Laboratories of the American Century
How Coral Atolls Became the Testing Grounds for American Environmental Sciences

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The coral atolls of Micronesia, rarely considered in global geopolitical history, were the staging grounds for multiple defining events of the mid-twentieth century. Micronesia, acquired by the United States from Japan during WWII, was consolidated into the Trust Territory of the Pacific Islands (TTPI), a highly militarized zone where select atolls were converted into nuclear testing grounds and others used as vital bases to extend American influence to Asia. Concurrent with testing, American administrators attempted to modernize the TTPI. To aid managers operating in an understudied environment, the U.S. Navy funded Scientific Investigations in Micronesia (SIM), a series of ecological investigations meant to produce total understanding of atoll ecology. Assumptions towards the atoll environment generated during WWII and atomic testing, however, influenced ecologists' research, causing initial SIM reports to affirm what both administrators believed: atolls were simplistic, isolated, natural laboratories most eminently suited for nuclear destruction.

As SIM matured, researchers pursued increasingly eclectic subjects, establishing increasing distance from their sponsors' assumptions. This growing independence culminated in Raymond Fosberg, SIM’s premier researcher, who developed and applied ecosystem theory to atolls. Ecosystem theory, an emergent model for describing environments, depicted the world (atolls included) as interconnected by global cycles of microscopic compounds that shaped and were shaped by macroscopic organisms. As a model, ecosystem theory is a direct predecessor to contemporary environmentalism and drew inspiration from the Castle Bravo weapons test—specifically nuclear fallout's ability to travel across and link “isolated” atolls—and systems thought, which defined High Cold War military strategy. Fosberg, through his connection to several prominent ecologists including Rachel Carson, was a vector for SIM to influence contemporary environmentalism. Through SIM, atolls became incubators where American ecology, weapons tests, and military thought melded together. The atoll was more than the foundation of U.S. power in the Pacific: atolls were the laboratories of the American Century.
# Table of Contents

Acknowledgements ........................................... ii  
List of Figures ........................................... iii  
Introduction ............................................... 1  
Anchored Aircraft Carriers: Initial Perceptions of Atolls ........................................... 7  
A Grand Experiment: Military and Atomic Influences on SIM ........................................... 20  
Change on the Fringe: The Evolution of SIM ............................................... 39  
Ecosystems: An Environmental Model for the Atomic Age ........................................... 51  
How to Modernize Micronesia? SIM’s Inglorious Conclusion ........................................... 63  
Appendix (Figures) ........................................... 69  
Bibliography ............................................... 91
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<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Map of the Republic of the Marshall Islands</td>
<td>69</td>
</tr>
<tr>
<td>2</td>
<td>From Majuro to Wellington</td>
<td>70</td>
</tr>
<tr>
<td>3</td>
<td>Sketch of Japanese Bomb Shelter on Kwajalein Atoll</td>
<td>71</td>
</tr>
<tr>
<td>4</td>
<td>Japanese Pill Box Front and Rear View</td>
<td>72</td>
</tr>
<tr>
<td>5</td>
<td>Kwajalein Airstrip Post Battle</td>
<td>73</td>
</tr>
<tr>
<td>6</td>
<td>Baker Shot’s Mushroom Cloud</td>
<td>74</td>
</tr>
<tr>
<td>7</td>
<td>Baker Shot Superimposed on Manhattan</td>
<td>75</td>
</tr>
<tr>
<td>8</td>
<td>“This is Bikini”</td>
<td>76</td>
</tr>
<tr>
<td>9</td>
<td>“Private Property Among the Young”</td>
<td>77</td>
</tr>
<tr>
<td>10</td>
<td>Moved to Rongerik</td>
<td>78</td>
</tr>
<tr>
<td>11</td>
<td>Clearing the Reef on Bikini Atoll</td>
<td>79</td>
</tr>
<tr>
<td>12</td>
<td>Bikini as a Laboratory</td>
<td>80</td>
</tr>
<tr>
<td>13</td>
<td>Bikini as a Playground</td>
<td>81</td>
</tr>
<tr>
<td>14</td>
<td>“Not an Atomic Playboy”</td>
<td>82</td>
</tr>
<tr>
<td>15</td>
<td>Map of Micronesia with Four Atolls Highlighted</td>
<td>83</td>
</tr>
<tr>
<td>16</td>
<td>Map of Arno Atoll</td>
<td>84</td>
</tr>
<tr>
<td>17</td>
<td>Physiographic Diagram of Arno Atoll</td>
<td>85</td>
</tr>
<tr>
<td>18</td>
<td>Generalized Cross Section of Arno Atoll</td>
<td>86</td>
</tr>
<tr>
<td>19</td>
<td>Cross Section of Arno Before a Typhoon</td>
<td>86</td>
</tr>
<tr>
<td>20</td>
<td>Cross Section of Arno Post Typhoon</td>
<td>87</td>
</tr>
<tr>
<td>21</td>
<td>Arnow’s Link Between Latitude and Rainfall in the Marshalls</td>
<td>88</td>
</tr>
<tr>
<td>22</td>
<td>Stone’s Zones of Soil on the Atoll</td>
<td>89</td>
</tr>
<tr>
<td>23</td>
<td>Reef Zones</td>
<td>90</td>
</tr>
</tbody>
</table>
"Those who talk of the Pacific Century see the Pacific as a doughnut. Everything that matters in on the rim. The middle is a hole. It is an empty quarter—something to be crossed."¹ Articulated by R. Gerard Ward in 1989, the idea of the empty Pacific is long-held and its origins seemingly apparent. Micronesia—the name for equatorial central Pacific region—is equal in size to the continental United States, but the total land area of Micronesia’s two thousand one hundred volcanic islands and coral atolls is just two thirds of the state of Rhode Island. In spite of the vast distances separating these Pacific islands from the continents, these miniscule atolls—thin rings of islands composed of calcified coral sitting atop extinct seamounts—were the staging grounds for several defining moments of the mid-twentieth century including a world war and a slew of nuclear weapons tests that occurred on Bikini and Eniwetok in the Marshall Islands. As atolls became battlegrounds, test zones, and bases for projecting U.S. influence abroad, local populations and environments were routinely devastated. The atolls became sacrifices for the sake of American security, influence, and prosperity.

Despite their centrality to the United States, few holistic histories of the Marshalls in the twentieth century exist. This lack of attention is symptomatic of Micronesia’s physical distance from traditional centers of power. The capital of the modern Republic of the Marshall Islands, Majuro, is approximately three thousand miles east of Wellington, New Zealand, and three thousand miles west of Honolulu (See Figures 1 and 2). The Pacific, the world’s largest ocean, completely dwarfs and insulates the “tiny islands.”

