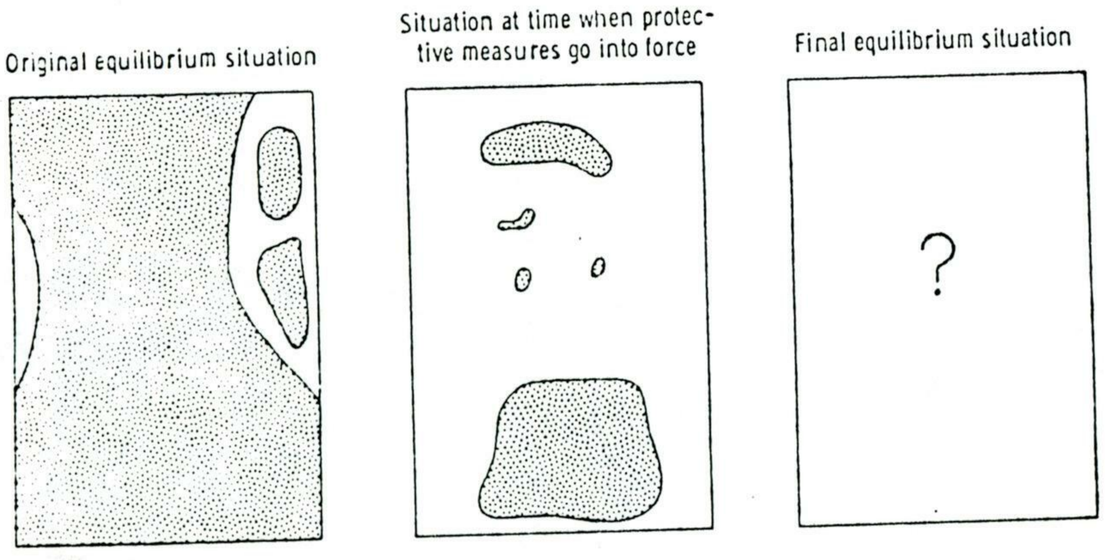


Fig. 1. Illustration of why the problems posed by designing a system of natural reserves are similar to the problems of island biogeography. In the situation before the onset of accelerating habitat destruction by modern man, many natural habitats were present as continuous expanses covering large areas (indicated by shaded areas of sketch on left). Species characteristic of such habitats were similarly distributed over large, relatively continuous expanses. By the time that extensive habitat destruction has occurred and some of the remaining fragments are declared natural reserves, the total area occupied by the habitat and its characteristic species is much reduced (centre sketch). The area is also fragmented into isolated pieces. For many species, such distributions are unstable. Applying the lessons of modern island biogeography to these islands of natural habitat surrounded by a sea of disturbed habitat may help predict their future prospects.

Throughout the world today the areas occupied by many natural habitats, and the distributional areas of many species, are undergoing two types of change (Fig. 1). First, the total area occupied by natural habitats and by species adversely affected by man is shrinking, at the expense of area occupied by man-made habitats and by species benefited by man. Second, formerly continuous natural habitats and distributional ranges of man-intolerant species are being fragmented into disjunctive pieces. If one applies the island metaphor to natural habitats and to man-intolerable species, island areas are shrinking, and large islands are being broken into archipelagos of small islands. These processes have important practical consequences for the future of natural habitats and man-intolerant species (Preston, 1962; Willis, 1974; Diamond, 1972, 1973; Terborgh, in press, *a*, *b*; Wilson & Willis, in press). Ecologists and biogeographers are gaining increasing

understanding of these processes as a result of the recent scientific revolution stemming from the work of MacArthur & Wilson (1963, 1967) and MacArthur (1972). In this paper I shall explore four implications of recent biogeographic work for conservation policies: (1) The ultimate *number* of species that a natural reserve will save is likely to be an increasing function of the reserve's area. (2) The *rate* at which species go extinct in a reserve is likely to be a decreasing function of the reserve's area. (3) The relation between reserved area and probability of a species' survival is characteristically different for different species. (4) Explicit suggestions can be made for the optimal geometric design of reserves.

HOW MANY SPECIES WILL SURVIVE?

Let us first examine the relation between reserve area and the number of species that the reserve can hold at equilibrium. As a practical illustration of this problem, consider the fact that we surely cannot save all the rain forest of the Amazon Basin. What fraction of Amazonia must be left as rain forest to guarantee the survival of half of Amazonia's plant and animal species, and how many species will actually survive if only 1% of Amazonia can be preserved as rain forest? Numerous model

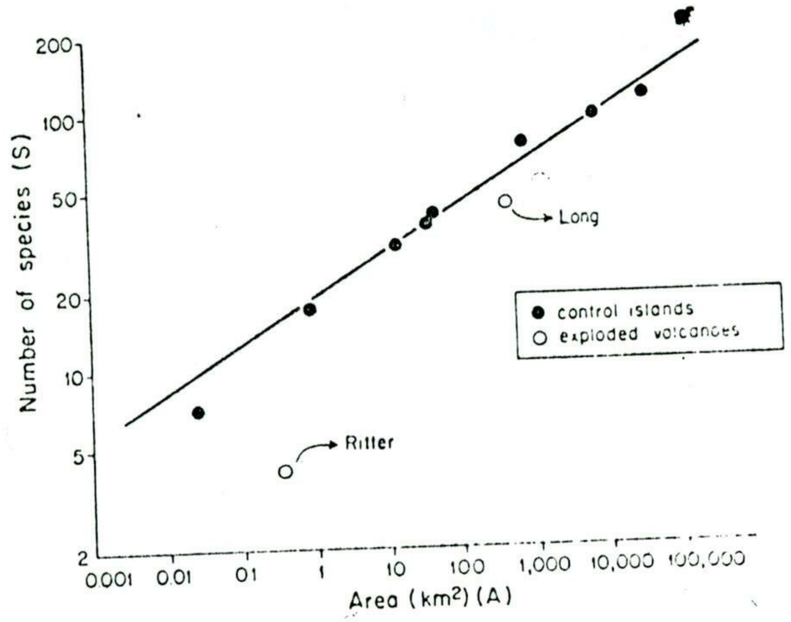


Fig. 2. Example of the relation between species number and island area in an archipelago. The ordinate is the number of resident, non-marine, lowland bird species (S) on the islands of Vitiaz and Dampier Straits near New Guinea in the south-west Pacific Ocean, plotted as a function of island area (A, in km²) on a double logarithmic scale. The points • represent relatively undisturbed islands. The straight line $S = 18.9A^{0.18}$ was fitted by least mean squares through the points for these islands. Note that species number increases regularly with island area. The two points ○ refer to Long and Ritter Islands, whose faunas were recently destroyed by volcanic explosions and which have not yet regained their equilibrium species number.

systems to suggest answers to these questions are provided by distributional studies of various plant or animal groups on various archipelagos throughout the world. If one compares islands of different size but with similar habitat and in the same archipelago, the number of species S on an island is usually found to increase with island area A in a double logarithmic relation:

$$S = S_0 A^z \quad (1)$$

where S_0 is a constant for a given species group in a given archipelago, and z usually assumes a value in the range 0.18-0.35 (Preston, 1962; MacArthur & Wilson, 1963, 1967; May, in press). A rough rule of thumb, corresponding to a z value of 0.30, is that a tenfold increase in island area means a twofold increase in the number of species. Figure 2 illustrates the species/area relation for the breeding land and freshwater bird species on the islands of the Bismarck Archipelago near New Guinea and shows that the number of bird species increases regularly with island area. If one compares islands of similar area but at different distances from the continent or large island that serves as the main source of colonisation, then one finds that the number of species on an island decreases with increasing distance. This feature is illustrated by Fig. 3, which shows that the number of bird species on

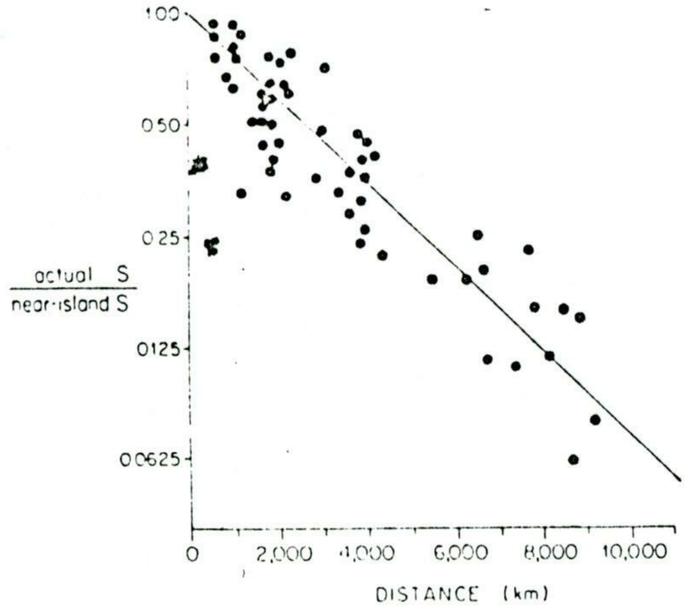


Fig. 3. Example of the relation between species number and island distance from the colonisation source in an island archipelago. The ordinate is the number of resident, non-marine, lowland bird species S on tropical south-west Pacific islands more than 500 km from New Guinea, divided by the number of species expected on an island of equivalent area less than 500 km from New Guinea. The expected near-island S was read off the species/area relation for such islands (Fig. 5). The abscissa is the island distance from New Guinea. Note that S decreases by a factor of 2 per 2600 km distance from New Guinea. (After Diamond, 1972.)

islands of the south-west Pacific decreases by a factor of 2 for each 2600 km of distance from New Guinea. For plants or animals with weaker powers of dispersal than birds, the fall-off in species number with distance is even more rapid.

Similar findings are obtained if, instead of oceanic islands, one compares habitat 'islands' within a continent or large island. For example, isolated as enclaves within the rain forest that covers most of New Guinea are two separate areas of savanna, which received most of their plant and animal species from Australia (Schodde & Calaby, 1972; Schodde & Hitchcock, 1972). The savanna which is larger and also closer to Australia supports twice as many savanna bird species as the smaller and more remote savanna (Fig. 4). Other examples are provided by mountains rising out of the 'sea' of lowlands, such as the isolated mountain ranges of Africa, South America, New Guinea and California. Thus, the number of bird species on each 'island' of alpine vegetation at high elevations in the northern Andes increases with area of alpine habitat and decreases with distance from the large alpine source area in the Andes of Ecuador (Vuilleumier, 1970).

