INTELLECTUAL HISTORY OF SEA GRANT

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Submitted in Partial Fulfillment of the Requirements of the
University Undergraduate Fellows Program

1985-86

Approved by:

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April 1986

ABSTRACT

Congress established the National Sea Grant College Program in 1966 to hasten the development, use and conservation of America's marine resources. The inspiration for Sea Grant was the land-grant colleges established by the Morrill Act of 1862 and later legislation which incorporated experiment stations and extension services as a part of the land-grant system. This paper explores the intellectual heritage that provided the basis for these institutions and argues that Sea Grant falls clearly within an intellectual tradition that emphasized practical over theoretical science, stressed the value of specialized knowledge for tackling social and economic problems, and encouraged the wide dissemination of scientific knowledge. These themes recurred throughout the development of the land-grant and Sea Grant programs and have been invoked recently in the legislation to create Space Grant colleges.

Acknowledgements

I wish to thank all those people who assisted me in this project. A special thanks to Dr. John Knauss who so kindly gave me access to his personal papers surrounding the Sea Grant program and who provided access to the papers and memoranda of the Pell Library Collection and Sea Grant Depository at the University of Rhode Island.

I also want to thank members of the History Department who were always helpful with their advice and comments and willing to provide their books.

My advisor, Dr. Robert A. Calvert, deserves my special thanks and gratitude for the guidance and encouragement that he has given. I am deeply indebted to him for the support and interest he has had from the beginning when I first asked him to help in this project. He was always there for me and I am grateful.

Last, but certainly not least, I want to thank my family for their love and patience.

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INTRODUCTION

Congress in 1966 established The National Sea Grant College Program to accelerate the development, use and conservation of the Nation's marine resources. During the past twenty years Sea Grant has served marine resource development by forging an effective partnership with universities, marine industries and government by enlisting the research skills of university scientists from many fields. Sea Grant has disseminated research findings to a wide audience through a network of advisory and education specialists. Technical, advisory and public information reports, conferences, workshops and personal contacts by Sea Grant marine agents and university researchers have ensured that information needed to use and develop marine resources reached those who needed it.

I became interested in the concept of Sea Grant and why Sea Grant emphasized the dissemination of practical information. It seemed to me that the notion of practical education seemed uniquely American. I wanted to identify the intellectual roots of this idea. Land grant was used as the analogy to Sea Grant and I wanted to test that analogy and identify the background that lead to the passage of the land-grant act in 1863. I began with the assumption that the formation of scientific institutions, such as land-grant colleges and Sea Grant, arose out of both a receptive climate for scientific thought or discovery and an emphasis that science and knowledge could be useful in the exploitation and understanding of the environment.

INTELLECTUAL BASIS OF AMERICAN SCIENTIFIC INSTITUTIONS

Prior to colonization, sixteenth century explorers, observers and naturalists were interested in classifying and exploiting the unique natural resources on the American continent. Early English settlers carried out this tradition in order to more successfully colonize the continent. This exploitation and discovery was nutured by the scientific societies in Europe. They wanted to verify the work of notables like Francis Bacon and Robert Boyle and also incorporate the new varieties of plants and animals into their pre-existent classification system. However, economic exploitation was the primary motivation for their scientific interest. This economic interest would persist throughout the subsequent development of the nation.[1] *

The interest in science did not diminish with colonization. The Puritans..."as part of their original baggage..." had also transported a post-Baconian notion that science could also be an "instrument to achieve mastery over nature."[2] This group, who were highly educated, believed that science was compatible with their religious beliefs where God was at the center of Creation. Explanations of natural laws by science provided an understanding and accommodation to their natural surroundings. Puritan ministers argued that science "would strengthen and brighten the evidence of Christian faith."[3]

The social order of the Puritans was structured around religious doctrine and the role of the clergy. Therefore, because the clergy promoted science along with religious doctrine, these ideas became part of Puritan culture and institutions. The similarity between scientific and religious values made it natural for most Americans to move "fluidly from one intellectual and emotional realm to another."[4]

*Southwest Historical Quarterly format

The receptive environment for science in the New World became part of the ways of American life. Science reinforced religious beliefs, encouraged and explained colonization and helped the settlers better understand their new surroundings. The practical nature of science provided the means by which the early settlers could economically exploit the land.

Even though Puritan religious ideology faded, an interest in science persisted. As the ideas and discoveries of people like Linneaus and Newton reached New England, they were easily accepted. They could accept the idea that through scientific inquiry and experimentation man's mind could find the absolute order in the universe. They also accepted a new concept of science that had a "mathematical and experimental foundation, relying upon sense experience rather than intuition...."[5] This period, known as the Enlightenment, did not displace "God as the Supreme Architect...." but did relegate Him to a less significant place.[6] From this time until the Revolution, science became more utilitarian.

Utilitarian science would have spokesmen such as Benjamin Franklin and Thomas Jefferson. Franklin "had an unshakable conviction that genuine science would yield useful results."[7] Jefferson, after receiving a treatise on manures from a chemist, wrote that "science never appears so beautiful as when applied to the uses of human life."[8] He also rebuked scientists who he claimed only wrote for one another and neglected the practical applications of their work. However, at that time, the historical record "did not give a clear indication that science had produced utilitarian results."[9]

In this period, too, science became increasingly wed to agricultural production. For example, Franklin believed that science would ultimately yield benefits for agriculture and that in the future "agriculture may diminish its labour and double its produce...."[10] This belief was shared by

scientists in Western Europe as well. Both in Europe and in America many scientific societies were formed that were concerned with the dissemination of knowledge and methods for agriculture.[10] They offered "awards for improvement in agriculture-either in method, useful implement inventions, or crop innovations."[11] These societies were primarily dedicated to hastening "the day when every scientific fact would find its destined useful role."[12] Even though these societies developed on both sides of the Atlantic, American farmers needed a unique type of technology and scientific investigation for this country. For example, efforts "were even made to experiment with English methods of intensive farming, but given the abundance of land and the shortage of labor in America this would have meant financial suicide...."[13]

These societies who promoted science rarely tried to apply theoretical science to practical ends. For the most part, they tried to imitate some of the most successful practices of the day as well as indulge in the experimentation of new methods. They carefully studied the existing practices in order to make the judgment as to what practice was most successful. By mid-century, England was experiencing a agricultural revolution and were trying to find new ways to make their farming more efficient. They realized Americans farmed in quite a different manner and were shocked at the waste and inefficiency in the American practices.[14]

There were two binding beliefs of these societies, however.[15] One was that farming was an admirable pursuit "most worthy of man and most pleasing to his Creator...."[16] Second, that agriculture was a "science, and like other sciences, could profit from reliable data derived from carefully conducted experiments."[17]

The Revolutionary War interrupted the exchange of knowledge and methods between Europe and America. With communications cut off with England, Americans could no longer look to Europe for support, supplies, information, and approval or recognition. There developed a "new spirit of nationalism

which affected every branch of the arts and sciences and reinvigorated the philosophers in their old hopes to make science truly useful."[18] Americans were forced to be more self-sufficient for they lacked both the institutional structure and equipment necessary for scientific investigation. They no longer had the access to European institutions of learning nor the scientific instruments made abroad.