The other reason the Marshalls and Micronesia are rarely acknowledged in history is, to be blunt, the region's general insignificance in conventional constructions of global politics. Yet, globally significant events, both by coincidence and design, took place on atolls in distant Micronesia. Japan and the United States both fought to control Micronesian atolls, which served as vital military bases for projecting each empire's influence throughout the Pacific.

The U.S. entry into Micronesia during WWII was unexpected, but never unplanned. As early as 1942, the Navy was outlining how it intended to administer Micronesia in the post-war period. The Navy established a partnership with Columbia University to train future administrators in 1943, well before the first invasions had even begun. After subduing Japan, Americans converted Bikini and Eniwetok into the Pacific Proving Grounds, a highly restricted space where powerful nuclear weapons were routinely tested and displayed to the world. Simultaneously, the U.S. administered Micronesia (with the exception of the Gilberts, now Kiribati) as the Trust Territory of the Pacific Islands (TTPI), the only Trust Territory of eleven created by the U.N. to be designated a Strategic Trust Territory. This unique permutation of Trusteeship allowed the United States to utilize Micronesia as a military outpost and restrict access to the territory, but still required the United States to perform the duties of a Trust Territory administrator (which included developing infrastructure and national institutions prior to relinquishing control).

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3 This information was gathered from the Alele National Archives in Majuro. However, U.N. documents are available in less distant archives. “Trusteeship Agreement for the Former Japanese Mandated Islands” (Alele National Archives, PVF 0164, Folder 1), 1-5.
Historical narratives on this crucial period focus exclusively on a single theme spawned outside of Micronesia. Military historians discuss WWII, either recounting grueling battles on Micronesian atolls or discussing the environmental repercussions of total war. Others chronicle the history of atomic testing on Bikini and Eniwetok. Recently, a subset of these historians has examined the effects of the atoll environment on testing and testing’s effects on Micronesia. Trusteeship has also attracted significant scholarly attention over time. Failed modernization efforts in Micronesia garner serious critiques from scholars, as does the continual U.S. military presence on atolls like Kwajalein.

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This diverse array of histories treats the Marshall Islands tangentially, as a passive stage where global events occurred. Each thematic history overlooks the influence of the atoll environment or Strategic Trusteeship. The Trust Territory of the Pacific Islands was a perpetually militarized zone where ideas about warfare, laboratories, post-colonial administration, nuclear weapons, and environments overlapped unlike anywhere else on Earth. This military superstructure provided the context for ideas about administration, science, and advanced weaponry to develop together and interweave on atolls. The quintessential and distinct elements of the American Century—military-academe complexes, nuclear weaponry, total war, and faith in science’s ability to guide U.S. decisions—were exported to Micronesia. On atolls these elements melded together and reformed, birthing an array of novel associations and ideas, including modern environmentalism, which diffused outward and became indispensable to America’s vision of the world. Micronesia was not merely a launching pad to Asia. Micronesia was the incubator, the laboratory of the American Century.

Powerful evidence for this assertion exists, this thesis argues, in a little-known program called Scientific Investigations in Micronesia (SIM). The program was dedicated to studying Micronesian and atoll ecology with the intent of informing administrative and modernization efforts in the Pacific. SIM was organized through the Pacific Science Board, a recently founded branch of the National Academy of Sciences, funded primarily by the U.S. Navy. During its seventeen-year duration from 1949 to 1966, SIM published one hundred seventeen articles, conducted intensive and complete investigations of five atolls, and aided in producing innumerable complementary studies and data on Micronesian ecology. Despite an impressive list of accomplishments, the
program is rarely referenced in contemporary histories or sciences because the program failed to heavily influence TTPI administration.

SIM's conception and evolution, this paper argues, are a definitive example of how distinct ideas concerning weaponry, science, and environments melded together in a permanently militarized zone. Ecologists entered Micronesia with several biases towards atolls, which were heavily informed by WWII and atomic testing. Testing in particular conditioned ecologists to believe that atolls were limited environments isolated from the rest of the world, perfect microcosms that could serve as laboratories. These assumptions were reinforced by early SIM studies, but as SIM matured, individual researchers began to challenge these assumptions and the unintended limitations imposed by Navy funding. The program's growth, however, pitted researchers against their previous studies, invalidating SIM's early research.

As a program for modernization, SIM became paralyzed, but several developments in science, particularly a growing understanding of radioactive fallout, prompted SIM ecologists to focus on newly defined global cycles. The concept of an insidious, invisible pollutant prompted ecologists to re-envision the world as a massive system composed of several interdependent cycles that transferred microscopic compounds around the planet. The nascent concept of ecosystems was adopted and applied to atolls by SIM's premier ecologist Raymond Fosberg, who shared strong ties with early environmentalists including Rachel Carson. The influence of nuclear weaponry and systems thought, a definitive feature of U.S. military strategy in the late '50s and early '60s, persisted in Fosberg, who served as a vector for spreading SIM's
influence. Through Fosberg, Micronesian atolls, once atomic laboratories, became the proving grounds for emergent theories on environmentalism itself.

This thesis explores the influences and legacy of the SIM program. The first section identifies the origin of U.S. opinions towards atolls, which heavily influenced SIM. The second section discusses SIM’s primary project, a macro-experiment that examined five separate atolls to generate data on atoll environments to aid administrators attempting to modernize Micronesia; this macro-experiment was undermined, however, by researchers’ inherited biases against the atoll environment and their attempts to cater to Navy funders. The third section explores SIM’s evolution, arguing ecologists grew increasingly independent from the Navy over time, due in part to heightened awareness of the effects of radioactive fallout. The fourth section concludes by exploring how Raymond Fosberg adopted and applied ecosystem theory to atolls. The thesis then concludes with a brief discussion on SIM’s conclusion and legacy.
ANCHORED AIRCRAFT CARRIERS
INITIAL PERCEPTIONS OF ATOLLS AND THEIR EFFECTS

WWII’s conclusion saw ownership of the Marshall Islands and Micronesia transfer to the United States, whose first impressions of these novel environments were forged in the most brutal battles of WWII. The atolls of Micronesia, devastated and impoverished in the wake of the war, were selected as atomic testing grounds in 1946 due to both their perceived isolation and lack of obvious commercial worth to the U.S. By 1947, the Marshalls and the vast majority of Micronesia were rechristened the TTPI, creating a perpetually militarized zone. The atoll environment became permanently linked to warfare, while continued nuclear weapons testing routinely emphasized the inherent isolation and perceived worthlessness of atolls. These early interpretations of Micronesia perpetually influenced U.S. administrative activities in the TTPI, including the SIM program.