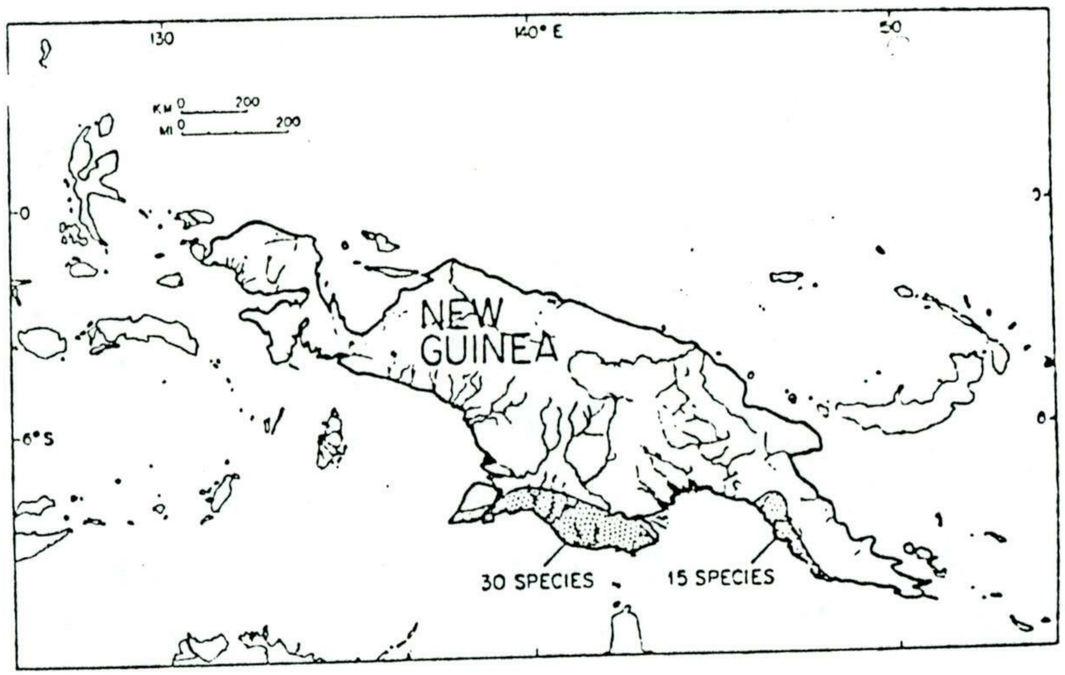


Fig. 4. Example of the relation between area of 'habitat islands' and the number of characteristic species they support. Most of New Guinea is covered by rain forest, but two separate areas on the south coast (shaded in the figure) support savanna woodland. The characteristic bird species of these savannas are mostly derived from Australia (the northern tips of Australia are just visible at the lower border of the figure). The so-called Trans-Fly savanna (left) not only has a larger area than the so-called Port Moresby savanna (right), but is also closer to the colonisation source of Australia. As a result, the Trans-Fly savanna supports twice as many bird species characteristic of savanna woodland (*c.* 30 compared with 15 species) as does the Port Moresby savanna.

Why is it that species number increases with increasing area of habitat but decreases with increasing isolation? In explanation of these findings, Preston (1962) and MacArthur & Wilson (1963, 1967) suggested that species number S on an island is set by (or approaches) an equilibrium between immigration rates and extinction rates. Species immigrate into an island as a result of dispersal of colonists from continents or other islands; the more remote the island, the lower is the immigration rate. Species established on an island run the risk of extinction due to fluctuation in population numbers; the smaller the island, the smaller is the population and the higher the extinction rate. Area also affects immigration and extinction rates in several other ways: through its relation to the regional magnitude of spatial and temporal variation in resources; by being correlated with the variety of available habitats as stressed by Lack (1973); and by being correlated with the number of 'hot spots', or sites of locally high utilisable resource production for a particular species (Diamond, in press). On a given island, extinction rates increase, and immigration rates decrease, with increasing S. The S value on an island in the steady state is the number at which immigration and extinction rates become equal. The larger and less isolated the island, the higher is the species number at which it should equilibrate.

The correctness of this interpretation has been established by several types of study. One has involved observing the increase in species number on an island whose fauna and/or flora have been destroyed. The most famous such study was provided by a 'natural experiment', the colonisation by birds of the vocanic island of Krakatoa after its fauna had been destroyed by an eruption in 1883 (Dammerman, 1948; see MacArthur & Wilson, 1967, pp. 43-51). Similar 'natural experiments' are provided by the birds of Long Island near New Guinea, whose fauna was destroyed by a volcanic eruption two centuries ago (*see* Fig. 2), and by the birds of seven coral islets in the Vitiaz-Dampier group near New Guinea, when a tidal wave destroyed the fauna in 1888 (Diamond, 1974). Simberloff & Wilson (1969) created an analogous 'artificial experiment' by fumigating several mangrove trees standing in the ocean off the coast of Florida and observing the recolonisation of these trees by arthropods. In all these studies, the number of species on the island returned within a relatively short time to the value appropriate to the island's area and isolation, confirming that this value really was an equilibrium value. Naturally, the rate of approach to equilibrium depends on the plant or animal group studied and the island's location: for example, successive surveys have shown the number of plant species on Krakatoa still to be rising and not yet to have reached equilibrium (Docters van Leeuwen, 1936; MacArthur & Wilson, 1967, p. 49).

Another type of test of the MacArthur-Wilson interpretation is provided by turnover studies at equilibrium. According to the MacArthur-Wilson interpretation, although the *number* of species on an island may remain near an equilibrium value, the *identities* of the species need not remain constant, because

new species are continually immigrating and other species are going extinct. Estimates of immigration and extinction rates at equilibrium have been obtained by comparing surveys of an island in separate years. Such studies have been carried out for the birds of the Channel Islands off California (Diamond, 1969; Hunt & Hunt, 1974; Jones & Diamond, in press), Karkar Island off New Guinea (Diamond, 1971), Vuatom Island off New Britain (Diamond, in press), and Mona Island off Puerto Rico (Terborgh & Faaborg, 1973). All these studies found that a certain number of species present in the earlier survey had disappeared by the time of the later survey, but that a similar number of other species immigrated in the intervening years, so that the total number of species remained approximately constant unless there was a major habitat disturbance. As expected from considering the risk of extinction in relation to population size, most of the populations that disappeared had initially consisted of few individuals. The turnover rates per year (immigration or extinction rates) observed in these studies have been in the order of 0.2-6% of the island's bird species for islands of 300-400 km^2 area.

Thus, the number of species that a reserve can 'hold' at equilibrium is likely to be set by a balance between immigration rates and extinction rates. The set-point will be at a larger number of species, the larger the reserve or the closer it is to a source of colonists:

1. If 90% of the area occupied by a habitat is converted by man into another habitat and the remaining 10% is saved as an undivided reserve, one might expect to save roughly about half of the species restricted to the preserved habitat type, while the populations of the remaining half of the species will eventually disappear from the reserve. It should be stressed explicitly that increased habitat diversity is part of the reason, but not the only one (*cf.* p. 134 for others), why larger areas hold more species. Thus, even if a reserve does include some of the type of habitat preferred by a threatened species, the species may still disappear because of population fluctuations, spatial or temporal variation in resources, and too few or too small 'hot spots'.

2. If one saves two reserves, the smaller reserve will retain fewer species if it is remote from the larger reserve than it would if it were near the larger reserve.

3. As the contrast increases between the preserved habitat types and the surrounding habitat types, or between the ecological requirements of a threatened species and the resources actually available in areas lying between reserves, the results of island biogeographic studies become increasingly relevant. The greater this contrast, the lower will be the population density of the threatened species in the area between reserves, and the lower will be the species' dispersal rate between the reserves. To some species the intervening area may be no barrier at all, while to other species it may be as much of a barrier as the ocean is to a flightless mammal.

HOW RAPIDLY WILL SPECIES GO EXTINCT ?

Suppose that 90% of a habitat is destroyed and the remaining 10% is saved as a faunal reserve. The reserve will initially support most, though not all, species restricted to the original expanse of habitat. (The actual proportion of the species present in such a portion of a larger habitat is discussed on pp. 9-10 and 16 of MacArthur & Wilson (1967).) However, we have just seen that at equilibrium the reserve will support only about half the species of the original expanse of habitat. Thus, at the time that the reserve is set aside, it will contain more species than its area can support at equilibrium as an island. Species will go extinct until the new equilibrium number is reached. Such a reserve will constitute the exact converse of an island which has had its fauna destroyed: equilibrium of species number will be approached from above, by an excess of extinction over immigration, rather than from below, by an excess of immigration over extinction. The important practical question thus arises: how rapidly will species number 'relax' to the new equilibrium value? If equilibrium times were of the order of millions of years, these extinctions would not be a matter of practical concern, whereas a reserve that lost half of its species in a decade would be unacceptable.

A natural experiment that permits one to assess 'relaxation rates' as a function of the reserve's area is provided by so-called land-bridge islands (Diamond, 1972, 1973). During the late Pleistocene, when much sea-water was locked up in glaciers, the ocean level was about 100-200 m lower than at present. Consequently, islands separated from continents or from larger islands by water less than 100 m deep formed part of the continents or larger islands, and shared the continental faunas and floras. Examples of such 'land-bridge islands' are Britain off Europe, Aru and other islands off New Guinea, Tasmania off Australia, Trinidad off South America, Borneo and Java off south-east Asia, and Fernando Po off Africa. When rising sea levels severed the land-bridges about 10,000 years ago, these land-bridge islands must have found themselves supersaturated; they initially supported a species-rich continental fauna rather than the smaller number of species appropriate to their area at equilibrium. Gradually, species must have been lost by an excess of extinctions over immigrations. Figure 5 illustrates how far the avifaunas of the satellite land-bridge islands of New Guinea have returned towards equilibrium in 10,000 years. The larger land-bridge islands, with areas of several hundred to several thousand km², still have more bird species than predicted for their area from the species/area relation based on islands at equilibrium, though they do have considerably fewer bird species than New Guinea itself. That is, the larger land-bridge islands have lost many but not all of their excess species in 10,000 years. However, land-bridge islands smaller than about 250 km² at present have the same number of bird species as similar-sized oceanic islands that never had a land-bridge. Thus, the smaller land-bridge islands have lost their entire excess of bird species in 10,000 years.