American science took a distinct turn because of the Revolution. Science and patriotism were linked together by a new sentiment of nationalism and a need which encouraged the general population to support American science. Prior to the War, science had the patronage of the rich and well-born. The outbreak of the War promoted the "work ethic which required of everybody that he should follow an obviously useful calling."[19] There was a sense that a lot of work had to be done to assist the country in the war crisis and to meet the new demands for institutions, supplies and knowledge. Certainly evidence supported assumptions that the general population always was interested in science, but the War changed this interest from a "curiosity" to one that asked that scientists deal with subjects of immediate use to the new Republic.

This attitude reflected a further reorientation of scientific pursuits to the practical and useful. There was popular reaction against esoteric science because it did not produce practical results. Esoteric science was associated with the ideas of the French Revolution as well. This association was a problem in the election of 1800 because Jefferson was known to be partial to the French and the voting public was suspicious of Jefferson's scientific interests. They linked Jefferson's scientific interests with deistic religious ideas and questioned the legitimacy of "scientific attainments for a public man."[20] This reaction against esoteric science was promoted by the Federalists and accounted for the reluctance of Congress to support science. However, there is evidence that there was still

some popular interest in science.

A popular constituency was to emerge during the first quarter of the century. This constituency evolved through a "typically American institution created in response to the growing demand for education and self-improvement...known as the lyceum.[21] These lyceums provided through lectures a method for teaching science to the general public. This movement not only popularized science, but imparted the notion that science was "good for all and would promote economic interests of people generally-the small businessman and the mechanic as well as the rich merchant and the large farmer...."[22] It was also through the lyceum that scientists were to appeal to the people by promoting the practicality of science and its benefits for all segments of society.[23] In that sense, a constituency for science was born. This popular constituency dominated scientific inquiry. They demanded scientific inquiry that had practical application. They militated against professional scientific experts at a time when sciences like chemistry, botany, geology and zoology would require expertise to understand the complexities of new theories.

As in the 1700's, specialized societies were to form. These societies would emphasize again agricultural interests and dissemination of knowledge. For example, in 1785 the members of the old American Philosophical Society met to establish the new Philadelphia Society for Promoting Agriculture. They believed that the old American Philosophical Society had "become too esoteric in its concerns...."[24] They now wanted to concentrate on agricultural needs, as did the American Academy of Arts and Sciences, formed in 1792. Both these societies were dedicated to the promotion of agriculture and were concerned with a way to apply science to farming.

Americans recognized that significant contribution to the advancement of science necessitated the aid of the federal government. Patriotism played a role, too. Americans were

eager to compete with Europe and to be recognized for their distinct scientific contributions. Throughout the nineteenth century Americans continued to compare themselves to the British. The idea of a "declaration of scientific independence from Europe remained the most common pleas of those who were urging government support of science throughout the period."[25] Americans felt that the British had a more magnanimous policy towards its scientists and that while the British were sending "its explorers to the borders of the United States,...the American government was sitting idly by and taking little interest in the work of its scientists."[26] This urging for governmental assistance would continue into the 1860's with the promotion of agricultural colleges.

In the meantime, government support of the sciences was confined to geographical surveys because they were important to practical economic interests. As in the early days of exploration and colonization geologic expeditions were to classify and exploit natural resources. In addition, states understood their own surveys and eventually their activities replaced the feds. Underlying the interests of state legislators in geological surveys was the "economic expansion of the country and the speculative tendencies that accompanied this expansion."[27] As new states were added to the union their residents were anxious also to have their potential resources surveyed.

In sum, interest in science has always existed in this country. Several themes reoccured. First, there has been a national impulse to use science and scientific discovery as a way to understand the environment. This science made possible economic exploitation as well as successful colonization. As the population moved and expanded to the west, the citizenry had a renewed interest in exploiting the wealth tied up in the natural resources. Geologic surveys, as well as railroad surveys, provided the mechanism to gather specimens and scientific knowledge. These surveys also aided in the development of the transportation and communication systems

as well. Second, science had always held a fascination for the people, and by the mid-1800's it had become subject to a new popular constituency that demanded a break from esoteric science to science that could be practical and useful. Third, this was a predominantly agrarian society. The special societies that formed spoke to agrarian interests and believed that science would ultimately yield useful and practical results for farming. However, there were no specific institutions that could speak to these interests of science and agriculture. By the 1850's young scientists were going to Europe for their scientific training. These scholars upon their return had neither the institutions nor the scientific community to support their professional goals. These new scientists "provided the motivation and specific scientific knowledge necessary to crystallize in institutional form the amorphous enthusiasm of Americans for science and the progress it seemed to imply."[28]

THE CREATION OF LAND-GRANT

The creation and passage of the land-grant act of 1862 and the agricultural experiment act of 1875 reflected the rapidly changing societal and economic conditions of mid-nineteenth century America. These acts testified, also, to the nation's emphasis on the practical application of scientific knowledge to the problems of society. By 1850 the population had expanded west and eighty-five out of every hundred citizens lived in rural areas and derived their income from agriculture, which produced most of the nation's wealth.[29] This rural and predominantly agricultural population was scattered over a land area which had grown from less than a million acres in 1787 to triple that amount by the Treaty of Guadalupe Hidalgo. This fertile land, possibly the most productive in the world at that time, was characterized by an economy where large families were an asset, most people worked in unmechanized agriculture and education beyond literacy was unnecessary. This pre-industrial society could not afford to sustain "any substantial portion of its productive-age population in 'non-productive' educational pursuits."[30] However, agriculture was experiencing periodic depressions and recoveries, old methods of cultivation were being used, soils were being depleted in the East and wasteful farming practices were typical of the West.