Americans Encounter Atolls

Just prior to Operation Crossroads, the first atomic test in the Pacific, expedition leader Admiral William Blandly described Bikini atoll as nothing more than an “anchored aircraft carrier,” before concluding one atoll could easily replace another. Blandly’s disregard towards an atoll facing a nuclear holocaust was commonplace. Militarized visions and callous attitudes towards Pacific environs—shared amongst servicemen, politicians, and eventually the TTPI’s administrators—were acquired during WWII, a result of the brutal battles characteristic of the Pacific theater. This mindset

persisted after the war, ultimately justifying the decision to use atolls as nuclear laboratories and informing SIM ecologists' biases against the environments they investigated.

Prior to December 7th, 1941, Micronesia held no significance to Americans. The bombing of Pearl Harbor and the invasion of the Philippines brought instantaneous change. The islands' previous irrelevance, a direct product of their location in the vast Pacific, was supplanted by unparalleled military significance. Strategists and war planners, however, were ill equipped for island warfare, lacking the expertise, technology, and maps prerequisite for amphibious assault (the last major U.S. expedition to the Pacific Islands had been the Wilkes expedition in the 1840s).9 Basic information regarding islands and their currents, reefs, diseases, and foliage remained sparse.10 Disaster was always a step away: an unobserved reef could trap an amphibious assault vehicle or a strong rip current could carry a platoon off course. Before invasions even began, the island environment proved a serious impediment to American progress.

Any misgivings towards the mysterious Pacific Islands were undoubtedly confirmed during invasions. A 1951 Marine Corps history project recalls the “beauty” of Guadalcanal with its “freshening sea breeze,” “brilliant tropical sky,” and “lush” jungle before concluding that, “Ashore, as many Allied and Japanese troops learned of all islands in the Solomons-New Britain-New Guinea area, the place lost its beauty.” The

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9 Peter A. Isely and Philip A. Crowl. The U.S. Marines and Amphibious War: Its Theory, and its Practice in the Pacific (Princeton: Princeton University, 1951), 120. The Wilkes Expedition was, intriguingly enough, a joint Navy-scientist expedition throughout the Pacific. Several scientists, including famed American geologist James Dana, joined the Navy on a grand expedition throughout the Pacific that explored several atolls and islands over four years. Historian David Igler argues that, for scientists like Dana, the expedition confirmed the exceptional character of the United States. Therefore, published works focused more on California and the American West than the Pacific Ocean itself. David Igler. “On Coral Reefs, Volcanoes, Gods, and Patriotic Geology,” 23.

10 Peter A. Isely and Philip A. Crowl, The U.S. Marines and Amphibious War, 124.
jungle would “black out the sun” and the islands possessed “bladed kunae grass high enough to saw at the throat [and] coral ridges covered with stones sufficiently sharp-edged to cut the sole of a shoe.” In addition, the islands carried multiple diseases—such as malaria—and created “a humidity that debilitates the body and infects its skin with running sores.” Survival in the “green hell” of the tropical Pacific proved a near insurmountable challenge, and island environments, previously unknown and uncared for, became obstacles to be overcome on the long road to Tokyo.

Pacific environments transformed from a hindrance into an active barrier when Japanese defenders began to appropriate nature to defend against the American advance (see Figures 3-5). The Japanese utilized caves and underground networks to harass American forces, while snipers hid in trees. Furthermore, Japanese soldiers constructed bunkers from natural resources like palm trees and vines that hardly rose from the ground, nullifying artillery barrages while camouflaging their position. Lastly, convoluted landscapes often prevented the use of modern armor and artillery. Thus the defending Japanese, as historians chronicled and marines undoubtedly observed, relied on the environment to prevent effective assaults. To Americans, the environment was not neutral, but complicit with the Japanese foe.

The effect of linking the island environment to the Japanese was unparalleled destruction. Edmund Russell—a prominent environmental historian—argues, “[T]otal war sucked nature into the maw of war...Ideas about nature also served the war effort.

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11 Ibid, 99, 101, 103. For corroborating statements from more recent work, see Michael C.C. Adams, The Best War Ever: America and World War II (Baltimore: Johns Hopkins, 1994), 73.
12 Peter A. Isely and Philip A. Crowl, The U.S. Marines and Amphibious War, 113.
13 Ibid, 123, 125.
They helped frame and express views of the enemy, oneself, and the proper interaction between the two.”\textsuperscript{15} The Japanese appropriation of nature made island environments themselves complicit, and therefore encouraged unprecedented destruction of both the occupier and the landscape.

As nature was sucked into combat, overwhelming shelling became commonplace, with later battle sites enduring days of relentless artillery barrages.\textsuperscript{16} Isely and Crowl’s history of the Pacific theater highlights the indifference held towards the islands: “Most notable was the obliteration of the enemy on Palm Islet, a tiny grove of coconut trees crawling with snipers which barely rises from the water.”\textsuperscript{17} No mention is made of the ultimate fate of the meager islet, though it may be assumed that the island was destroyed. Such assaults were meant, according to witnesses, to force the enemy from hiding by eliminating his natural refuge. Nature was antithetical to the invading American forces; a lush jungle likely contained Japanese snipers and encampments, and defeating the Japanese required the decimation of the environment through American technology.

Despite their treacherous terrain, marines died by the thousands to conquer these distant, strategically valuable islands. The value of a Pacific island did not lie in the island itself. Rather, it lay in the ability of the island to provide a permanent air base, a permanent escape from the island. In order to island hop, Americans obliterated the natural setting the Japanese had appropriated, relying on an industrialized style of warfare characterized by excessive shelling and heavy machinery prior to “carving” an airstrip onto the island. The conquest of each island became quasi-ritualistic, with American

\textsuperscript{15} Edmund Russell, \textit{War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring} (New York: Cambridge, 2001), 117
\textsuperscript{16} Peter A. Isely and Philip A. Crowl, \textit{The U.S. Marines and Amphibious War}, 444
\textsuperscript{17} Ibid, 125
concrete ultimately replacing Japanese dirt. Islands and atolls were converted into, as Admiral Blandly stated, anchored aircraft carriers.\textsuperscript{18}

The origin of Admiral Blandly’s distaste towards previously inconsequential scatterings of land now seems apparent: the foreign and challenging terrain defended by a determined opponent birthed a disturbing association between the environment and the Japanese; in turn, the Japanese military use of these landscapes demonized the environment, which dehumanized the Japanese in a vicious cycle that encouraged the unmatched brutality of the Pacific theater. Although the majority of histories (including those examined thus far) focus on Southern Oceania, MacArthur, and the national legend of island hopping, historic evidence indicates Micronesia also experienced a war defined by a determined enemy, a seemingly hostile environment, and widespread destruction.