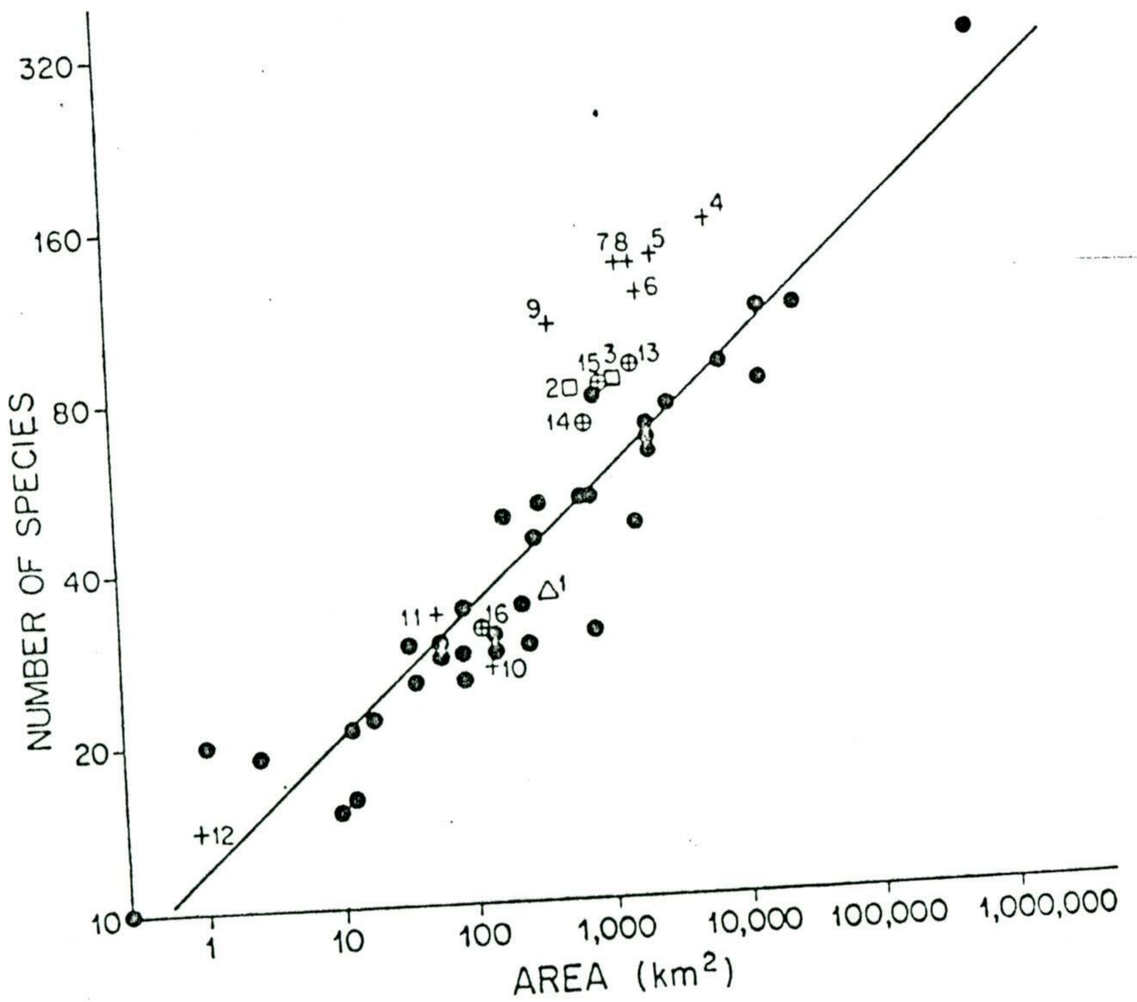


Fig. 5. Example of how one can use land-bridge islands to estimate extinction rates in the faunas of natural reserves. The ordinate is the number of resident, non-marine, lowland bird species on New Guinea satellite islands, plotted as a function of island area on a double logarithmic scale. The points • are islands which have not had a recent land-connection to New Guinea and whose avifaunas are presumed to be at equilibrium. The numbered point △ (1) refers to a recently exploded volcano whose avifauna has not yet returned to equilibrium; points + (4-12), to islands connected to New Guinea by land-bridges at times of lower sea-level 10,000 years ago; points ⊕ (13-16), to islands formerly connected by land-bridges to some other large island but not to New Guinea itself; and points □ (2-3), to islands that lie on a shallow shelf and had a much larger area at times of lower sea-level. Up to the time that the land-bridges were severed by rising sea-level, the New Guinea land-bridge islands (+, 4-12) must have supported nearly the full New Guinea quota of 325 lowland species (point in the upper right-hand corner). At present none of these land-bridge islands supports anything close to 325 species, the larger ones (+, 4-9) do, however, still have more species than expected at equilibrium (as given by points • and the straight line); and the smaller ones (+, 10-12) already have about the number of species expected at equilibrium. The conclusion is that no land-bridge island has been able to hold more than half its initial number of species, but that the larger islands have been able to hold an excess of species for longer. The same conclusion follows from points • and □. (From Diamond, 1972.)

The re-equilibration of land-bridge islands is the resultant of the extinction rate E (in species/year) exceeding the immigration rate I (in species/year) until an equilibrium species number S_{eq} is attained. Both I and E depend on the instantaneous species number $S(t)$, where t represents time (in years). As a highly simplified model, let us assume constant coefficients K_i and K_e (in year^{-1}) of immigration and extinction, respectively:

$$E = K_e S(t) \tag{2}$$

$$I = K_i[S^* - S(t)] \tag{3}$$

where S^* is the mainland species pool, and $[S^* - S(t)]$ is the number of species in the pool not present on the island at time t, hence available as potential immigrants. At equilibrium, when $dS/dt = I - E = 0$, S_{eq} is given by

$$S_{eq} = K_i S^*/(K_i + K_e) \tag{4}$$

If a land-bridge island initially (at $t = 0$) supports a species number $S(0)$ that exceeds S_{eq}, the rate at which $S(t)$ declines from $S(0)$ towards S_{eq} is obtained by integrating the differential equation

$$dS/dt = I - E = (K_i + K_e)[K_i S^*/(K_i + K_e) - S(t)]$$

with the boundary condition $S(t) = S(0)$ at $t = 0$, to obtain:

$$[S(t) - S_{eq}]/[S(0) - S_{eq}] = \exp(-t/t_r) \tag{5}$$

The relaxation time t_r is the length of time required for the species excess $[S(t) - S_{eq}]$ to relax to $1/e$ or 36.8% of the initial excess $[S(0) - S_{eq}]$, where e is the base of natural logarithms. Relaxation is 90% complete after 2.303 relaxation times.

As an example of the use of this formula, consider the land-bridge island of Misol near New Guinea. At the time 10,000 years ago when it formed part of New Guinea, Misol must have supported nearly the full New Guinea lowlands fauna of 325 bird species. With an area of 2040 km², Misol should support only 65 species at equilibrium, by comparison with the species/area relation for islands that lacked land-bridges and are at equilibrium. The present species number on Misol is 135, much less than the initial value of 325 but still in excess of the final equilibrium value. Substituting $S(0) = 325$, $S(t) = 135$, $S_{eq} = 65$, $t = 10{,}000$ years into eqn. (5) yields a relaxation time of 7600 years for the avifauna of Misol.

Similar calculations have been carried out for other land-bridge islands formerly connected to New Guinea, for islands formerly connected to some other large satellite island but not to New Guinea itself, and for islands that lie on a shallow-water shelf and that formerly must have been much larger in area although without

connection to a larger island. A similar analysis in a continental situation was mad by Brown (1971), who studied distributions of small non-volant mammals i forests which are now isolated on the tops of mountains rising out of western Nort American desert basins but which were formerly connected by a continuous fores belt during times of cooler Pleistocene climates. Terborgh (in press, *a*, *b*) has mad a similar analysis of the avifaunas of Caribbean islands and has dramatically confirmed the accuracy of his calculations by showing that they correctly predic the extinction rates observed within the present century on Barro Colorado Islan (Willis, 1974). Both Terborgh's analyses of Caribbean birds and mine of Ne Guinea birds show that relaxation times increase with increasing island area. Bot analyses also show that eqns. (2) and (3) are oversimplified: K_i actually increase with $S(t)$, and K_i decreases with $S(t)$.

Thus, the gradual decline of species number from a high initial value to a lowe equilibrium value on land-bridge islands may furnish a model for what coul happen when a fraction of an expanse of habitat is set aside as a reserve and th remaining habitat is destroyed. A small reserve not only will eventually contain fe species but will also initially lose species at a high rate. For reserves of a few km² extinction rates of sedentary bird and mammal species unable to colonise from on reserve to another are so high as to be easily measurable in a few decades. Within a few thousand years even a reserve of 1000 km² will have lost most such specie confined to the reserve habitat. These estimates assume that man's land-us practices do not grossly alter the preserved habitat. More rapid changes in specie composition are likely to occur if sylviculture or other human use changes th habitat structure.

WHAT SPECIES WILL SURVIVE?

In the preceding pages we have considered the problem of survival from a statistical point of view: what fraction of its initial fauna will a reserve eventually save, and how rapidly will the remainder go extinct? We have not yet considered the survival probabilities of individual species. If each species had equal probabilities of survival, then it would be a viable conservation strategy to be satisfied with large numbers of small reserves. Each such vest-pocket reserve would lose most of its species before reaching equilibrium, but with enough reserves any given species would be likely to be among the survivors in at least one reserve. In this section w shall examine the flaw in this strategy: different species have very different area requirements for survival.

The survival problem needs to be considered from two points of view: the chance that a reserve where a species has gone extinct will be recolonised from another reserve, and the chance that a species will go extinct in an isolated reserve. Consider the former question first. Suppose that there are many small reserves. Suppose next

that a given species is incapable of dispersing from one reserve to another across the intervening sea of unsuitable habitat. The isolated populations in each reserve run a finite risk of extinction. If there is no possibility of recolonisation, each extinction is irrevocable, and it is only a question of time before the last population of the species disappears. Suppose on the other hand that dispersal from one reserve to another is possible. Then, although a species temporarily goes extinct in one reserve, the species may have recolonised that reserve by the time it goes extinct in another reserve. If there are enough reserves or high enough recolonisation rates or low enough extinction rates, the chances of the species disappearing simultaneously from all reserves are low, and the long-term survival prospects are bright. Dispersal ability obviously differs enormously among plant and animal species. Flying animals tend to disperse better than non-flying ones; plants with wind-borne seeds tend to disperse better than plants with heavy nuts. The more sedentary the species, the more irrevocable is any local extinction, and the more difficult will it be to devise a successful conservation strategy. Thus, conservation problems will be most acute for slowly dispersing species in normally stable habitats, such as tropical rain forest. Even power of flight cannot be assumed to guarantee high dispersal ability. For instance, 134 of the 325 lowland bird species of New Guinea are absent from all oceanic islands more than a few km from New Guinea, and are confined to New Guinea plus islands with recent land-bridge connections to New Guinea. Similarly, many neotropical bird families with dozens of species have not even a single representative on a single New World island lacking a recent land-bridge to South or Central America; and not a single member of many large Asian bird families has been able to cross Wallace's Line separating the Sunda Shelf land-bridge islands from the oceanic islands of Indonesia. Such bird species have insuperable psychological barriers to crossing water gaps, and are generally characteristic of stable forest habitats. Thus, low recolonisation rates may mean either that a species *cannot* cross unsuitable habitats (a mountain forest rodent faced by a desert barrier), or that it *will not* cross unsuitable habitats (some tropical forest birds faced by a water gap).

Having seen that species vary in their ability to recolonise, let us now consider how species vary in extinction rates of local populations. The New Guinea land-bridge islands again offer a convenient test situation (Diamond, 1972, in press). Recall that these islands initially supported most of the New Guinea lowlands fauna, that the land-bridges were severed about 10,000 years ago, that 134 New Guinea lowlands bird species do not cross water gaps, and that any extinctions of populations of these species on the land-bridge islands cannot therefore have been reversed by recolonisation. Virtually all these species are now absent from all land-bridge islands smaller than 50 km², because extinction rates on small islands are so high that virtually no isolated population survives 10,000 years. However, these 134 species vary greatly today in their distribution on the seven larger (450-8000 km²) land-bridge islands. At the one extreme, some species, such as the

frilled monarch flycatcher *(Monarcha telescophthalmus)*, have survived on all seven islands. At the other extreme, 32 species have disappeared from all seven islands, and must be especially prone to extinction in isolated populations. Most of these 32 species fit into one or more of three categories: birds whose initial populations must have numbered few individuals because of very large territory requirements (*e.g.* the New Guinea harpy eagle *(Harpyopsis novaeguineae)*); birds whose initial populations must have numbered few individuals because of specialised habitat requirements (*e.g.* the swamp rail *(Megacrex inepta)*); and birds which are dependent on seasonal or patchy food sources and normally go through drastic population fluctuations (*e.g.* fruit-eaters and flower-feeders).