It would be the 1880's "before persons otherwise employed would equal farmers."[31] Industry was in its infancy and manufacturing businesses were small. The "total value added to the economy by all forms of manufacturing...in 1850...was a little less than a quarter of a billion dollars."[32] With the growth of industry there would emerge new demands to provide an educational system that would prepare experts and managers.

In general, the 1850's presented the leaders of agriculture, education, government and industry witha wide variety

of new demands. Francis Wayland captured the challenges of the era when he observed in his report to the Brown Corporation "that lands were to be surveyed, roads to be constructed, ships to be built and navigated, soils of every kind...were to be cultivated, manufactures were to be established which would soon come into competition with those of more advanced nations...."[33]

Education seemed to face the clearest mandate for change. The American educational system was basically a primary school system with about 3.5 million pupils enrolled, and only 20,000 of them in grades nine and above. Less than one per cent were high school graduates. Degrees awarded by institutions of higher learning numbered fewer than three thousand.[34] With the exception of a few schools, colleges in this country were modeled on the European and British plan intended for the traditional professional careers and higher education was "reserved for a minority...and offered a strictly limited course of classical studies oriented towards the past...."[35]

Farmers were skeptical that this classical education would benefit them and they had not been persuaded that scientific methods could solve their special problems. There were a few schools established in the early 1800's developed expressly "to apply science to common purposes of life."[36] They were schools like West Point (1802), Norwich Academy (1802) and Rensselaer (1824) which reflected the continuing belief in America that somehow science could be useful and applicable to the problems of agriculture and industry. However, the average farmer remained skeptical and it took a few leaders involved in agriculture and industry to take the lead to push for a way to combine the practicalities of farming with the prevailing methods of education.

The people involved in the movement to do something for agriculture and education were primarily gentlemen farmers who formed or joined agricultural societies or "joined or led movements to uplift agricultural education...."[37] These societies had hoped to see science applied to agriculture in order to increase the "products of the land within the American states."[38] The establishment of the United States Agricultural Society in 1852 was a result of this movement to improve agriculture. These societies had brought together influential citizens concerned with farm progress who were to be an intricate part of the constituency that pushed for the subsequent land-grant legislation in 1862. There were some "300 active organizations in 31 states and five territories, and by 1860 the number had increased...."[39]

A few agricultural schools had formed during the 1850's and 1860's, but these schools did not flourish because of widespread public apathy and inadequate funds. However, these schools are important illustrations of the agitation of agricultural interest groups of the time. Most of these institutions had disappeared by the time of the passage of the land-grant legislation.

In the meantime, leaders from industrial states were working to build a constituency that would push for industrial education in their states. These leaders were also skeptical that classical studies would suit their needs. They hoped to supplement the classics and humanities with subjects "helpful to industrial and agricultural progress; subjects that would lift the farmer and mechanic out of their old limitations."[40]

Jonathan Baldwin Turner, a schoolmaster and academician from Illinois, stepped forward as the spokesman for the concept of industrial education. He offerd a plan for a state industrial university in Illinois.[41] This plan suggested a scheme of education that joined a modified "traditional college curriculum with the exhibitional activities of agricultural societies."[42] Turner's plan has

been "called the common man's educational Bill of Rights."[43] It called for innovations later to be considered essential to the land-grant idea:

> "education for the working man, practical education in the pursuits and professions of practical life, experimentation and research, the college reaching into the community through institutes andlyceums, opportunity to study almost any subject, the use of land to support the endeavor, and the concept of a definite endowment given to each state on an equal basis."[44]

Even though Turner's plan did not become a reality at that time, it did prompt the Illinois Legislature to send to Congress in 1853 a set of "resolutions declaring that a system of industrial universities...in each state...would develop the people and tend to intellectualize the rising generation." [45] The Turner plan had two further effects. One was that other legislation sent to Congress that was national in scope would include a request for federal subsidies or participation. Two, the land-grant legislation would use the idea of land to support educational institutions.

There were two other traditions that would be important in the evolution of the land-grant concept. One is the persistent belief in the role of science to benefit society. The young scientists who went to Germany in the 1840's represented this tradition well. They believed that science would ultimately contribute to the body of human knowledge and be beneficial to agricultural problems. They also believed that through science progress was possible. They argued that "though American students might concede that German pure science led the world, their own American countrymen seemed far more skillful and ingenious in the application of science and technology to the improving of man's lot."[46]

Evan Pugh and Samuel W. Johnson were typical examples of these men and their ideas. When they returned from their studies in Germany, they set out to campaign for educational

and scientific reform. They had observed Germany's "infant network of agricultural experiment stations" and transported the idea to America.[47] They urged legislators and farmers that science would have to constitute an essential element in agricultural and industrial education.[48] These men spent long hours in "cultivating men of influence...in speaking at fairs and farmer's clubs, and in writing popular articles for farm weeklies."[49] These efforts paid off in the subsequent creation of agricultural experiment stations.[50]

It is clear from the example of Pugh and Johnson that the tradition of the role of science in America was that of a practical and useful application of scientific knowledge to the problems and needs of society. Again Americans had sought the theoretical training from Europe and turned around and applied that knowledge to practical problems.

The second tradition was the granting of land to aid the cause of education. Turner had mentioned this idea in the so-called"common man's educational bill of rights", but actually the precedent was used in Europe as early as 1618. King James had instructed that ten thousand acres be set aside by the Virginia Company for use for a college. Also both the Northwest Ordinance of 1785 and the Ordinance of 1787 reserved land for the maintenance of public schools. This precedent was included in the charters of each of the twenty-one states established prior to the Civil War.[51] This state and federal action meant that governments were committed to financially aiding education. Therefore, it was logical that the subsequent land-grant legislation would look to the national government for assistance.[52]

Both the traditional belief in the benefits of science and the precedent of granting land to aid education were critical to the evolution of the land-grant concept. Agricultural societies and their leaders were joined by the farmer who "despite their apparent isolation and ignorance were not immune to the growing concepts of democracy."[53] These farmers were beginning to voice their dissatisfaction

with their economic plight, their social inequality and their political infirmity.[54] When crops failed the whole country was affected. Therefore, agrarian needs and problems were a pressing issue for more than the farmer. It was the combination of the agrarian constituency, the conditions and the traditions that initiated the movement towards land-grant institutions.