An atoll’s worth, like a Polynesian island’s worth, lay in its potential to support an airbase, to provide the launching point for the next military expedition. The atoll was the gateway to Asia.

Only a select few atolls, though, possessed the potential to aid American military objectives. For every atoll deemed essential, dozens were ignored and maligned. The crucial atolls’ natural environment was destroyed and an airstrip constructed. Micronesia and the Marshall Islands fell under the purview of Admiral Nimitz, who, in direct contrast to MacArthur’s slow procession from island to island, only acquired atolls with high strategic value.\textsuperscript{19} The less militarily consequential atolls and their Japanese

\textsuperscript{18} \textit{Ibid.}, 165, 529.

\textsuperscript{19} Admiral Chester W. Nimitz served as fleet admiral and Commander in Chief for both the United States Pacific Fleet and Pacific Ocean Area (CinCPAC and CinCPOA) during WWII. Nimitz is famous for assuming command just after Pearl Harbor and halting the Japanese at historic battles like the Battle of Coral Sea and Midway. He signed for the United States during the official Japanese surrender. Unlike MacArthur, Nimitz was precise, only commanding invasions of strategically crucial islands (an island’s importance was determined by its potential to disrupt the Japanese supply lines).
garrisons, like those on Jaluit (see Figure 1), were isolated for the duration of the conflict.

In the Marshalls, three atolls—Majuro, Kwajalein, and Eniwetok—were deemed essential to progress while the others were secondary objectives (or were ignored entirely).20 The atolls the Americans did prioritize, however, became embroiled in the full intensity of warfare characteristic of the Polynesian campaigns.

Information regarding atolls was sparse. One official Navy history went so far as to call the Marshalls the “isles of mystery.” Logistical errors, such as American troops landing on the wrong island in Majuro atoll during Operation Flintlock, were commonplace. Although this particular snafu proved comical rather than tragic since the Japanese had abandoned Majuro in 1942, American soldiers still looted Japanese charts to prevent similar occurrences.21

While Majuro reflected the chronic dearth of information characteristic of the Pacific theater, Kwajalein demonstrated the destructive potential of warfare in Micronesia. During the four-day invasion of Kwajalein, approximately fifteen thousand tons of bombs were dropped on the atoll’s sixteen square miles of land (937.5 tons/square mile), prompting one officer’s somber quip: “Never in the history of human conflict has

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20 Commander Dorothy E. Richards, *United States Naval Administration of the Trust Territory of the Pacific Islands Volume I*, 118-129. The capture of the Marshall Islands consisted of two larger operations: Flintlock (the capture of Majuro and Kwajalein), and Catchpole (the capture of Eniwetok). In addition, several months were spent neutralizing remaining Japanese forces after the initial operations were completed. This strategy proved stunningly effective during, for example, the capture of Majuro and Arno. Majuro was the first Marshall Island invaded, while Arno was among the last; eighteen miles separate the two atolls, yet Japanese from Arno hardly interfered with American operations and were safely ignored. *Ibid*, 125.

21 The entire defending force on Majuro consisted of a single officer when American forces arrived. *Ibid*, 120, 121, 123, 124.
so much been thrown by so many at so few.” 22 By the war’s end, atolls were almost barren, and their inhabitants, already impoverished, were on the brink of starvation. 23

By WWII’s end, American antipathy towards the atoll environment (and all Pacific environments) had fully developed. A recalcitrant opponent and unyielding environment were both subdued through a program of industrial warfare predicated on indiscriminate destruction. The atoll, once repurposed as an airbase, paved the road to Tokyo. However, Japan’s surrender robbed atolls of value. The U.S. Navy found itself in possession of two thousand “tiny islands” that, while useful as bases, were outdated compared to mobile aircraft carriers. Like many warships at the war’s conclusion, the atoll required decommissioning, which ultimately occurred in the form of Operation Crossroads, the world’s first atomic peacetime weapons test. Crossroads assembled hundreds of obsolete and purposeless battleships from the U.S., Germany, and Japan on the ill-fated Bikini Atoll, continuing the wartime tradition of obliterating atoll environments.

**Atolls & Operation Crossroads**

Operation Crossroads saw, “42,000 men, 242 ships, 156 airplanes, 4 television cameras, 750 cameras, 5000 pressure gauges, 25,000 radiation recorders, 204 goats, [and] 200 pigs” 24 descend on the hitherto unheard of Bikini atoll. Crossroads was envisioned as the first of several experiments to determine (and demonstrate to the Soviets) the power

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22 The invasion of Kwajalein lasted from January 31st, 1944 to February 3rd, 1944. *Ibid*, 120.
of atomic weapons. The tests also revised perceptions of the atoll environment. The choice to perform weapons testing on Bikini Atoll affirmed how prewar conceptions of Pacific Atolls as isolated merged with wartime hostility towards the atoll environment to produce a scientific experiment guaranteeing environmental devastation. The result was the assumption that Bikini, and all atolls, were isolates capable of modeling the larger world, the perfect environment for weapons testing.

Crossroads was designed to determine the effects of atomic weaponry on naval fleets if the device was delivered by air (Able) or detonated underwater (Baker). Able, whose explosive power produced, “A glow almost as bright as the face of the sun and very much larger,” failed to produce the cataclysmic explosion expected. Baker, however, literally blew everyone out of the water (see Figures 6). The Arkansas, a battleship, was thrown across the lagoon while the fleet of ships faced massive waves and radiation, inspiring observer Daniel Wilkes to write, “The gates of Hell yawned briefly across a peaceful stretch of the Pacific and then clanged shut with the fury of a thousand monsters and steaming radioactive water.” Baker in an instant demonstrated the raw, cosmic power Americans now wielded. The official pictorial history of Crossroads, hoping to capture the bomb’s sheer scope and terrible power, super-imposed Baker shot on the Manhattan skyline (see Figure 7). The picture of Baker’s cloud towering over the Empire State Building promises the untold destructive power displayed at Bikini will one

day appear over urban skylines. Until that fateful day, Bikini will serve as a model, allowing comparisons to be drawn between Manhattan and the Pacific without actually recreating the apocalypse in a populated space.