Another natural experiment in differential extinction is provided by New Hanover, an island of 1200 km² in the Bismarck Archipelago near New Guinea. In the late Pleistocene, New Hanover was connected by a land-bridge to the larger island of New Ireland and must then have shared most of New Ireland's species. Today New Hanover has lost about 22% of New Ireland's species, a fractional loss that does not sound serious. However, among these lost species are 19 of the 26 New Ireland species confined to the larger Bismarck islands, including every endemic Bismarck species in this category. That is, New Hanover differentially lost those species most in need of protection. As a faunal reserve, New Hanover would rate as a disaster. Yet its area of 1200 km² is not small by the standards of many of the tropical rain forest parks that one can realistically hope for today.

As a further example of a natural experiment in differential extinction, consider the mammals isolated on mountain tops rising from North American desert basins, mentioned in the previous section. Like the bird species restricted to the New Guinea land-bridge islands, the isolated populations of these mammal species have been exposed to the risk of extinction for the past 10,000 years, without opportunity for recolonisation. Today, some of these mammal species are still present on most of the mountains, while other species have disappeared from all but a few mountains. The species with the highest extinction rates are those whose initial populations must have numbered few individuals: either because the species is a carnivore rather than a herbivore, or because it has specialised habitat requirements, or because it is a large animal (Brown, 1971).

A method of quantifying the survival prospects of a species is to determine its so-called incidence function (Diamond, in press). On islands of the New Guinea region one notes that some bird species occur only on the largest and most species-rich islands; other species also occur on medium-sized islands; and others also occur on small islands. To display these patterns graphically, one groups islands into classes containing similar numbers of bird species (*e.g.* 1-4, 5-9, 10-20, 21-35, 36-50, etc.); calculates the *incidence J* or fraction of the islands in a given class on which a particular species occurs; and plots incidence against the total species number *S* on the island (Fig. 6). Since *S* is closely correlated with area, in effect these graphs represent the probability that a species will occur on an island of a particular size.

For most species, J goes to zero for S values below some value characteristic of the particular species, meaning that there is no chance of survival on islands below a certain size. These incidence functions can be interpreted in terms of the biology of the particular species (*e.g.* its population density, reproductive strategy, and dispersal ability). From these incidence functions one can estimate what chance a certain species has of surviving on a reserve of a certain size.

Thus, different species have different probabilities of persisting on a reserve of a given size. These probabilities depend on the abundance of the species and the

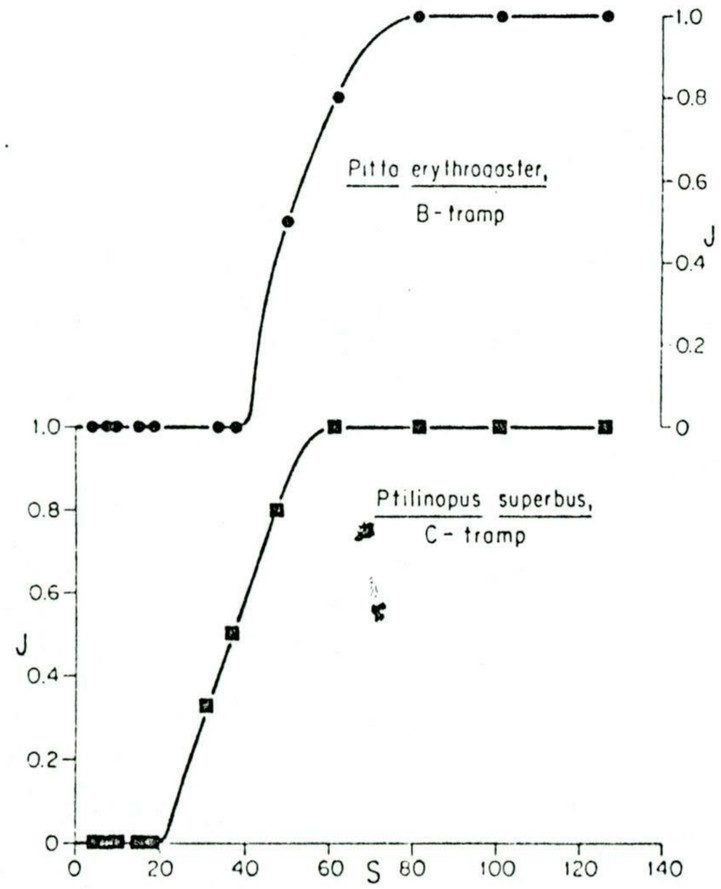


Fig. 6. So-called incidence functions for two bird species of the Bismarck Archipelago near New Guinea. The incidence $J(S)$ is defined as the fraction of the islands with a given total number of bird species S that a given species occurs on. For example, the so-called B-tramp *Pitta erythrogaster* (•) is on all islands (*i.e.* $J = 1.0$) with $S > 80$, on about half of the islands ($J = 0.5$) with S around 55, and on no island ($J = 0$) with $S < 40$. Other bird species of the Bismarck Archipelago have different incidence functions: for example, the so-called C-tramp *Ptilinopus superbus* (▪) is on all islands with $S > 60$ and on many islands ($J = 0.3$-0.8) with $S = 30$-50. Since S is mainly a function of island area, the message is that each species requires some characteristic minimum area of island for it to have a reasonable chance of surviving.

magnitude of its population fluctuations, and also on its ability to recolonise a reserve on which it has once gone extinct. Even on reserves as large as 10,000 km², some species have negligible prospects of long-term survival. Such species would be doomed by a system of many small reserves, even if the aggregate area of the system were large.

WHAT DESIGN PRINCIPLES WILL MINIMISE EXTINCTION RATES IN NATURAL RESERVES?

In the preceding sections we have examined how the eventual number of species that a reserve can hold is related to area, how extinction rates are related to area, and how area-dependent survival prospects vary among species. Given this background information, let us finally consider what the designer of natural

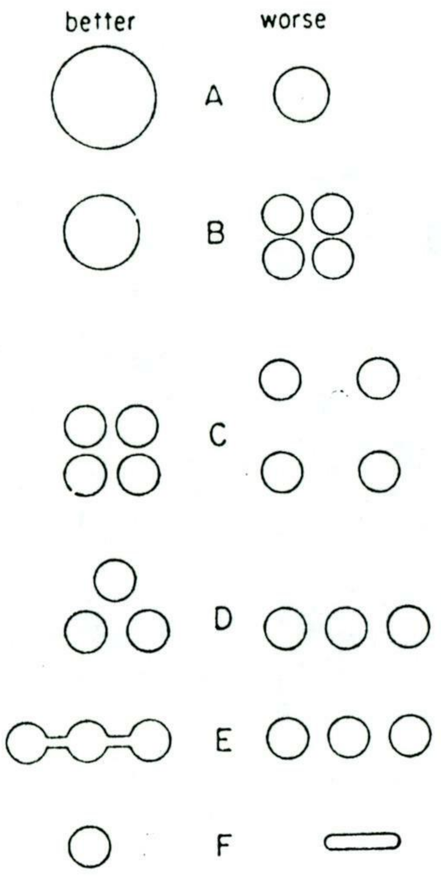


Fig. 7. Suggested geometric principles, derived from island biogeographic studies, for the design of natural reserves. In each of the six cases labelled A to F, species extinction rates will be lower for the reserve design on the left than for the reserve design on the right. See text for discussion.

reserves can do to minimise extinction rates (Diamond, 1972, 1973; Terborgh, in press, *a*, *b*, Wilson & Willis, in press). Figure 7 (modified from Wilson & Willis, in press) summarises a series of design principles, identified as A, B, C, D, E and F.

A large reserve is better than a small reserve (principle A), for two reasons: the large reserve can hold more species at equilibrium, and it will have lower extinction rates.

In practice, the area available for reserves must represent a compromise between competing social and political interests. Given a certain total area available for reserves in a homogeneous habitat, the reserve should generally be divided into as few disjunctive pieces as possible (principle B), for essentially the reasons underlying principle A. Many species that would have a good chance of surviving in a single large reserve would have their survival chances reduced if the same area were apportioned among several smaller reserves. Many species, especially those of tropical forests, are stopped by narrow dispersal barriers. For such species even a highway swath through a reserve could have the effect of converting one large island into two half-sized islands. Principle B needs to be qualified by the statement that separate reserves in an inhomogeneous region may each favour the survival of a different group of species; and that even in a homogeneous region, separate reserves may save more species of a set of vicariant similar species, one of which would ultimately exclude the others from a single reserve.

If the available area must be broken into several disjunctive reserves, then these reserves should be as close to each other as possible, if the habitat is homogeneous (principle C). Proximity will increase immigration rates between reserves, hence the probability that colonists from one reserve will reach another reserve where the population of the colonist species has gone extinct.

If there are several disjunctive reserves, these should ideally be grouped equidistant from each other rather than grouped linearly (principle D). An equidistant grouping means that populations from each reserve can readily recolonise, or be recolonised from, another reserve. In a linear arrangement, the terminal reserves are relatively remote from each other, reducing exchange of colonists.

If there are several disjunctive reserves, connecting them by strips of the protected habitat (Preston, 1962; Willis, 1974) may significantly improve their conservation function at little further cost in land withdrawn from development (principle E). This is because species of the protected habitat can then disperse between reserves without having to cross a sea of unsuitable habitat. Especially in the case of sedentary species with restricted habitat preferences, such as understorey rain forest species or some bird species of California oak woodland and chaparral, corridors between reserves may dramatically increase dispersal rates over what would otherwise be negligible values.

Any given reserve should be as nearly circular in shape as other considerations permit, to minimise dispersal distances within the reserve (principle F). If the

reserve is too elongate or has dead-end peninsulas, dispersal rates to outlying parts of the reserve from more central parts may be sufficiently low to perpetuate local extinctions by island-like effects.

ACKNOWLEDGEMENTS

Field work in the south-west Pacific was supported by the National Geographic Society, Explorers Club, American Philosophical Society, Chapman Fund and Sanford Trust of the American Museum of Natural History, and Alpha Helix New Guinea Program of the National Science Foundation.

REFERENCES

BROWN, J. H. (1971). Mammals on mountaintops: nonequilibrium insular biogeography. *Am. Nat.*, **105**, 467-78.

DAMMERMAN, K. W. (1948). The fauna of Krakatau 1883-1933. *Verh. Koninkl. Ned. Akad. Wetenschap. Afdel. Natuurk.*, 44(2), 1-594.

DIAMOND, J. M. (1969). Avifaunal equilibria and species turnover rates on the Channel Islands of California. *Proc. natn. Acad. Sci. USA*, **64**, 57-63.

DIAMOND, J. M. (1971). Comparison of faunal equilibrium turnover rates on a tropical island and a temperate island. *Proc. natn. Acad. Sci. USA*, **68**, 2742-5.

DIAMOND, J. M. (1972). Biogeographic kinetics: estimation of relaxation times for avifaunas of southwest Pacific islands. *Proc. natn. Acad. Sci. USA*, **69**, 3199-203.

DIAMOND, J. M. (1973). Distributional ecology of New Guinea birds. *Science, N.Y.*, **179**, 759-69.

DIAMOND, J. M. (1974). Colonization of exploded volcanic islands by birds: the supertramp strategy. *Science, N.Y.*, **184**, 802-6.