The notion that a democratic society will flourish if there is an emphasis placed on the individual and his contributions to the society, was another element important to the development of land-grant. Land-grant institutions would support this idea by providing equal access of educational opportunity not only to the sons and daughters of farmers and mechanics but also to those of the privileged and wealthy. The ideology of the land-grant movement would maintain that "liberty and equality could not survive unless all men had full opportunity to pursue all occupations at the highest practicable level."[55] Justin Morrill of Vermont, who authored the land-grant bill, spoke to this idea when he stated that the "bill he devised was not intended to create mere agricultural schools; that he opposed class legislation for farmers alone...." [56]

The Morrill Act of 1862, which established land-grant colleges, pointed to several recurrent themes. One, the Morrill Act grew out of a strong agricultural constituency that argued for assistance for the farmer who was faced with rapid changes and deteriorating conditions. This bill spoke to the economic necessity of an agrarian nation who needed to be able to compete on the world market. Second, this bill emerged from a climate of crisis. Positive steps were required to prepare future industrial and farming classes for the future in which more specialized training would be a necessity. Third, the Morrill Act included two recognizable traditions--applying scientific knowledge to specific problems and the granting of land for educational purposes.

Both Jonathan Turner and Justin Morrill advocated a new education for agricultural and industrial classes. Although Turner's plan is best known for advocating education for industrial classes, he also wrote exploratory pieces on the relationship of science to farming. Both Morrill and Turner realized that the existing colleges were unresponsive to the needs of the average working man. Turner was quoted as saying, "old colleges have hauled a canoe alongside their hughe professional steamships and invited the farmers and mechanics to jump on board and sail with them; but the difficulty is, they will not embark."[57]

Scholars have debated whether or not Justin Morrill originated the idea of land-grant or if he stole Turner's idea. Dean Eugene Davenport of Illinois, in 1907 at a meeting of the Society for the Promotion of Agricultural Science, queried as to "whether Professor J. B. Turner had not provided directly the essential ideas of the act bearing the Vermont representative's name and was not consequently the true author."[58] Despite the Turner-Morrill controversy, Morrill happened to have the right political acumen and keen parliamentary ability which brought the legislation into being.[59] Possibly Morrill, like Turner, was aware of the pervasive feeling that a new kind of education was required for a growing industrial and agricultural constituency. Morrill had to know that agricultural societies were promoting change. He may also have heard of the Resolutions sent to Congress by the Illinois Legislature which expressed Turner's ideas. Moreover, Morrill was responding in part to his own political concerns. He represented an agricultural state and as "a good Republican he recognized early the need of his party to woo and win the agricultural interests."[60]

At the time when Morrill first attempted to get his bill passed, public lands were diminishing rapidly, soils were depleted in the East and most states were financially unable to support an educational institution without some

assistance. Due to these conditions, the Morrill Act was passed in 1862. It was signed by President Lincoln and provided the following:

1. The donation by the federal government of public lands to the "states and territories which may provide colleges for the benefit of agriculture and the mechanic arts." [61] This provision is clearly based on the precedent of the Northwest Ordinance.

2. As each state accepted title to the lands they were then obligated to establish "at least one college where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts...in such manner as the Legislature of the states may respectfully prescribe in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life."[62]

3. This Act also provided that the money realized from the grants of land "shall constitute a perpetual fund...to the endowment, support and maintenance" of the land-grant college.[63]

Interestingly, Section 5 of the Act provided for the purchase of a "farm for experimental purposes."[64] It also required each state to issue a annual report that would include improvements or experiments made and to share that report with the other land-grant institutions. This had the effect of binding these land-grant schools to one another as well as a method for dissemination of new knowledge.

The Morrill Act was an attempt to combine the liberal with the practical or vocational one. However, during the time the bill was before Congress, the educational aspects of the legislation was not really touched upon.[65] What was important is that by 1862 the need for agricultural and mechanical instruction had been recognized. However, as a result of the lack of discussion of the educational

provisions of the bill, the subsequently "emerging institutions evolved from the legislation rather than being specifically provided within it." [66]

It is important to understand that this legislation was a response to economic interests, a constituency, and traditions, and because the educational provisions were not specific many influences would shape the evolution of these colleges. One of the most important influences came about twenty-five years later. It was the Hatch Act of 1887 which established agricultural experiment stations. These stations were placed at land-grant institutions and marked the "start of the direct application of science to the problems of agriculture."[67] These stations were the end result of the work of people like Pugh and Johnson and other agricultural societies and groups. Many experiment stations existed prior to the 1887 legislation. They had followed, once again, the European example of experiment stations, but the American "work became in time even more practical...responding to the principal concerns of the farmer."[68]

By the time of the federal legislation of 1887 there was a recognized need to "diffuse among the people of the United States useful and practical information on subjects connected with agriculture, and to promote scientific investigation..."[69] The impact these stations had on the colleges was important. As a result of experiment stations, organized research became a part of the college structure and curriculum and the practice of diffusing and disseminating knowledge was established. Of course, this practice had been used by the earlier agricultural societies as well.

Other sections of land-grant institutions were also diversifying. Home economics, military instruction, veterinary medicine, and engineering were added to land-grant colleges. This diversification was a reflection of expanding national interests in fields other than agriculture as a more complex urban society grew.

The interest in things "practical" was a persistent theme through the development of land-grant institutions. For example, the tensions between the so-called classical and new education appeared in all the agricultural colleges. In Texas, for example, the Grange argued that there should be a school dedicated to vocational training and not a traditional school which "lead the young man away from the farm and all other industrial pursuits...."[70] When confronted with the possibility that higher learning might turn their young men away from farming, the Grange asserted their influence with the State Legislature and petitioned to assure that A & M College, established under the Morrill Act, would surely be dedicated to agricultural and mechanical pursuits. The Grange criticized A & M's emphasis on military and literary subjects. As a consequence of Grange pressure, agriculture was emphasized and later the Grange would "recommend the college to everyone desiring practical and scientific education."[71]

This example from Texas illustrated the tensions between useful and classical education as well as the fact that pressure groups like the Grange would intercede to ensure that the mandate of the Morrill Act was being met. This was further evidence of the strong agrarian interest present at this time as well. This tension was expressed elsewhere. In the northeast, Connecticut, Rhode Island and New Hampshire wanted to remain "classical" schools, but as in the case of Texas, the Grange and the State Agricultural Society interceded to make sure that the emphasis shifted to agriculture.[72] The shortage of funds in these states would heighten this tension.