Why use the coral atoll to test weapons? Although Americans were searching for new uses for atolls in the wake of the war, designating them as the testing grounds for awesome weapons (paradoxically both an insult and high honor) seems nonsensical. Why did experts believe an atoll could contain the extraordinary power of the sun, but not fulfill more mundane needs (like basic commercial ventures, or advancing military objectives)? Acquired distaste towards the environment is not a sufficient basis for weapons testing. Instead, prewar perceptions of atolls as isolated combined with wartime habits of destroying atoll environments guaranteed Bikini became a test site.

The stated rationale for selecting Bikini for atomic weapons testing over all other possible test sites was its isolation. Bikini was hundreds of miles from any fishing lanes or population centers (but still close enough to Kwajalein to allow personnel to land at local airstrips).\(^8\) Vast physical distance—from both the mainland and large islands—approximated true isolation; the approximation eventually became absolute truth as physicists, who commonly use vast distance as justification for making approximations (i.e. a distant star is a point, not a sphere), claimed Bikini was too removed for radioactive isotopes to escape the atoll. Therefore, the isolated atoll became an isolate, a safe location for atomic testing, and one capable of containing any detrimental effects.\(^29\)

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The second reason Bikini was selected for testing was, of course, the perceived worthlessness of the atoll. Once chosen, Bikini was aggressively disparaged to the American public, both to justify the exile of the natives and the imminent destruction of their home. *Operation Crossroads: The Official Pictorial Record* captures American sentiments towards Bikini, showcasing Bikini with a series of photos that emphasized the atoll’s size and poverty (See Figures 8-10). The photograph titled “This is Bikini” shows coarse sand in the foreground and the lagoon in the background, with faceless natives and coconut trees scattered along a particularly narrow strip of land. The second, a picture of two naked boys, is succeeded by the caption “Private property among the young is hampered by lack of pockets.”30 Both photos emphasize simplicity and a lack of opportunity. Naked children and scantily clad natives, faces obscured, demonstrate how Bikini Atoll is insufficient for its inhabitants, whether or not the inhabitants agree. By moving Bikinians to better atolls, the U.S. was “saving” them.31 In fact, *The Official Pictorial Record* includes photos of the Bikinians at Rongerik, well-established and fully clothed in their new home, which possessed more fertile soil and freshwater (a detail included in the photo’s caption).32 And, of course, public officials such as Admiral Blandly continually portrayed Bikini as worthless to anything non-military.33 The overall

message was clear: Bikini, isolated and infertile, was already inhospitable. Atomic devastation would not destroy anything worth preserving.\textsuperscript{34}

Through citing physical distance and wartime attitudes, proponents of atomic weapons testing justified choosing Bikini and coral atolls in general as testing grounds. Physical distance was translated into complete isolation, while disparaging hyperbole guaranteed the habitual destruction of atolls that occurred during wartime would continue in peacetime. Atomic testing was the latest iteration of American scorn for atolls. However, by utilizing these islands as models, Americans imbued the atoll with a novel purpose: the atoll would become a laboratory for weaponry.

Crossroads, and all other atomic experiments, required both an isolate and a laboratory—an artificial space where every factor and variable is controlled to facilitate the measurement of specific phenomena. Bikini, once the inhabitants were removed,\textsuperscript{35} perfectly resembled an isolate; it was deserted, small, and removed from any community. Subsequently, the atoll was drastically modified during Crossroads: the lagoons’ troublesome reefs were cleared with dynamite, operation centers were constructed, and instruments were installed (See Figures 11-13).\textsuperscript{36} The atoll was now a laboratory, a fume hood where toxic elements were relegated and safely stored. The atoll laboratory modeled the world at large, becoming a space where “questions about [environmental]

\textsuperscript{34} It is also worth noting that Blandly once defended himself and the tests by saying he was not an “atomic playboy.” This quote, along with a picture of him and his wife celebrating Crossroads’ success by cutting a cake shaped like a mushroom cloud are pertinent (see Figure 14).

\textsuperscript{35} The story of the Bikinians is well-documented in other sources and remains fundamental to the Marshallese national identity. For more information, see Jack Niedenthal, \textit{For the Good of Mankind: A History of the People of Bikini and their Islands}. Majuro, Marshall Islands: Bravo, 2001.

vulnerability and manipulability on a vast scale"37 were posed. And, by modeling the world while remaining isolated from it, the atoll began to be considered a microcosm of Earth itself.38

Laboratories of the American Century

In the wake of Crossroads, atolls acquired novel utility. Once again, they were indispensable military tools, serving as isolated testing sites for the nation’s deadliest weapons. Self-contained and removed from civilization, the atoll was nature’s disposable laboratory, a near perfect miniature of the world. Despite Blandly’s pointed comments, larger atolls still served as vital bases to extend the United States’ influence, supplementing aircraft carriers that needed sites to refuel. The eventual consolidation of Micronesia into a US-administered trusteeship codified military visions of atolls and associated every atoll with the strategically vital Bikini or Eniwetok. By association, each atoll became a laboratory until the detonation of CASTLE Bravo Shot on Bikini Atoll in 1954, when the idealized atoll isolate was obliterated by nuclear fallout.

Continued testing and the consolidation of Micronesia into a Strategic Trust Territory cemented the nascent idea of the atoll laboratory.39 Strategic Trusteeship effectively canonized military perspectives on atolls by allowing the U.S. to restrict access to Micronesia, creating a martial atmosphere, while also enforcing the isolation physicists claimed exited on atolls. A Strategic Trust was still a UN Trust, and therefore the U.S. was required to modernize the territory. To modernize Micronesia, American

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39 Historian Elizabeth DeLoughrey argues the operation names of early weapons tests on Eniwetok, especially Operation Greenhouse, invoked the idea of the isolated atoll. See *Ibid*, 170-171.
administrators needed to create a national identity amongst several distinct island tribes and provide the foundation for modern infrastructure. Such an ambitious project, administrators felt, would require a complete understanding of atoll society and ecology. Guided by this ambition, administrators organized several Navy-funded investigative projects including SIM, which accepted and extended the connection between laboratories and atolls throughout Micronesia.