DIAMOND, J. M. (in press). Incidence functions, assembly rules, and resource coupling of New Guinea bird communities. In *Ecological structure of species communities*, ed. by M. L. Cody & J. M. Diamond. Cambridge, Mass., Harvard University Press.

DOCTERS VAN LEEUWEN, W. M. (1936). Krakatau, 1833 to 1933. *Ann. Jard. Bot. Buitenzorg*, **56-57**, 1-506.

HUNT, G. J. Jr & HUNT, M. W. (1974). Trophic levels and turnover rates: the avifauna of Santa Barbara Island, California. *Condor*.

JONES, H. L. & DIAMOND, J. M. (in press). *Species equilibrium and turnover in the avifauna of the California Channel Islands*. Princeton, N.J., Princeton University Press.

LACK, D. (1973). The numbers and species of hummingbirds in the West Indies. *Evolution*, **27**, 326-7.

MACARTHUR, R. H. & WILSON, E. O. (1963). An equilibrium theory of insular zoogeography. *Evolution*, **17**, 373-87.

MACARTHUR, R. H. & WILSON, E. O. (1967). *The theory of island biogeography*. Princeton, N.J., Princeton University Press.

MACARTHUR, R. H. (1972). *Geographical ecology*. New York, Harper & Row.

MAY, R. M. (in press). Patterns of species abundance and diversity. In *Ecological structure of species communities*, ed. by M. L. Cody & J. M. Diamond. Cambridge, Mass., Harvard University Press.

PRESTON, F. W. (1962). The canonical distribution of commonness and rarity. *Ecology*, **43**, 185-215, 410-32.

SCHODDE, R. & CALABY, J. H. (1972). The biogeography of the Australo-Papuan bird and mammal faunas in relation to Torres Strait. In *Bridge and barrier: the natural and cultural history of Torres Strait*, ed. by D. Walker, 257-300. Canberra, Australian National University.

SCHODDE, R. & HITCHCOCK, W. B. (1972). Birds. In *Encyclopedia of Papua and New Guinea*, **1**, ed. by P. A. Ryan, 67-86. Melbourne, Melbourne University Press.

SIMBERLOFF, D. S. & WILSON, E. O. (1969). Experimental zoogeography of islands: the colonization of empty islands. *Ecology*, 50, 278-96.
TERBORGH, J. W. (in press, *a*). Faunal equilibria and the design of wildlife preserves. In *Trends in tropical ecology*. New York, Academic Press.
TERBORGH, J. W. (in press, *b*). Preservation of natural diversity: the problem of extinction prone species. *BioScience*.
TERBORGH, J. W. & FAABORG, J. (1973). Turnover and ecological release in the avifauna of Mona Island, Puerto Rico. *Auk*, 90, 759-79.
VUILLEUMIER, F. (1970). Insular biogeography in continental regions. I. The northern Andes of South America. *Am. Nat.*, 104, 373-88.
WILLIS, E. O. (1974). Populations and local extinctions of birds on Barro Colorado Island, Panama. *Ecol. Monogr.*, 44, 153-69.
WILSON, E. O. & WILLIS, E. O. (in press). Applied biogeography. In *Ecological structure of species communities*, ed. by M. L. Cody & J. M. Diamond. Cambridge, Mass., Harvard University Press.

KHUTSE GAME RESERVE BC PRESERVING THE KALAHARI

JEFFREY L. DAWSON & THOMAS M. BU

Department of Wildlife and National
P.O. Box 131, Gaborone, Botswa

ABSTRACT

The central and southwestern Kalahari of Botswana square kilometres of semi-arid sandy plains, over wl hartebeest, wildebeest, springbok and gemsbok still ecosystem. About one-third of the area has been pre and one national park. The most accessible is Khutse of pans and dry savanna, located on the eastern edge habitats, wildlife and general ecology of Khutse are di be orientated towards preserving its essential wil ecological and educational purposes.

INTRODUCTION

Khutse Game Reserve, located in the eastern portio Botswana, comprises 2440 km² of typical Kalahari ha it is remote and largely undeveloped, its position a Gaborone, the capital of Botswana, gives it increasin as the most accessible reserve for viewing the Kalah

The central and south-western Kalahari of Bots largest relatively undisturbed ecosystems in Africa. It and gently undulating plain of sand, covered in open semi-arid climate, virtual absence of surface water made the area inimical to human settlement; po inhabitants live at subsistence level, with hunting, pastoralism as the main activities. Wildlife is heavi abundant; the most important animals are several s

*Present address: *Department of Wildlife, Michigan State Unive*

Biol. Conserv. (7) (1975)— © Applied Science Publishers Ltd, E
Printed in Great Britain

Attachment 4

Pine Bush Preserves

EXHIBIT 3

STATE OF NEW YORK
SUPREME COURT

COUNTY OF ALBANY

In the Matter of the Application of

SAVE THE PINE BUSH, INC., REZSIN ADAMS, President, JOHN WOLCOTT, GREGORY BELL, LINDA BECKER, MARK PLAAT and LYNNE JACKSON, as Officers and Individuals and Taxpayers; POINT OF WOODS CONDOMINIUMS; TURNING POINT CONDOMINIUMS I, II and III; H. RICHARD BARRETT, as an Individual and a Taxpayer,

Plaintiff-Petitioners,

-against-

THE CITY OF ALBANY and THE PLANNING BOARD; ENVIRONMENTAL QUALITY REVIEW BOARD and COMMON COUNCIL OF THE CITY OF ALBANY; THE ALBANY COUNTY INDUSTRIAL DEVELOPMENT AGENCY and WILLARD T. ANDERSON,

Defendant-Respondents.

Supreme Court, Albany County Special Term, May 17, 1985

Justice Edward S. Conway, presiding

(Calendar #15)

APPEARANCES:

OLIVER & OLIVER, Esqs.
Attorneys for Plaintiff-Petitioners
Lewis B. Oliver, Jr., Esq., of Counsel
156 Madison Avenue
Albany, New York 12202

RUTNIK & RUTNIK, Esqs.
Attorneys for Defendant-Respondent Anderson
Peter A. Lynch, Esq., of Counsel
112 State Street, Suite 1320
Albany, New York 12207

CONWAY, J:

This is an Article 78 proceeding in which plaintiff-petitioners seek a judgment: 1) that the Commercial-Pine Bush zoning district in the Zoning Ordinance of the City of Albany is null and void; 2) that Section 6 of the Site Plan Review Ordinance of the City of Albany is null and void; 3) declaring that the zoning change and site plan approval for the Madison Avenue Office Park is null and void; and 4) enjoining any construction or grading or issuance of grading or building permits or any other approval as to the Madison Avenue Office Park until the State Environmental Quality Review Act (SEQRA) has been complied with.

Plaintiff-petitioners also make a motion (which is denominated in their papers as a cross-motion) to sever the first counterclaim set forth in the amended verified answer of the defendant-respondent Willard T. Anderson which sets forth a cause of action for prima facie tort. The motion to sever the counterclaim is granted.

This is a declaratory judgment action to declare that certain zoning changes and actions by the defendant-respondents in the Pine Bush are null and void and should be preliminarily and permanently enjoined.

The plaintiff-petitioners contend, among other things, that the Pine Bush is a unique environmental area containing the only remaining large pine barrens on inland sand dunes in the United States and is the home of the Karner Blue butterfly

which is an endangered species, and that there is only 2000 to 4000 acres of pine barrens remaining in the Pine Bush out of an original tract of 40 square miles. That the Commercial-Pine Bush (C-PB) zoning district created by the Common Council of the City of Albany is null and void as no lead agency was designated prior to the enactment of the C-PB zoning district and the notification of involved agencies and lead agency designation procedures required by 6 NYCRR 617.6(d) were not complied with.

The petitioners further contend that the Common Council illegally and improperly delegated the responsibility to conduct environmental hearings and make the determination of significance or non-significance with respect to the enactment of the C-PB, to the Environmental Quality Review Board (EQRB) in violation of Environmental Conservation Law (ECL), Section 8-0111, Subd. 6. The enactment of the C-PB district was a Type I action under the SEQRA and therefore it requires the preparation of an Environmental Impact Statement (EIS) before any action may be taken pursuant to 6 NYCRR 617.12(a), and no EIS was prepared with respect to the environmental impact of the creation of the C-PB zoning district.

Further, the petitioners contend that Section 6 of the Site Plan Review Ordinance of the City of Albany, which establishes a Pine Bush Site Plan Review District in the area west of Fuller Road in the City of Albany, which in turn establishes criteria for site plan review of projects within

the Pine Bush Site Plan Review District by the Planning Board, is null and void, as no lead agency was designated prior to the enactment of Section 6 and the notification of involved agencies and lead agency designation procedures required by 6 NYCRR 617.6(d) were not complied with. Further, that it was a nullity as the enactment of Section 6 was a Type I action under SEQRA which required the preparation of an EIS prior to its enactment and the Common Council failed to look at the environmental impacts flowing from the enactment of Section 6 and failed to prepare a negative declaration or otherwise comply with 6 NYCRR 617.10(b) and failed to make written findings or otherwise comply with 6 NYCRR 617.9(c) prior to the enactment of Section 6.

Petitioners further contend that the zone change from R-1 to C-PB for the Madison Avenue Office Park is null and void because the Common Council failed to consider the cumulative impact of development proposals pending at the time of the approval. That during the time which the respondent agencies of the City of Albany had the environmental impact of the Madison Avenue Office Park under consideration, there were also under consideration by the said agencies 10 other development proposals comprising 295.9 acres which required plat approvals, zone changes or site plan approvals. That this constitutes approximately 54% of all remaining undeveloped acres in the Pine Bush within the City of Albany, and 6 NYCRR 617.11(a)(11) and 617.11(b) require the Common Council, the Planning Board

and the EQRB to consider the cumulative impact of all the proposed developments in the remaining Albany Pine Bush.

It is the contention of the respondents that the enactment of the C-PB zoning district by the City of Albany Common Council was made in accordance with a well considered plan in accordance with General City Law, Section 20, Subd. 25 and was made in compliance with the SEQRA.

It is the further contention of the respondents that the record clearly establishes that the Common Council did provide intelligible standards to the Site Plan Review Agency in considering actions proposed for a C-PB zoned area when it enacted the new Article 7-A of the City of Albany Zoning Ordinance and that the provisions of new Article 7-A of the City of Albany Zoning Ordinance, entitled "Site Plan Review", creates intelligible standards and practical limitations on the Site Plan Review Agency in applying that part of the C-PB zoning classification which allows as a principally permitted use "single story office buildings or otherwise conforming to the land contour" as determined by the appropriate Site Plan Review Agency. That the standard review is intelligible, definite, in full compliance with SEQRA, and is not an illegal delegation of authority, and the enactment of the Site Plan Review by the Common Council was not a "Type I" action inasmuch as it merely amended a part of an existing zoning ordinance.

Respondents further contend that the Common Council clearly took a hard look at the environmental impacts

associated with the proposed Madison Avenue Office Park, as well as the cumulative impact of all other relevant proposals and that the preparation, approval, filing and publication of the Draft Environmental Impact Statement (DEIS) and the Final Environmental Impact Statement (FEIS) for the Madison Avenue Office Park was made in full compliance with the procedural guidelines set forth in 6 NYCRR, Part 617 (SEQRA).