By the second Morrill Act of 1890 these problems would be resolved. The Grange remained instrumental in the framing of the 1890 Act and influenced the provision that the "new endowment should be preserved from any possible expenditure in the ordinary college training in belles-lettres and the dead languages."[73] In other words, the bill restricted

teaching areas and also provided funds to be equally shared with the black colleges. By the time of the passage of this 1890 Act land-grant colleges had matured and were characterized by three things, research, teaching and extension. The necessity of conducting research to promote agriculture had been recognized.[74] The Grange had successfully promoted the cause of separate agricultural schools which was an indication of both the political strength of agriculture as well as the continuing interest in the benefit of science to assist agricultural problems. After the 1890 Act land grant institutions were recognized more as state institutions rather than national ones. The states had assumed a larger role by that time and the land-grant income was more sufficient.

By 1890, thus, a model for practical education had emerged. The colleges were considered practical institutions that took applied science out to the farmers and citizens. The education given was a specialized one that emphasized mechanics, engineering, and agriculture. It not only gave "book" instructions, but it created examples that citizens could emulate, experiment stations, home demonstrations, extension services. Since these local units served a local population, these state colleges became that -- more state than national institutions. The states, in turn, assumed more of a role in financing these schools. This pattern would continue until the passage of the Smith Lever Act in 1914. This Act, though guided through the Congress by Senator Hoke Smith of Georgia and Representative Ashbury F. Lever of South Carolina, emerged out of the activities of Dr. Seaman A. Knapp of Texas A & M College. Knapp, who complained that too many faculty members thought A & M College stood for "Academic and Military" rather than agriculture and mechanics believed that extension work was an essential ingredient in agricultural colleges' mandates.[75] He convinced David F. Houston, the young president of A & M College of the idea and it took hold rapidly in the southern

states. When Houston became the Head of the Department of Agriculture in the Wilson Administration, he threw his support enthusiastically behind federal support for agricultural extension, resulting in the Smith-Lever Act. This Act put in place a permanent system of county agents who maintained direct contact with the people of the community with the result that "the farmers themselves and their wives have been made partners with their government...."[76]

Actually, this Act continued in the pattern of previous land-grant legislation by extending the benefits of federal aid to those colleges established under the Acts of 1862 and 1890. "Its purpose was to inaugurate in connection with these colleges 'agricultural extension work...in order to aid in diffusing among the people of the United States useful and practical information on subjects relating to agriculture and home economics, and to encourage the application of the same.'"[77]

This same trend of relying on the dissemination of practical or useful information to the public continued from the land-grant legislation until 1935. Other legislation would follow in the traditions of the Morrill, Hatch and Smith-Lever Acts. Another bill, sponsored by Senator Hoke Smith became the Smith-Hughes Act of 1917 which provided federal monies to states who were willing to add instruction in agriculture, trade and industry to their secondary school programs. The Bankhead-Jones Act of 1935 also provided federal funds to expand research in State experiment stations, land-grant schools and the Department of Agriculture. There was, thus, a long tradition, before Sea Grant, of government extending aid to practical research.

In sum, land-grant institutions were the result of several factors: One, agriculture dominated the 1860's. When agriculture faced problems it rippled through the whole nation. Economically, agriculture faced periods of depression and was not in a position to be competitive world-wide. The high birth rate among farmers -- 52 live births per 1,000

people in 1840 -- indicated the kind of growth that would require sweeping changes in the educational system. That system would respond to the growth of industry and agriculture.

Second, a strong agricultural constituency had developed to speak for agrarian interests. This constituency had its roots in the early agricultural societies and by the 1850's had become a geographically dispersed group that had a strong and diverse base of political support.

Third, a tradition had been generated for government intervention and assistance for important sectors of the economy. There remained, too, the persistent belief that the benefits of science could be applied to economic and societal problems.

Fourth, the Morrill and Hatch Acts established institutions that were to promote useful and practical scientific knowledge and apply it to the problems of agriculture and industry. These institutions were sufficiently flexible to evolve and respond to national crises like war and depression. For example, after Congress declared War in 1941, the National Association of Land Grant Colleges issued a statement indicating that its members would offer to the nation...all of their facilities for such essential scientific, technical and professional training and research...as may be necessary...."[78] This response demonstrated that these colleges by this time could offer this kind of assistance. Indeed, through food preservation work, research in aeronautics and electronics, and military training through the Reserve Officers' Training Corps (R.O.T.C.), the land-grant institutions had clearly demonstrated their ability to contribute to new demands and crises, in a way only vaguely anticipated by their founders.

These conditions -- social need, political support, a tradition of national interest in practical research, and the creation of new institutions to pursue these interests -- were critical to the success of the land-grant system.

Nearly one hundred years later a similar set of conditions drew heavily on the land-grant experience to establish the National Sea Grant College Program.

THE CREATION OF SEA GRANT

Despite an interest in military aspects of ocean use which grew out of the World War II experience, there was very little interest in broad resource questions about the oceans through the 1950's. The 1958 Budget reflected this low level of interest in oceanography. Out of a budget of roughly five billion dollars for research and development, oceanographic research only received less than thirty million dollars.[79] More telling, possibly, since 1948 the government had increased funds for research and development by some five hundred per cent, and oceanography only grew by fifty per cent.[80]

Oceanography, like science in general, received a boost with the launch of the Russian Sputnik I. The launch of Sputnik drove the government into a race for scientific superiority and prompted the creation of numerous governmental institutions including the National Aeronautics and Space Administration (NASA), the post of Special Assistant for Science and Technology at the White House, and the National Academy of Sciences Committee on Oceanography (NASCO).

During this same period the United States fishing industry was having trouble competing on the world market. Its fleets ranked the lowest among those of major fishing nations and experts were upset that the Japanese operated more efficiently and productively off the West Coast, as did the Russians on George's Bank.[81] These foreign rivals were more successful because they had better vessels and better methods of fishing that ignored conservation techniques and other restrictions that bound the United States fishing fleets. The fishing industry sought to respond to these conditions by pressing the federal government to implement protections and controls aimed at foreign fishermen.