The connection between atoll and laboratory would survive until Operation Castle and the detonation of Bravo shot, the most powerful thermonuclear device ever tested by the United States. The incident demonstrated even the atoll could not contain Bravo’s radioactive fallout, which travelled far enough to affect the Lucky Dragon, a Japanese fishing boat, and the inhabited atoll of Rongelap. The perfect metaphor, atoll as lab, isolate, and microcosm, began to fail, eventually prompting SIM ecologists to explore new models to conceptualize the atoll environment.

Thin atolls with meager resources were unsuited to industrial or modern economies. For trusteeship to succeed, for a modern nation-state to emerge in the central Pacific, administrators believed only expert manipulation of the atoll environment coupled with careful economic development could succeed. Although the war generated intense interest in the Pacific Ocean and islands, little information on Micronesia—and atolls in particular—existed. Scientific Investigations in Micronesia (SIM) was one of several programs designed to remedy this ignorance.

SIM, first launched in 1949, was the latest in a series of military-funded academic expeditions to Micronesia, all of which were organized through the PSB (Pacific Science Board). The PSB was a specialized branch of the National Academy of Sciences founded at the behest of Navy to organize research expeditions to Micronesia. These expeditions were funded through grants from the Office of Naval Resources (ONR). Each expedition was intended to aid U.S. administrators by providing information to catalyze

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42 Commander Dorothy E. Richards, *United States Naval Administration of the Trust Territory of the Pacific Islands Volume III* (Office of the Chief of Naval Operations, 1957), 571-573. Since WWII's conclusion, several officials had called for some coordinated research effort in the Pacific. The framework for an organization capable of organizing several expeditions already existed in the National Academy of Sciences and its sub-branch, the National Research Council (NRC). During WWI, the Committee of Pacific Exploration was established and, by 1916, was transferred completely to the NRC and National Academy of Sciences. It was eventually renamed the Committee of Pacific Investigations and allowed the NRC to participate in the Pacific Science Congresses, a premiere assembly of scientists studying any aspect of the ocean. As of 1945, the University of Hawaii had recommended the NRC head any investigation and 1946 saw the Navy Chief of the Office of Research and Inventions (soon to be renamed the Office of Naval Research), anthropologist George P. Murdock of Yale and ecologist Harold J. Coolidge of Harvard meet at a Pacific Science Congress. The meeting laid the official framework for the Pacific Science Board, which was fully operational by 1947.
modernization efforts.\textsuperscript{33} The first of these programs, CIMA,\textsuperscript{44} was intended to serve as “basic research, not a survey, in order to provide a solid foundation for meaningful planning that would result in the integration of civil administration with indigenous culture.”\textsuperscript{45} Through CIMA, the U.S. hoped to meet its obligation to the U.N.: to administer the territory and create a modern society, not a colony.

After CIMA’s conclusion in 1949, the PSB launched several new projects—among them the Conservation Committee for Micronesia, the Pacific Geologic Mapping Program, and the Insect Control Committee for Micronesia. The most ambitious of these programs was SIM, a prolonged study meant to produce total comprehension of the atoll environment and the creatures that inhabited it, including the indigenous population.\textsuperscript{46} Originally, SIM was envisioned as a two-year project; following the program’s first expedition to Arno Atoll—a season-long expedition that saw thirteen scientists from several disciplines each examine a facet of the atoll’s ecology—the ONR continued funding SIM, extending the program’s life by more than a decade.\textsuperscript{47} The PSB organized similar studies on Onotoa Atoll (Gilbert Islands/Kiribati), Raroia Atoll (Tuamotu Archipelago, French Polynesia), Ifaluk Atoll (Central Carolines) and Kapingamarangi Atoll (Eastern Carolines, see Figure 15).

\textsuperscript{44} Coordinated Investigations in Micronesian Anthropology.
\textsuperscript{45} Richards, United States Naval Administration of the Trust Territory of the Pacific Islands Volume III, 578.
\textsuperscript{47} Richards, United States Naval Administration of the Trust Territory of the Pacific Islands Volume III, 585. Harold J. Coolidge, Final Report on Scientific Investigations in Micronesia, 3. Robert C. Kiste and Suzanne Falgout, “Anthropology and Micronesia: The Context,” 30. The Arno expedition was the founding program of the Coral Atoll Project (CAP). Although several early members of SIM make reference to CAP as a separate program, CAP became so prominent that it became almost synonymous with the work performed during SIM.
From their inception to their conclusion, the five atoll expeditions were envisioned as a massive experiment (or macro-experiment). This macro-experiment was occurring throughout Micronesia, an area that Raymond Fosberg—a renowned botanist and the most prominent scientist to emerge from SIM—called a “natural laboratory” for “research in tropical ecology,” an example of a “limited tropical total environment” capable of serving as the proving grounds for ecological sciences.48 Speaking of SIM’s greater purpose at a conference in Washington D.C. just after the conclusion of the program’s first expedition, Fosberg told curious ecologists:

Understanding [the environment] is certainly the first prerequisite for anything. If this study contributes, over the years, to the readaptation of atoll peoples and their place in the world, as well as providing a key to the understanding of other, more complex total environments, it will have amply justified itself.49

Fosberg assumed that administrators and researchers goals could collaborate to achieve their respective goals. Ecological investigations could inform administrators and help Pacific Islanders adjust to drastic changes to the atoll environment. Meanwhile, ecologists could use the atoll as a model or laboratory for understanding “more complex environments.” Most importantly, SIM and its primary researchers envisioned the program as a series of expeditions producing basic research without any adverse effects from Navy funding, the martial atmosphere of the TTPI, or weapons testing in the Marshall Islands.

This optimism proved misplaced. Throughout these expeditions, the assumptions towards the atoll environment generated during WWII and Operation Crossroads heavily influenced ecological investigations. SIM ecologists and the Atomic Energy Commission’s scientists imagined the atoll as a natural laboratory, a connection that

49 Ibid, 9.
allowed biases developed by physicists to influence ecologists. Simultaneously, Navy patentage of the sciences in the strategic trust territory encouraged scientists to cater to their financiers. As a result, scientific studies, especially in the earlier expeditions, focused on gathering information on atoll societies to aid modernization efforts rather than advancing a basic understanding of atoll ecology. Ultimately, the five atoll expeditions, organized as one macro-experiment to determine consistencies and distinctions between disparate atolls, served to confirm physicists and administrators’ assumptions: atolls were isolates with little inherent worth beyond their ability to serve as models for continental environments.