It is the opinion of this Court that the zone change for the Madison Avenue Office Park is a nullity because the Common Council failed to consider the cumulative impact of some 10 other projects which were pending before various agencies of the City of Albany simultaneously with the Madison Avenue Office Park. All of these projects are located in the Pine Bush area which is the area bounded by Routes 5, 20, 146 and Fuller Road. The other projects, if approved and constructed, will have a severe and deleterious cumulative effect on the Pine Bush as a whole, beyond the boundaries of individual project sites. These harmful environmental impacts are cumulative because they increase in magnitude and severity as the number of individual projects constructed increases. These impacts could cause the loss of the unique pine barrens vegetation and rare and unusual plant and animal species which characterize the Pine Bush as a distinct natural region within New York State and the Northeast.

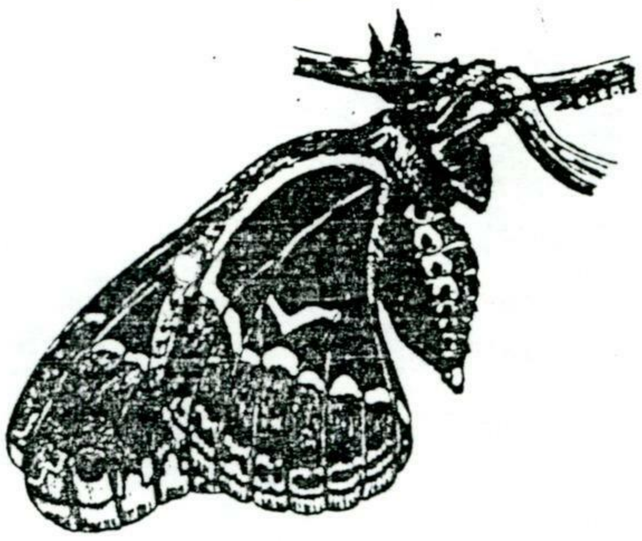
These cumulative impacts and their multiplied effects from many individual projects should have been considered in the environmental review process before the decision was made concerning the Madison Avenue Office Park.

In this Court's opinion, the petitioners contention, that the zone change for the Madison Avenue Office Park is null and void because the Common Council failed to consider the cumulative impact of development proposals pending at the time, is correct. It is therefore unnecessary to rule on the other contentions and the petitioners are entitled to judgment for all the relief demanded in their complaint.

Petitioners to submit order on two days' notice to all other attorneys of record.

All papers to the Attorneys for Plaintiff-Petitioners
for filing upon entry of the order hereon.
Decision mailed 6/24/85. Copies to all Parties.

EXHIBIT 4



John F. Cryan

19 Tomkins Court
Commack, New York 11725
(516) 543-8946

21 March 1986

Willard A. Bruce
City of Albany Planning Board
City Hall
Albany, New York 12207

Dear Mr. Bruce:

This letter is my review of the Draft Generic Environmental Impact Statement (DGEIS) for nine development proposals in the Albany Pine Bush. As you know, last year I prepared an affidavit on the cumulative impacts of these development proposals upon the Pine Bush. This affidavit formed part of the basis of the Supreme Court decision requiring the identification and analysis of the cumulative impacts of these and other development projects on the Pine Bush before the City of Albany made its decisions on whether to approve these projects. I attach a copy of this affidavit to this letter.

My cumulative impact affidavit identified and discussed some of the major cumulative impacts of these nine projects upon the Pine Bush. They included:

1) Ecological "island effects" resulting from the diminishing and fragmentation of the Pine Bush "island" by development. This is the major cumulative impact of these projects upon the Pine Bush, and is in turn the cause of many of the following impacts.

2) Losses of the rarest and most endangered species in the Pine Bush, like the Karner Blue Butterfly, Buck Moth, Hognose Snake, and Birdsfoot Violet, as a result of direct habitat destruction, island effects which reduce their essential habitats to areas too small for population survival, or habitat changes caused by lack of wildfires, edge effects, or other environmental impacts triggered by island effects.

3) Reduction or suppression of the required wildfires at ten- to fifteen-year intervals. Without these fires, the upland Pine Bush ecosystem will be invaded and destroyed by weedy plants, with the loss of its rare and endangered species.

4) "Edge effects" caused by the fragmentation of the Pine Bush by development with its buildings, pavement, and artificial landscape plantings. As developed edges along the natural pine barrens preserves increase, more weedy plants will invade and choke the preserves at faster rates. This will also happen as natural areas are reduced and fragmented.

5) Direct habitat destruction, a little at a time, by each development project. This will cause direct losses of critical endangered species habitat and destruction of vital portions of the Pitch Pine/Scrub Oak or pine barrens plant community. This community is down to only about 2,000 acres, or less than five percent of its original size.

6) Increased human access to, and destruction of, the natural areas in the Pine Bush as a result of locating a greater human population in the Pine Bush. Such deleterious activities as off-road vehicle use, illegal hunting and shooting, dumping, trampling, and vandalism will all increase in the natural areas from greater human population size and proximity.

7) Groundwater degradation, and resultant wetland water quality and vegetative impairment, caused by more nutrients and pollutants entering Pine Bush aquifers from developed areas.

8) Secondary ecological effects, such as the loss of many species of nocturnal flying insects, some of them rare and endangered, from the Pine Bush due to increased outdoor night lighting, which attracts thousands of species of nocturnal insects and prevents them from reproducing. This will harm the entire food chain of the Pine Bush, including reptiles, amphibians, birds, and mammals.

9) The physical effects of these changes, particularly as they affect the delicate Pine Bush ecosystem. For example, increased air pollution from vehicles and fixed sources will cause the demise of the pollution-sensitive lichen species growing in the Pine Bush. Or the imposition of streets, traffic, parking lots, and buildings and other hostile habitats will cause increased mortality and lower reproductive success in rare species like the Karner Blue, Buck Moth, and Hognose Snake, resulting in population reductions and extirpations.

10) The <u>synergistic effects</u>, or combined and multiplied effects, of all of the environmental impacts listed above acting together, over the course of all of the development projects throughout the Pine Bush. All of thse impacts are related to one another, cause one another, or, when taken together, have impacts greater or different than when taken separately. Synergistic effects are true cumulative impacts because many of them are not immediately apparent, but take time or many development projects to become visible.

To be a complete and adequate document for the purposes of deciding whether to approve or deny these projects, this DGEIS must meet all of the requirements of the State Environmental Quality Review Act (SEQR), Chapter 8 of the Environmental Conservation Law, 6 NYCRR Part 617. To do this, the DGEIS must identify all relevant environmental impacts, take a "hard look" at them, and make a "reasoned elaboration" of the basis for its determinations about these impacts (H.C.M.E.S. v NYS Urban Development Corp., 69 A. D. 2nd 222, 418 N. Y. S. 2nd 827, 13 July 79).

To take a "hard look" at environmental impacts requires the DGEIS to completely, precisely, and accurately describe such impacts; identify and evaluate all viable alternatives to environmentally-damaging actions; and examine synergistic effects — the impacts of two or more environmental impacts acting together. Cumulative impacts often involve synergistic effects. To properly analyse such cumulative impacts as I listed above, quantitative, scientific, research-based data is needed.

The essential question, then, is this: Does this DGEIS satisfy the Supreme Court's mandate to correctly and adequately identify, assess, and evaluate the cumulative environmental impacts of these projects upon the Pine Bush? The answer is that it does not.

The DGEIS is incomplete under SEQR and in light of SEQR case law because it fails to take the required "hard look" at the cumulative environmental impacts in this case, and because it fails to make a "reasoned elaboration" of the basis for its conclusions. The document is incomplete under SEQR for the following reasons:

1) Although it correctly identifies some of the important cumulative impacts of the development projects on the Pine Bush, the DGEIS fails to identify or discuss many other impacts at all, including the following:

   a) The damage to natural areas in the Pine Bush caused by increased human access generally and by off-road vehicles, dumping, trampling, removal of plants and animals, illegal hunting, and vandalism generated by placing more people in the center of the Pine Bush.

   b) The harm that increased night lighting will cause to nocturnal insects, including rare pine barrens species, and the Pine Bush ecological food chains dependent on them.

   c) The continued destruction of the Pine Bush lichen flora by increased air pollution.

   d) The specific impacts of additional streets, pavement, buildings, traffic, and other hostile human-made environments upon the movements and reproductive successes of Pine Bush animal species, especially rare or endangered ones, and upon the abilities of native pine barrens plants to disperse to and colonize different areas.

   e) All of the many and varied synergistic environmental impacts caused by individual impacts working in concert.

2) The DGEIS fails to assess the magnitude of the impacts that it does discuss; i. e., it does not say how strong or severe these impacts will be, how important they are relative to one another, or how they will affect the Pine Bush over

various periods of time. There is no statement ranking the impacts in importance. One is left to guess the relative importance of the impacts discussed from the amount of page space and appendix space devoted to each one, and from this measure it would seem that the traffic, air pollution, and economic effects are much more important than the ecological impacts, when in fact just the opposite is true.

3) The discussions of the most important cumulative impacts — island effects, disruption and suppression of fires, edge effects, direct habitat destruction, endangered species losses, and shifts in the Pitch Pine/Scrub Oak plant community — are not based on concrete, scientific data for the most part, are vague and general, rather than specific, and lack the level of detail necessary to take the required "hard look" at these vitally important impacts. The "reasoned elaboration" required as a basis for permit decisions is impossible without the hard, detailed, scientific data needed to justify conclusions about whether these projects can be allowed or not. The data needed in this DGEIS is not the voluminous, esoteric, or academic sort found in narrow, scholarly works, but relevant, solid facts to help answer questions like the following: How many Pine Bush species will be lost if these projects are approved? Which species will be lost from island effects? Will endangered species like the Buck Moth or the Karner Blue be the first to go? Which species will be lost from direct habitat destruction? How will fire frequencies and intensities be affected? Which plant species will invade the pine barrens more? At what rates? Will political pressure from the new residents stop all fires in the Pine Bush? How will the "domino effect" — the demand for more development in the vicinity of new development — affect the undeveloped Pine Bush land outside the nine projects? This DGEIS answers none of these, and dozens more, vital questions about the environmental impacts of these projects. It is incomplete because it does not contain the data needed to answer these questions in a sound, scientific way.

4) The DGEIS has an almost complete lack of quantitative data on the most important cumulative environmental impacts: island effects, species losses, vegetative degradation, suppression of wildfires, and synergistic effects — in short, the ecological impacts. This is very surprising because these are obviously the most important environmental impacts and the GDEIS does gather and present copious quantitative data on far less important impacts like traffic, air quality, and economic impacts that are far less germaine to the central question: Can the Pine Bush survive these nine, or indeed any more, developments in its central, 2,000-acre core area? Only ecological, scientific, quantitative data can answer this question, and this GDEIS contains almost none. The following is some of the basic hard data needed to make the GDEIS complete:

a) Species-area curves showing the effects of core area reduction on the species diversity of the Pine Bush.