Given the condition of the fishing industry and the experience of land grant, one response to the adverse

conditions affecting the fishing industry, and the more general failure to take advantage of the potential resources of the oceans, was a proposal by Athelstan Spilhaus to create a new institution based on land grant. Dr. Spilhaus was the Dean of the Institute of Technology at the University of Minnesota and a member of the NASCO Committee. In 1959 the NASCO Committee recommended more concentration of efforts and monies in marine research. Both his knowledge of land-grant institutions and his work on NASCO was "to add to his growing belief that American universities had much to contribute to man's knowledge and wise use of the sea."[82]

Dr. Spilhaus suggested in a speech before a meeting of the American Fisheries Society in 1963, that in order to address the problems of a troubled fishing industry:

> "Why, to promote the relationship between academic, state, federal, and industrial institutions in fisheries, do we not do what wise men had done for the better cultivation of the land a century ago. Why not have 'Sea Grant Colleges?'"[83]

This statement struck a responsive chord among the delegates at this meeting for many of them were affiliated with successful land-grant colleges, and the phrase "Sea Grant Colleges" made the parallel to land grant readily apparent.[84] The delegates knew the philosophy and concepts of land-grant and made the mental analogy without any problem.

This analogy to land-grant continued as the Sea Grant idea took shape. The comparison evoked a positive response that is reflected in the correspondence and speeches surrounding the formulation of the program. Among those impressed with the concept was University of Rhode Island marine scientist Saul Saila, who had attended the fisheries conference. Upon returning to Rhode Island, Saila wrote to Spilhaus indicating his support of the idea of a Sea Grant college. By this time, Spilhaus had received many such letters from others who were there. Consequently, he took the initiative and wrote to the President of the University of Rhode Island, Dr. Francis Horn, indicating that he thought

Rhode Island "could pioneer as a 'Sea Grant' institution" because of the work already going on in their Marine Laboratory.[85] In this letter, Spilhaus pointed out very clearly his notion of Sea Grant and it's parallel to land-grant:

> "In an address I made at the recent national convention of the American Fisheries Society I stressed the need of creating 'Sea Grant' colleges parallel to the Land Grant colleges (of course, combined with them). The Land Grant colleges, with their colleges of agriculture, experiment stations, extension service, and county agents, are largely responsible for the extraordinary achievements in agriculture. We need the same effort in fisheries right now.
>
> Within the Sea Grant university would be a college of aquaculture, marine aquacultural experiment stations, fishery extension services, and sea-going fishing port agents. Only in this way can we communicate the good work in the marine sciences to the people who are making use of the resources of the sea." [86]

Dr. John Knauss, Dean of the Graduate School at the University of Rhode Island also received a copy of this letter. Knauss, after writing back to Spilhaus "affirming support for the sea grant college idea" became, with Horn's endorsement, the spokesman and creator of a symposium to "discuss what a state university could contribute to the economic, scientific, and technological development of marine resources."[87]

At the same time other organizations were looking for a way to aid the fishing industry. For example, The Bureau of Commercial Fisheries of the Fish and Wildlife Service had begun to establish a nucleus of a shellfish advisory service.[88] Bureau officials felt the industry would be in better condition "if they were using fully the great fund of scientific and other knowledge which had been accumulated by State and Federal agencies, the universities, and private research organizations."[89] The American Friends Service Committee of Cambridge, Massachusetts had a similar idea.

They wished to establish a system of extension centers to aid the fishing industry of Massachusetts. They also argued that knowledge "now tends to accumulate in research centers, laboratories, and various educational institutions...and only a few fishermen get the benefit of the knowledge."[90] The transfer of the knowledge to the fishermen, hence, did not take place. The ones who needed the information the most did not receive it. The Committee cited the agricultural college experience as a way to solve this problem, staging "...this was the case in the early days of the agricultural program before the advent of experimental stations and extension service."[91]

Both the Bureau of Commercial Fisheries and the Friends Committee were falling back on the traditions incorporated in the land-grant system -- the dissemination of knowledge to solve specific problems and the reliance on an experiment or extension network. In this sense, the building of a constituency to develop a Sea Grant program was a necessary and almost natural response and followed the constituency developing process that land-grant colleges hae used. The land-grant tradition, which relied on early practices from the agricultural societies, for example, was now an accepted method of problem solving.

In the subsequent development of both the conference to discuss the Sea Grant concept and in the promotion of the legislation in Congress the analogy to land-grant persisted. Several familiar themes would emerge, that were reminiscent of themes that were prevalent in the development of land-grant. First, Sea Grant proponents believed in the benefits of practical knowledge and science to aid in the solution of national problems, in this case the development and use of marine resources. Second, a constituency for such a program was taking shape, particularly among academic marine scientists and parts of the commercial fishing industry, who were willing to pursue their interests through new legislation. Third, Americans have traditionally responded to change and

and crises by drawing on familiar andsuccessful ideas, such as the use of science to promote progress, the dissemination of knowledge, and the application of science to solve social problems.

Within this atmosphere of concern for the fishing industry and using traditional means of problem-solving, Knauss began to organize the Sea Grant Conference and the Democratic Senator from Rhode Island, Claiborne Pell, launched his campaign for federal legislation.

In June, 1965, Senator Pell spoke before the Senate about the establishment of Sea Grant colleges, noting that "we did not know how to use the land profitably for agriculture until the great age of agricultural development in science and technology was spearheaded by the...approach of the agricultural institutions."[92] He went on to argue that a similar institution for the application of practical research to oceans should be developed and citing the need to transfer research before the exploitation of ocean resources could take place, explained that he intended to introduce a bill that would evolve into the Sea Grant College Program.

In the meantime, Spilhaus continued to promote his ideas through many speeches. He took the initiative once again and contacted both Senator Warren Magnuson of Washington and Representative Paul G. Rogers of Florida, who indicated their interest in co-sponsoring such legislation. He also contacted Senator Edward Kennedy of Massachusetts who would later co-sponsor the Senate Sea Grant bill. With Spilhaus and Pell working to build a constituency for the Sea Grant idea, Knauss set up the Sea Grant conference for October 28 and 29, 1965. Pell had already introduced Senate Bill 2439 to establish Sea Grant Colleges in July, 1965.