**Dissecting SIM’s Macro-Experiment**

The expeditions to the five scattered atolls were the crux of the SIM project. The atolls were not chosen at random, but rather for their location, size, and the lack of logistical challenges associated with researching each one. By achieving a complete understanding of the mechanics and inter-relations of every relevant organism and natural feature, scientists and the Navy believed they could model atolls throughout the TTPI based on variables like local climate and latitude. In other words, each expedition represented the continuation of a massive experiment where, ultimately, scientific comprehension of the physical space would beget control. By envisioning atolls as laboratories for ecological experiments to occur, however, ecologists unwittingly bridged a gap between environmental and physical sciences that allowed physicists’ biases to inform the SIM macro-experiment.

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50 Arno, for instance, was chosen due to its proximity to Majuro, which was one of the major administrative atolls with a large airstrip and several military bases. See the “Acknowledgements” page in Joe T. Marshall, “Vertebrate Ecology of Arno Atoll, Marshall Islands.” *Atoll Research Bulletin* 3 (1951).
Experiment, like laboratory, is a word bearing an array of associations and constraints. An experiment occurs within the laboratory, a constructed space where all variables are accounted for and controlled. The experiment itself repeatedly reproduces an observable phenomenon while varying specific factors to witness their effects and produce a description of the ultimate cause of the phenomenon.\textsuperscript{51} In other words, the experiment takes an event—something that indisputably occurs—and dresses it in language that implies total comprehension; the experiment provides the knowledge and definition of an event in human terms, and therefore allows individuals to react to that knowledge.\textsuperscript{52}

Despite occurring in the sterilized laboratory space,\textsuperscript{53} the experiment is heavily influenced by the researcher who designed it. The researcher determines which factors to vary, when data is acceptable or contaminated, and interprets the results of the experiment. Any understanding of the observed event is derived from the researcher’s prior experiences, influenced by several larger cultural and socio-economic trends.\textsuperscript{54} The experiment is a cultural product, even if the phenomenon is not. The laboratory, capable of accounting for several ‘natural’ biases, cannot totally nullify the perspective of the observer, a distinct product of time, place, and culture.\textsuperscript{55}

\textsuperscript{53} The amount of effort—time, money, and labor—expended in any lab on cleaning instruments and glassware or optimizing experiments to minimize potential sources of contamination well exceeds the amount of time spent producing data. Biologists use a combination of bleach (to kill microbial communities) and an autoclave (a furnace) to cremate any detritus or remaining microbes. Environmental chemists, who deal with an array of chemicals and cannot afford cross-contamination between corals and sediments, often heat all glassware at 450 degrees Celsius for twelve or more hours before an experiment to ensure all organic chemicals have evaporated. Authority in a laboratory space is derived from sterility.
How then is the term experiment applicable to a series of investigative studies that do not manipulate or alter the natural landscape, but only report information they observe? Ecologists could not physically transplant an atoll from one location to another to vary conditions like size, trade winds, or annual rainfall. Instead, to imitate the control and variation achieved in a chemical fume hood, the scientists were physically transported to several atolls, seeking to determine how variations in those critical features distinguished atolls from one another. Therefore, the entirety of Micronesia becomes the laboratory; the experimental question is “what environmental factors are crucial for producing observed variability in atoll ecology;” and hypotheses are tested through several experiments (i.e. by visiting several distinct atoll).

SIM’s envisioning of the atoll and the totality of Micronesia as a laboratory had both obvious and subtle implications. Obviously for any space to serve as a laboratory, the researcher must exercise complete control over the entirety of the area: the very use of atolls as laboratories was demonstrative of American authority. The atoll, however, first became a natural laboratory during atomic testing, long before ecological investigations began. The term bore distinct connotations for each group. For ecologists, the natural laboratory was a space deserving of study. In comparison, military scientists

57 The massive ecological experiment performed by SIM chose five atolls to represent two thousand. Arno, the first, represented the large, moist atolls close to an urbanized center (Majuro), while Raroia represented moderate-sized, moist atolls removed from large urban centers. Additionally, Arno was selected because, despite its proximity with Majuro, the atoll had not been developed or as heavily influenced by colonizing Europeans. Onotoa was selected due to its unique shape, high rainfall, and location less than ten degrees south of the equator; similarities between Arno and Onotoa would demonstrate consistency due to latitude. Ifaluk represented a northerly atoll. Lastly, Kapingamarangi represented small, moist, southern atolls. Observations about each atoll served as data points to support or disprove grand hypotheses on the nature of atolls, and the parameters were predetermined by the layout of Micronesia, the “natural laboratory.” F.R. Fosberg. “Ecological Research on Coral Atolls,” 8. Harold J. Coolidge, “Origins of the Conservation Conference” in Conservation in Micronesia: A Report on Two Conferences Held Under the Auspices of the Pacific Science Board in Honolulu, T.H. and Washington D.C. in April and May 1948 (Washington D.C.: National Research Council, 1948): 6-9.
envisioned the atoll as a place to perform studies. Ecologists valued the atoll—it was worth studying—and atomic testing disparaged atolls—they were the space on Earth most deserving of destruction. Of course, both these views are paradoxical. Ecologists highly valued the atoll as a model for more complex spaces, as did atomic researchers. So there existed both a shared terminology (natural lab) and a shared intent towards atolls (to use them as models) between disparate scientific disciplines.

The shared terminology served as a bridge, connecting two distinct ideas of laboratory. These two diametrically opposed views of atolls, despite existing simultaneously, did not fuse or equally influence one another. The initial conception of the atoll as the isolated, self-contained, and interchangeable microcosm was a well-established fact before SIM even began. Operation Crossroads confirmed atolls were capable of absorbing the power of two atomic blasts—the world was not destroyed and no discernible negative effects were experienced on the continents. Unless the atoll was isolated, it could not contain such destructive force, the logic went. Military scientists, through atomic testing, treated the atoll as a self-contained space fit for destruction; SIM was founded on the assumptions of these military scientists, whose view of atolls was itself inherited from WWII. Ecologists ‘knew’ atolls were isolated and lacked worth long before launching expeditions. The studies performed would reinforce that perception.