This is the most important data needed to assess island effects, and it is absent from the DGEIS. Species-area curves should be done for all species, as well as selected groups, like the birds, mammals, reptiles and amphibians, insects, and vascular plants.

b) A map showing all of the existing vegetation in the City of Albany Pine Bush, broken down into easily recognizable and scientifically-based vegetation types, so that losses of specific vegetation types can be assessed. There is no such map in the DGEIS. The Nature Conservancy Heritage Program lines are not accurate or precise enough to make reliable calculations of the acreage of Pitch Pine/Scrub Oak vegetation, for example, possible. These lines are just rough indications of the location of the best pine barrens vegetation.

c) Aerial photos showing existing conditions in the Albany portion of the Pine Bush.

d) The plants, animals, and ecological communities found on each site, rather than the general species lists for the Pine Bush based on literature rather than field research. If this information is not included in the DGEIS, it will have to be included in separate, site-specific impact statements for each project.

e) Maps showing critical habitat areas for the many other rare and endangered Pine Bush species other than the Karner Blue, like the Buck Moth, Hognose Snake, Worm Snake, Perseus Dusky Wing Skipper, Spadefoot Toad, and Birdsfoot Violet. The Karner Blue distribution map is eight years old and very inaccurate; better data exists which shows that the Karner Blue uses over half of the acreage proposed for development as part of its essential habitat.

f) Tables and maps of past wildfire frequencies, intensities, ignition points, causes, directions, location, acreages affected, temperatures, speeds, kill percentage of plant species, and effects on vegetation and regrowth rates and species eliminated. This data should be gathered for the Pine Bush and other pine barrens areas to use as a baseline to assess impacts of development and natural pine barrens reduction and fragmentation on wildfires.

g) Ecological data on minimum area requirements, minimum population sizes, and other parameters of species survival for at least the rarest Pine Bush species, so that accurate predictions could be made of which species would be lost if the Pine Bush core area dropped below a minimum size. Also, data on autecology, life histories, hostplant or prey requirements, and other habitat needs for the rarest Pine Bush species.

h) Data matrices should be created which show the synergistic, or multiplied effects, of any and all combinations of cumulative impacts listed earlier in this letter. For example, what are the combined impacts of habitat area reduction or fragmentation and wildfire suppression? Or direct habitat destruction and greater mortality rates from more vehicular traffic and hostile built environments? Or all four? Multivariate analyses should be done to assess synergistic effects of two or more impacts.

5) The DGEIS contains many erroneous, vague, or conflicting conclusions because of its incomplete or inaccurate data. For example, the relationship between habitat area size and fire management capability is very simple in reality — the more pine barrens area preserved, and the more contiguous it is, the easier it will be to have controlled wildfires. The DGEIS makes it seem that fire management will be less difficult under the full development alternative than under the no development alternative it discusses; this is obviously absurd. The DGEIS concludes that the Karner Meadows/Blueberry Hill area should not be preserved, and in another section states that this area should be acquired for preservation if funds can be found. Existing data show that this area is the third largest contiguous Pitch Pine/Scrub Oak habitat left in the Pine Bush; that it is a vital Karner Blue and Buck Moth critical habitat area, that it is connected to the rest of the Pine Bush to the west and north, and that it can burn naturally without threatening nearby houses (it burned twice recently, in 1978 and 1979, and again in 1983, without harming adjacent homes to the south). Or the DGEIS states that only 38 acres of essential habitat for the Karner Blue will be destroyed by the nine projects, when the real figure is about 120 acres, based on my research from 1980 to 1985, which supplants the data in my 1980 report to the DEC relied upon by the DGEIS. Much of this Karner Blue habitat is at Karner Meadows.

6) The DGEIS presents the wrong data on fire management techniques because of a lack of information on fire needs and fire effects in the Pine Bush. The Pine Bush is a heavy fuel, high fire frequency pine barrens area. It accumulates fuel at two to ten times the rate of the Long Island Pine Barrens, for example, because its sands hold more water and nutrients, so the plants grow faster and produce more biomass per year. Accordingly, the Pine Bush requires hot, fast spring fires to maintain its pine barrens vegetation. None of the five burning techniques will accomplish this; most produce fires too slow or too cool to maintain healthy regrowth of this plant community. Any form of clearing or windrowing is clearly inappropriate in the Pine Bush, as it will destroy endangered species like the Buck Moth and ruin the aesthetic character of the existing pine barrens vegetation. Hot, fast fires are also necessary to kill the aggressive invading weed trees that have taken over large stretches of developed Pine

Bush to the west, and threaten to completely overwhelm the tiny, 2,000-acre core area remaining. The only way these fire requirements can be met is to burn large blocks of land — 200 or more acres at a time — and use the existing road and trail systems as fire breaks and fire lines. This means that there can be no development in the central core area, and that there is already too much development for ideal fire management. The DGEIS should have presented this information, because it is vital to understanding the relationship between the nine projects and the ability to maintain fire-dependent pine barrens vegetation in the Pine Bush core.

7) The DGEIS completely fails to identify alternative sites for each of the nine projects that are outside the Pine Bush core area, either elsewhere within the City of Albany's boundaries, or somewhere nearby in the surrounding Capital District. If there is really need for these sorts of residential and commercial projects, why do they have to be built in the heart of the last five percent of one of the most environmentally sensitive and significant areas in the entire state, when there are plenty of other, much less critical areas available? The reasons offered for siting these projects in the critical core Pine Bush area are very feeble. The City claims to have invested $ 9 million in infrastructure in the Pine Bush, and wants to make sure the investment is used. Well, the City should have examined the environmental consequences of that investment before putting that money in the ground in the form of roads and utilities and sewers. The $ 9 million investment was a misguided policy decision made by the City to encourage development in the Pine Bush, and has caused much of the development pressure that has nearly destroyed this unique natural area. Is not the Pine Bush worth much more than $ 9 million to present and future generations? Is it not in fact priceless? So why should the mistakes of the past make a fait accompli of the future? The SEQR process was created to help us avoid the environmental mistakes of the past, to stop mindless, uncontrolled development, and to insure that decisions are made based on facts, not politics. The consideration of alternate sites for these nine projects and for any other project proposed in the Pine Bush core area is a vital part of the SEQR process, and this DGEIS is incomplete under SEQR because it fails to consider alternate sites for the projects. The following information should be added to the DGEIS:

a) A map showing all of the vacant parcels and their zoning in the City of Albany, and which of these sites are suitable alternatives for each type of project. I know, for example, that the City has a decaying and underutilized warehouse district north of SUNYA and the State Office Building Campus that could take many new commercial, office, or industrial projects proposed for the Pine Bush. The City also has old, run-down residential districts

which could be redeveloped instead of destroying critical Pine Bush natural areas.

b) Identification of alternate sites for each type of project in surrounding, nearby Capital District towns or villages if it is proven that no alternate sites exist within the City of Albany.

c) Consideration of City of Albany acquisition of all of its remaining undeveloped Pine Bush land through a city bond issue or a special section of the upcoming state environmental bond issue.

d) Consideration of additional state payments to the City in lieu of the tax revenues lost if either the City of Albany or the state buys up the remaining undeveloped Pine Bush land within the City limits. This would save the City from any tax losses if it preserved the remainder of the Pine Bush core.

I would like to conclude with a few thoughts about the SEQR process and my own assessment of the impacts of development in the Pine Bush core.

The SEQR process is not another ministerial act of government, not just some formula or routine to follow. The lead agency is not just supposed to run through the steps of preparing an environmental impact statement in rote fashion, accept it as complete, hold hearings, take public comments, then just go ahead and decide to do what it wanted to anyway. No, SEQR mandates that the decision be based on the facts about environmental impacts, that the least environmentally damaging choice be made, and that all alternatives be evaluated, and an alternative chosen if it is better than what is proposed.

I have been studying the Pine Bush and its rare and endangered species for over thirteen years. In the course of that time I have gathered a large and invaluable body of field data about the ecology of the Pine Bush and the effects of development upon this fragile and unique area. Some of this data has been scientifically analysed and published, and much remains to be examined. I believe my research experience in the Pine Bush is second to none, and I have drawn a single conclusion which is supported by all of my various research projects in the Pine Bush and many other pine barrens areas: <u>The Pine Bush is now at or below the minimum acreage it needs to survive</u>. There is only about 2,000 acres of pine barrens vegetation left at the Pine Bush core. Every acre left is needed to ensure the survival of the pine barrens ecosystem and the remaining rare and endangered species it supports. The attached species-area graph, which I have prepared from my field investigations, shows that 2,000 acres is at the "break point" for pine barrens islands. Below that size, pine barrens areas lose species rapidly from island effects, and the rarest ones go first. Vegetative integrity also declines rapidly below 2,000 acres from fire suppression, edge effects, weedy plant invasion, and other

causes. If the Pine Bush and its endangered species like the Karner Blue and Buck Moth are to be saved, no more development must be allowed in the core area, and the remaining undeveloped land in the core area must be acquired and preserved. The Nature Conservancy has made a commitment to start that task, but the City of Albany must, with the help of the state, finish it.

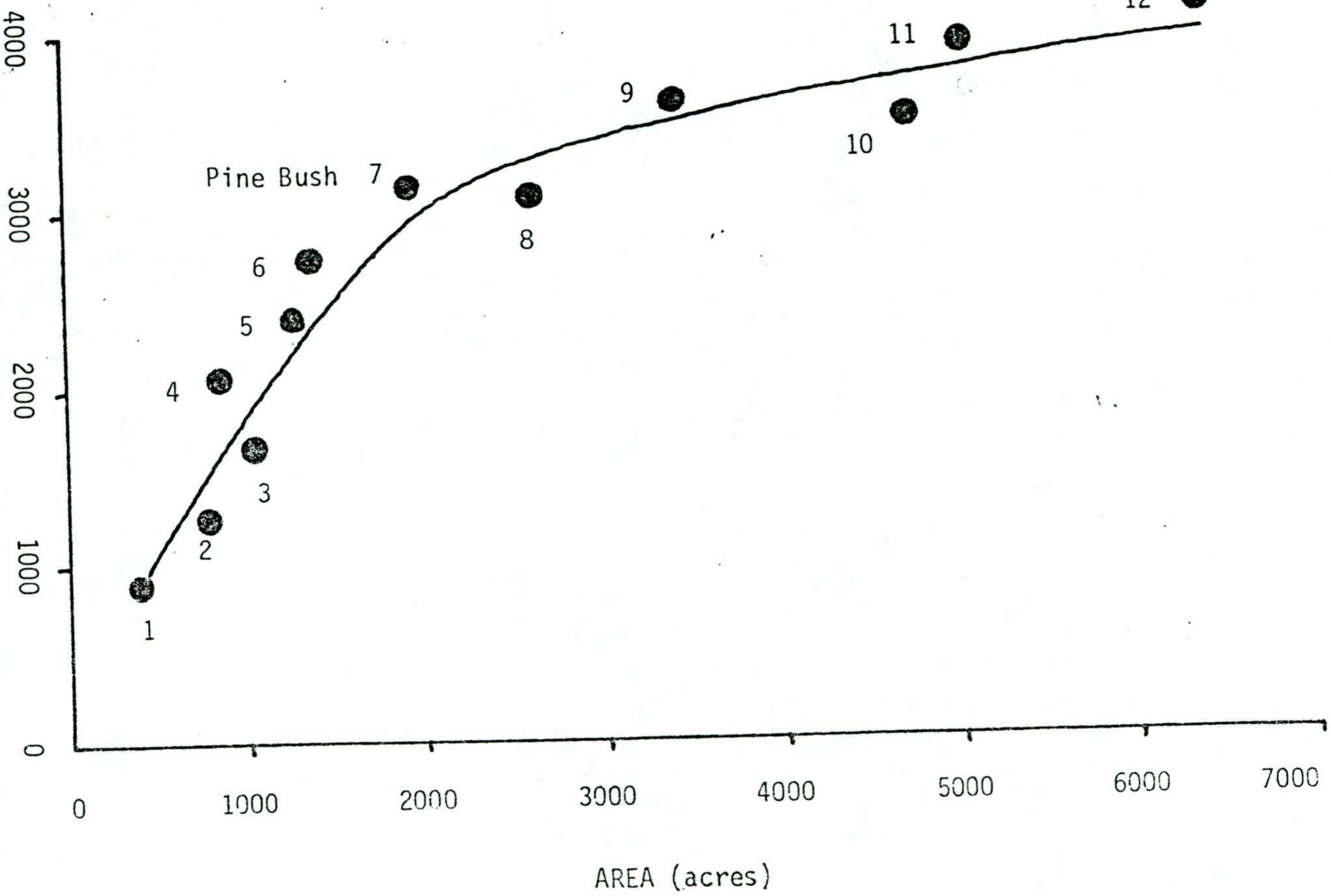
The City should seize this last opportunity to plan for and correctly decide the future of the entire Pine Bush area within its borders. The Draft Generic Environmental Impact Statement is incomplete and needs major additions and revisions before it can serve as a decision-making document for the Pine Bush. It should be enlarged to serve as a decision-making document for the entire Pine Bush, not just the nine projects considered. In this way, the City can fulfill its legal obligation to uphold the letter and spirit of SEQR and the Supreme Court decision requiring complete analysis of cumulative impacts of development. The City can also then fulfill its moral obligation to preserve enough of the Pine Bush so that this great natural area will remain to give its many benefits -- rare and beautiful species, scenic vistas, wetlands, historic and cultural resources, peace and tranquility -- to all future generations.