The Conference, "The Concept of a Sea-Grant University," included prominent scientists and respresentatives of colleges and universities that had an interest in oceanography and marine resources, as well as government officials from both

state and federal levels. Representatives of other institutions and laboratories dedicated to marine sciences were also invited. The letter of invitation explained once again the land-grant Sea Grant analogy by indicating that even though "the nation's land-grant colleges, when first established more than 100 years ago, were sometimes critically labelled, 'cow colleges',...they were instrumental in making American agriculture the most efficient and productive in the world."[93] The letter indicated that "a growing number of people are suggesting that attempts should be made to apply a similar formula to developing our ocean resources...." [94] Again and again the correspondence relating to the Conference would refer to the successful land-grant analogy, a point of reference which made sense to those who first heard Spilhaus speak of the sea grant concept and evidently continued to spark interest throughout the marine community. The replies to the Conference invitation,for the most part, were very positive and enthusiastic. There were very few negative responses, one of which was from a respondent who felt that the "term 'sea grant colleges'...was a cute, meaningless distortion of the land-grant concept...."[95]

The Conferenee, which finally scheduled fourteen prominent scientists and educators to speak, provided the forum to define what Sea Grant colleges were to be and how they would function. The Conference was also a mechanism for building the constituency for the Sea Grant legislation. Clearly Senator Pell and Spilhaus thought that they should rely heavily on the land-grant analogy, including the dissemination of the knowledge to the users. For example, Spilhaus said that ocean engineering could be important to bring

> "everyone close to the oceans and develop the sea's resources for everyone's use just as on land. Engineering has provided us with our dams, our fuels, our skyscrapers, highways, planes, ships, satellites, and the biological engineering which we call agriculture has supplied us with our abundance of good food. I have said that ocean

> engineering will fill the gap between marine scientists and those who use the sea. But we need a way of bringing the vast body of scientific knowledge about the sea to the people who use it."[96]

He also drew explicity from the land-grant model when he indicated that just as land-grant colleges had been given "in perpetuity grants of land for their experimental plots," so could sea grant colleges be given "grants of seashore or lakeshore...as their experimental plots to stimulate the development of aquaculture...."[97] This mechanism was later dropped for political reasons, but at the time it provided another direct link to the land-grant precedent. Spilhaus also envisioned the broad application of all kinds of practical knowledge to ocean problems, including both the natural as well as the social sciences and humanities. This broad intellectual base would serve to promote the economic development and exploitation of the oceans.

Pell concurred with this broader approach. He also relied on the land-grant analogy and gave them credit for their tremendous success with agriculture while expressing the hope that the nation could now turn its energies into aquaculture.[98] Eighteen months after Pell introduced the Sea Grant bill it was signed into law by President Lyndon B. Johnson on October 22, 1966. This bill moved through the House and Senate with unusual dispatch, because the political climate was condusive to such a bill, it had the backing of the academic marine community and the success of land-grant's approach to research, education and advisory services was well-known.

It is important to note, that during this time biologists, engineers, oceanographers and other ocean experts were developing oceanographic science that was not being applied in any useful way. Therefore, Pell was really introducing a mechanism in the sea grant concept that could make use of this knowledge in three ways: First, funds would be made available to colleges and universities "for the purposes of

expanding practical education in the marine sciences."[99] Second, there would be an applied research program to "translate the findings of basic research scientists into results...."[100] The program would also sponsor "applied research in the fields of marine conservation, aquaculture techniques, including harvesting marine farms, pollution control...."[101] Third, the bill would provide for a system of "extension services designed to bring the latest developments in the marine sciences to the attention of the workers in the field, scientists, and the interested public."[102]

Pell deliberately noted the similarity between his bill and the two Morrill Acts, the Hatch Act and the Smith-Lever Act. He indicated that "the similarity is intentional..." because if this "Congress can provide the same impetus to the marine sciences that the acts cited provided in agriculture, the leadership of the United States in developing the ocean resources is assured."[103]

Pell also argued that this bill would serve the citizenry as well as the scientific community and that it would boost the economy and world trade.

In 1971 Spilhaus' Sea Grant Colleges became a reality. The Secretary of Commerce finally designated the first four Sea Grant colleges (including Texas A & M). By 1984, there were thirty-one programs in twenty-nine coastal states, and Puerto Rico, twenty-one of which were designated full Sea Grant Colleges. Between 1979 and 1984 they had supported activities in thirty-nine states, plus Guam and the District of Columbia. This growth was accompanied by the rapid expansion of the marine advisory service which was based on a network of coastal county agents clearly modeled on the experience of the agricultural extension service and university specialists. By 1983 some three hundred and fifty men and women served as Sea Grant's link between university researchers and those involved in ocean resource development, use and management.

With respect to research, Sea Grant has made use of advisory groups from government, industry and the universities. These advisory groups make recommendations for the general direction of research, which has had both the impact of serving state and national interests as well as a diversity of research areas. In other words, the research has responded directly to the problems and concerns of the users, much like the research done for the farmers a century ago.

Sea Grant has put into motion the mechanisms envisioned by Pell and Spilhaus. Indeed, the people serving in the Sea Grant program have incorporated these visions in such a way as to unify the so-called Sea Grant network, or rather what has become known as the network. This network shares the belief that knowledge gained by scientists should not only be widely shared and used, but should be applied and oriented to specific problems. They also believe that ocean issues can be most effectively tackled by the use of many disciplines; and that skills and resources in the nation's universities are the key to expanded use of the oceans and their resources. They also share the belief that both basic and applied research is important to the Sea Grant program. These commonly shared values cement the analogy of the Sea Grant concept to the land-grant idea.

The conservative Heritage Foundation has summed up the success of Sea Grant when it stated that the program has "an impressive record of success, primarily because it is based largely on local priorities and needs...and operates in partnership with State and local governments, private industry, and universities...."[103] Despite this success the Reagan Administration in 1981 sought to eliminate the program on fiscal grounds. They believed that support could be turned over to the states and industry because they were the primary beneficiaries of the projects.

During the fight with the Reagan Administration over termination, the Sea Grant Association, formed in 1967 to promote the interests of the new Sea Grant program, made an

alliance with the National Association of State Universities and Land-Grant Colleges (NASULGC). NASULGC was one of the most politically effective higher education organizations in Washington, and Sea Grant Directors, many of whom were from land-grant institutions, were well aware that the political resources of these schools were based on a long tradition of experience in state politics, the prestige of their presidents, and the personal skills of their Washington representatives. What seems more stiking, however, is that this affiliation is so "natural" given Sea Grant's origin and the analogy to land-grant.