Very truly yours,

John F. Cryan

John F. Cryan

enc.



SPECIES-AREA CURVE for Pine Barrens ecological islands. The species numbers for each area are the total numbers of vascular plants, vertebrates, and diurnal insect groups found at each Pine Barrens site from 1972 to 1985. Note that the "break point" of the curve lies at about the 2,000-acre area size. The Albany Pine Bush core area is at that size now. Below this size, species diversity declines rapidly. Areas:

1)	ITT Pine Barrens, Hauppauge, LI, NY	400 acres
2)	Oak Brush Plains at Pinelawn, LI, NY	800 acres
3)	Montague Sand Plain, MA	1,100 acres
4)	Calverton National Cemetery, LI	900 acres
5)	South Fork Pine Barrens, LI	1,300 acres
6)	Oak Brush Plains at Edgewood, LI	1,400 acres
7)	Pine Bush	2,000 acres
8)	Brookhaven State Park, LI	2,500 acres
9)	Connetquot State Park, LI	3,500 acres
10)	Manorville Hills, LI	4,800 acres
11)	Riverhead Hills, LII	5,000 acres
12)	Dwarf Pine Plains and vicinity, LI	6,400 acres

AFFIDAVIT ON PINE BUSH 8 SEPT. 1986

EXHIBIT 5

STATE OF NEW YORK)
: SS.:
COUNTY OF NEW YORK)

JOHN F. CRYAN, being duly sworn, deposes and says:

1. My qualifications are summarized in Paragraph 1 and Attachment 1 of Exhibit 1 to this affidavit. I have been conducting research on the plants, animals, vegetation, fire ecology, endangered species (especially the Karner Blue Butterfly and the Buck Moth), and other scientific aspects of the Albany Pine Bush since 1973.

2. I have been very interested in, and a key participant in, the recent debate over the cumulative impacts of development upon the central "core area" of the Pine Bush. On 3 March 1985, I wrote an affidavit for Save the Pine Bush, Inc., et al, in support of their petition before State Supreme Court to, among other things, require the City of Albany, as lead agency under the State Environmental Quality Review Act (SEQR; Article 8 of the Environmental Conservation Law), to examine the cumulative impacts of development within the Pine Bush before approving an individual project proposal. The 1985 Cryan affidavit is Exhibit 1 of this affidavit. It lists and describes the major cumulative impacts of development in the Pine Bush, and says the major cumulative impact is the "island effect".

3. On 17 May 1985, State Supreme Court Justice Edward S. Conway issued a decision (Exhibit 2 of this affidavit). This decision affirmed that the City of Albany should have considered the cumulative impacts of development on the Pine Bush before approving an individual project proposal.

4. Upon information and belief, the City of Albany hired a consultant, Malcolm Pirnie, Inc., at a cost of approximately $100,000.00, to prepare a Draft Generic Environmental Impact Statement (DGEIS) on the cumulative impacts of nine proposed development projects in the Pine Bush, along with alternatives for development and preservation. The DGEIS was accepted by the city as complete on 26 February 1986.

5. On 21 March 1986, I wrote a ten-page letter to the city containing extensive comments on the DGEIS. This letter is Exhibit 3 of this affidavit. My letter explained that the DGEIS was incomplete under SEQR, and that it needed extensive additions and corrections, which I listed, to be complete and a useful decision-making document under SEQR. My letter reiterated that "island effects" were the major cumulative impact of development in the Pine Bush, and included a graph from my research showing that ecological "islands" of Pine Barrens tend to lost species rapidly if they fall below 2,000 acres in size. The Pine Barrens, or Pitch Pine/Scrub Oak vegetation, of the Pine Bush is about 2,000 acres in area at present, down from an original size of over 25,000 acres.

6. On 4 June 1986, the city issued a Final Generic Environmental Impact Statement (FGEIS), which contains the text of the original DGEIS plus comments received on the DGEIS, the responses of the city to those comments, and some relatively minor text revisions to the DGEIS in response to the comments on the DGEIS. A second consultant, Thomas Givnish, was retained to answer some of the comments received on the DGEIS.

7. In May 1985, prior to and independent of the cumulative FGEIS process, the city accepted a Final Environmental Impact Statement (FEIS) on the largest of the project proposals pending, Karner Meadows, a 121-acre residential subdivision. The Karner Meadows FEIS did not address cumulative impacts of development in the Pine Bush.

8. On 1 July 1986, the City of Albany issued its statement of SEQR findings. In its findings, the city selected the alternative of full development of the Pine Bush outside the existing preserve and proposed Nature Conservancy additions to the preserve. The City also stated that three of the nine project sites should be considered for acquisition if funding were made available: the 30-acre Madison Avenue Office Park parcel, the 72-acre Pine Valley site, and the 121-acre Karner Meadows site.

9. Upon information and belief, on 11 August 1986, the City of Albany granted approvals for Karner Meadows and another project, the State Employees Credit Union, which are two of the nine projects specifically mentioned in the FGEIS.

10. The City of Albany has failed to measure, estimate, study, assess or accurately take into account the most important cumulative impact of development on the Pine Bush, the "island effect". The FGEIS has no scientific or other research-based information in it sufficient to answer the central cumulative impact question: What is the minimum acreage that the Pine Bush needs to survive? Unless this question is answered, and answered scientifically, no one can assess the cumulative impacts of development on the Pine Bush. The FGEIS does not answer or address this central question. The city's findings statement does not answer this question either, and the city begs the issue by stating that "it is virtually impossible to establish a threshold preserve size that represents a numerical minimum amount of acreage necessary to maintain existing species diversity ..." (Findings, Paragraph 3). The city has not addressed the most vital Pine Bush cumulative impact issue, until it collects and analyses the data required to answer the question of how many acres of pine barrens need to be preserved to save the Pine Bush.

11. The only scientific data in the FGEIS supporting an answer to the minimum Pine Bush size question are in the graph included in my 21 March 1986 letter. This graph clearly shows a "break point" in pine barrens species diversity at or near the 2,000-acre preserve size. Below 2,000 acres, species diversity decreases rapidly. The research which led to the production of this graph further showed that the rarest, most endangered, and most specialized Pine Barrens species disappeared first as preserve size decreased. This means that rare, endangered, or specialized Pine Bush species like the Karner Blue Butterfly, Buck Moth, Hognose Snake, Worm Snake, Spadefoot Toad, Prairie Warbler, Eastern Bluebird, Yellow Swallow-wort, Albany Beechdrops, and Birdsfoot Violet, to name a few, will be extirpated first as more developments are allowed and the size of the Pine Bush decreases.

12. The second consultant, Thomas Givnish, attempted to downplay the significance of this species-area graph by stating that it should have been transformed to logarithmic scales and that it was unclear whether the "break point" was at 2,000 acres or 1,500 acres (FGEIS, Appendix F). My graph was plotted on untransformed scales precisely to show where the "break point" falls in real world terms not under mathematically transformed conditions. This is very important for decision-making on Pine Bush development proposals. Also, while it is true that there is some uncertainty in pinpointing a "break point" in the graph, Givnish gives only a low estimate of 1,500 acres for the

minimum pine barrens preserve size. From my graph, the minimum size could be as large as 2,500 to 3,000 acres. I chose 2,000 acres as my best interpretation of the sharpest break in the curve. To be safe, using this data, one should assume 2,500 to 3,000 acres is the minimum size needed for a pine barrens "island" to survive.

13. The 5-page Givnish letter is the only contribution by the City of Albany of a scientist with some barrens expertise to the FGEIS. This letter (FGEIS, Appendix F) offers no data or conclusions that would answer the central question of minimum pine barrens preserve size. It is merely a critique of data and conclusions offered by others as part of the SEQR comment process.

14. Both the city (Findings, Paragraph 3) and its consultants (FGEIS, Appendices B and F) argue that trying to answer the question of minimum preserve size would be impossible, beyond the scope of SEQR, and too costly. From my experience, it is very possible to answer this question, and my data point to an answer - about 2,000 acres of pine barrens habitat are required. It is certainly not beyond the scope of SEQR to answer this question; preserve size is the most important cumulative impact on the Pine Bush, and the FGEIS does not provide an answer to it. More research, data collection, and analysis could certainly be done at a reasonable cost. The city spent approximately $100,000.00

on the FGEIS. For a fraction of that amount, the city could have gathered and analysed existing and new data to address the minimum preserve size question. I have conducted surveys and studies related to the minimum pine barrens size question which cost under $10,000.00. One does not need exhaustive surveys to construct species-area curves; various sampling and estimating techniques for species diversity in habitat islands are available. Much data on species diversity already exists for the Pine Bush and other pine barrens islands and needed only to be compiled and analysed in the FGEIS to reach a conclusion on minimum preserve size needed.

15. The FGEIS and the Karner Meadows FEIS underestimate the importance of the pine barrens vegetation in the southeast quadrant (south of Washington Avenue Extension and east of Route 155) of the Pine Bush. Neither document addresses the impacts of Karner Meadows Phases II and III (the multifamily and commercial phases), which cover 132 acres, or the Woodlands (formerly Pine Circle) proposal, which covers 80 acres. Within the southeast quad, there is a total of about 400 acres of existing natural vegetation, contained in the Karner Meadows Phases I, II, and III, Woodlands, and set asides within the Dunes and Karner Industrial Park. About 250 of these 400 acres is Pitch Pine-Scrub Oak, or pine barrens habitat. Of this, about half, or 120 acres, has been recently burned and is relatively open and free of