In sum, Sea Grant was created out of the same factors that created land-grant: One, the fishing industry was economically depressed and unable to compete internationally. The same was true for agriculture in the 1860's.

Two, both Sea Grant and land-grant had a strong constituency built on their behalf, by person's interested in the application of useful and practical application of knowledge to the problems of agriculture or marine resources.

Three, Sea Grant was created to respond to an economic and social condition. It was able to rely on the tradition of land grant, and land-grant relied on the traditions developed early in the nation's history of the specialized agricultural societies.

All of these factors have contributed to Sea Grant's success. Because of land-grant the traditions and institutions were already in place to promote the research, education and advisory services of the program.

LAND-GRANT, SEA GRANT, SPACE GRANT

Understanding the intellectual bases of social institutions is important not only for understanding the role particular ideas play in a nation's culture, but also as a measure against which new ideas can be tested and new institutions created. The success of land-grant and Sea Grant in responding to the challenges set for them make them attractive models for efforts to use scientific knowledge to promote economic and commercial development. The most recent example was the introduction of a bill by Texas Senator Lloyd Bentsen to establish a National Space Grant College Program. The language introducing the bill was a clear echo of Dean Spilhaus' challenge in 1963, for according to Senator Bentsen, "a system of Space Grant Colleges would do for space exploration what Land Grant colleges have done for agriculture and mechanical arts over the past 123 years."[104]

In order to speculate on the prospects for using the land-grant model for a new set of institutional arrangements it is useful to review the key ideas and social conditions which nutured these two programs. First, each emerged out of the same hospitable intellectual traditions. From the earliest years of the Puritan settlements Americans have accepted science, often with great enthusiasm, particularly if that knowledge helped them address problems of immediate social or economic concern. The early settlers relied on science for understanding their new environment and with this understanding they were able to exploit the abundant natural resources of their new home land. This utilitarian view of science became part of the nation's cultural and intellectual life, and the dominant view of the relationsip between scientific knowledge and society. Even though Americans lacked the formal institutions for scientific education, they

readily borrowed ideas from the Europeans and shaped them to suit American needs. In doing so, they reflected a flexible, pragmatic approach to the use of knowledge which has recurred throughout the American experience.

Creation of the land-grant colleges was an excellent example of the kind of institution that was created to meet changing social and economic conditions. The colleges emerged out of an agrarian society that required specialized training in agricultural science, as well as a new kind of education that was responsive to the needs of the burgeoning agricultural population in the 1850's and 1860's. At that time there were no mechanisms to aid the farmer who was faced with old technology, old tools, and depleted soil. The Morrill Act provided an alternative to the classical education of that period, as well as a means to put science in the service of the farmer. The law originally sought to create colleges that would train the sons and daughters of farmers and mechanics, but over its more than 100 years of evolution changed to become an instrument of broad service to all classes and segments of society. Through their experiment stations and extension programs created useful new knowledge and disseminated it widely. In addition to this powerful force for the democratization of education, the new colleges proved themselves to be exceptionally adaptable to changing times and circumstances. Their educational and scientific contributions during two world wars provided dramatic examples of their ability to respond to rapidly shifting social demands.

This tradition of applying scientific knowledge to new problems was the foundation for Sea Grant as well. Like land grant, Sea Grant emerged out of the new demands and changing economic and political conditions. The domestic fishing industry was in a shambles. It could not longer compete on the world market nor take advantage of the scientific knowledge generated in the nation's colleges and universities. As in the case of land-grant, research and education were the

answer.

The mechanisms for achieving the goals of these programs -- extension, publication and demonstration, and geographical diversity -- virtually guaranteed creation of constituencies built around the spcial economic interests of fishing, agriculture, and academic research. During the 1860's leaders like Jonathan Turner and Justin Morrill reflected the dominant interests of agricuture. They were responding to diminishing productivity, an inability to compete economically on the world market, problems of old technology, and farmers increasingly frustrated by their economic situations and the irrelevance of classical education for their needs. Similarly, Sea Grant was the creation of men who saw in applied research and education a way to aid an industry that was also hampered by dated equipment, unable to compete economically, and rarely informed about useful new scientific advances. So even though the two programs were inventions of responsive and articulate academic and political leaders and not the result of any popular movement, they both provided useful services in many congressional districts, which in turn has had the effect of creating solid political support in both the counties and the Congress.

It is, of course, a bit premature to measure the much younger Sea Grant College Program against the achievements of the more mature land-grant system. In additon to its youth, Sea Grant has been inhibited from realizng the full promise of its intellectual tradition because it simply has never received much federal support. For example, in fiscal year 1985 the total federal Sea Grant budget was $39.0 million or six percent of federal funds for land grant, and about 10 percent of federal support for the Cooperative Extension Service alone.[105]

Again, however, the important point is not the relative size of the program, but its potential for growth and change. Spilhaus' use of the land grant analogy was successful not

only in persuading Congress to pass the program but in creating a program that has worked in much the way its designers had hoped. It has promoted research that is not only applicable to immediate problems but it has also provided research support for the marine subjects outside the traditional oceanographic fields such as ocean engineering, fisheries research, and marine-related social sciences. While other organizations such as the National Science Foundation and the Office of Naval Research continue to support mainly basic research, Sea Grant has sought to respond to areas of more explicitly commercial or management interests. Indeed, Sea Grant has been criticized for being "too much concerned with relevance and too anxious to cite accomplishments in the real world."[106] However, both Sea Grant and land-grant as well as their extension programs were designed to be institutions that could use scientific knowledge generated in the universities and put this to work on problems of fisheries and agriculture, thus responding to the needs of their constituents. That is why they were created.

Given these basic features of the land and sea grant ideas -- roots deep in the American intellectual tradition, the use of universities to meet social and economic needs, a preference for practical knowledge, and the creation of loyal political constituencies -- the space grant concept draws on two powerful analogies. The key question is whether there is a convincing social need for such a program at this time, whether there are political visionaries like Turner, Morrill, Spilhaus, Pell and Rogers capable of translating space grant from an idea to a program, and perhaps most important, whether a highly specialized, technologically sophisticated program required for the commercialization of space can generate the strong base of political support that has sustained the land-grant and Sea Grant networks.

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