**The Arno Consensus: The ‘Atomic Influence’ on SIM**

The SIM macro-experiment selected five atolls to represent two thousand. In each expedition, an atoll was reduced to a data point. Each atoll expedition therefore needed to

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58 Prior to Crossroads, many were uncertain what the effect of testing in the ocean would be. Several laymen claimed that atomic testing would boil the ocean or create mile-high tsunamis. These doomsayers’ predictions were not fulfilled. See Daniel Wilkes, “Bikini Breath of Death,” 84.
gather comparable data in similar fields to construct a coherent picture of variation across atolls. If the experiments performed on each atoll varied too greatly, comparison of data became impossible. Therefore, research performed on Arno exerted tremendous influence over subsequent studies performed on Onotoa, Raroia, and Kapingamarangi. Each expedition had to tailor itself until it bore enough similarity to the original Arno expedition to allow for comparison, which encouraged homogeneity between expeditions. Consistent data only reinforced ecologists' convictions. Subsequent expeditions never challenged the conclusions reached on Arno Atoll, mainly that the atoll itself was a simplistic, self-contained model of the larger world. Instead, later reports referenced the Arno expedition, treating it as a foundation. After Arno, all atolls were assumed to be simplistic, to have low potential for future development, and to be highly susceptible to the whims of the Pacific Ocean. At Arno itself, researches emphasized the

59 Examinations performed on Ifaluk were exceptional because the research crew was smaller and dedicated their efforts to publishing a single book describing all ecology from a geologist's perspective.


similarities between every atoll and downplayed distinguishing features, usually while characterizing Arno as a flat, indistinct, and isolated ring of land.

Ecologists who participated in the Arno expedition routinely advanced Arno as a model for all other atolls. Among the several researchers who partook in the Arno expedition was Robert Hiatt, a seasoned scientist who had previously conducted investigations in Pacific ecology through the University of Hawaii at Honolulu. At Arno, Hiatt studied marine life, and concluded his published report with:

In general the fauna and flora resembles other coral atolls of the Central Pacific, but certain differences are striking. While the author believes that studies on one atoll may serve as a sound basis for regulations and interpretations on others, it is certainly obvious that real and important differences exist... Once these changes were related to environmental changes, generalizations for all atolls within certain defined environmental conditions could be made.\(^{62}\)

Hiatt concludes from his study of Arno that, while important differences exist between atolls, Arno is a sufficient model for interpreting other atolls and devising new policies to administer the TTPI. For Hiatt, the similarities of between marine flora and fauna on distinct atolls are more significant than the differences; continued study will elucidate what environmental factors are responsible for deviations from observations made at Arno. Embedded in Hiatt’s generalization of coral atolls is the assumption that distinguishing features between atolls are inconsequential, that distinct atolls are not deserving of individual recognition or study.\(^{63}\)

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\(^{63}\) Other members of the expedition emphasized Arno’s value as a representative for other atolls. Earl Stone Jr. characterized the soil types throughout Arno based on a combination of depth, organic content, and chemical profiling. Based on observations, he produced diagrams showing island types based on soil deposition. Four cross-sections of hypothetical islands are depicted, each labeled to indicate the presence of swamps or taro pits. These cross sections can be generalized: every island in every atoll could be readily classified, as could the soils present. Again, similarity was emphasized over individuality. Earl L. Stone Jr., “The Soils of Arno Atoll, Marshall Islands.” *Atoll Research Bulletin.* No. 5 (Nov. 15, 1951): 3.
Hiatt’s fellow expedition member John Wells also presented a general picture of atolls in “The Coral Reefs of Arno Atoll.” Wells opens his report with a brief poem that claims atolls lack distinguishing features: “An atoll has a top that’s flat /And featureless extremely. /Corals and mountains make a mat /Where mountains are not seemly.”

Wells figures corroborate the poem’s claims, and include a map depicting the distribution of reefs in Arno Atoll (see Figure 16) with an accompanying physiographic diagram (Figure 17), a cross section of Arno Atoll (Figure 18), and a cross section of a hypothetical island before and after a typhoon (Figures 19 and 20) among others. None of the figures recreate the atoll’s distinctive physical features. Instead, cross sections of the entire atoll are used to emphasize a single fact: the atoll is almost featureless and therefore is representative of all atolls.

The map and physiographic diagram also emphasize isolation. In the map, Arno is alone and surrounded by ocean, while the physiographic diagram illustrates the sharp drop-off that isolates Arno from other atolls and the world at large. And, in such a massive ocean, tiny Arno is exposed to natural disasters like typhoons. Cross sections comparing a hypothetical island before and after a typhoon showcase potential devastation: the atoll before the typhoon, composed of brick-like stones, transforms into an inchoate pile of rubble. Wells’s arguments of isolation, flimsiness, and a lack of interesting features (and therefore lack of anything worth preserving) are never directly stated, but resonate in his abstract figures.

Lastly, soil scientist Earl Stone Jr. renders judgment on Arno’s commercial value in “The Agriculture of Arno Atoll.” Stone asserts, “like other aspects of the Atoll, the

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agriculture is marked by simplicity,” and claims the implementation of Western
techniques would produce an appreciable, but limited increase in agricultural produce.65
Immediately, atoll agriculture and the environment as a whole is characterized as a space
with limited potential, lacking diversity or complexity. Building on Stone's conclusions
William Hatheway, a botanist for the Arno expedition who wrote “The Land Vegetation
of Arno Atoll,” reports:

[I]t was the author's impression that the people of Arno were not eager to acquire wealth
and property. Regular working hours were unknown...More efficient management of the
Arno coconut groves would possibly double the cash income of the “ri jerbal” but only at
the sacrifice of leisure hours. Abundant leisure is perhaps one of the most pleasant
aspects of Marshallese life.66

Like Stone, Hatheway indicates that the agricultural potential of Arno is untapped, mostly
due to a lack of farming techniques. However, like Stone, Hatheway also concludes,
based on Arno’s limited flora and poor soil, that the atoll cannot host plantations and any
new farming techniques would have minimal impact.67 The environment, even if
improved, could not acquire commercial worth. Since both Hatheway and Stone consider
Arno representative of all atolls, this judgment extends to the entire atoll environment,
which both consider limited and lacking in appreciable commercial worth. Like Wells
and Hiatt before them, Stone and Hatheway confirm physicists' assumptions towards
atolls.

Although stated opinions towards Arno varied drastically between reports, a
consensus of sorts emerges. For researchers the atoll was, in Arno hydrologist Doak

Vegetation of Arno Atoll,” 8, 19-22. Leonard Mason's report shares this view. See “Anthropology-
Cox’s words, a heap of sand and low quality soil on top of calcified reef. Members of the Arno expedition advanced Arno as a model for all atolls, and then proceeded to disparage the local environment. Arno was always envisioned as a single atoll in a wide ocean, an isolated, thin string of land; it was inherently simplistic—limited—as were its biota and human inhabitants.

The conclusions reached by researchers on Arno confirmed the assumptions of military scientists about the nature of atolls. They were simple and replaceable. These presumptions about the nature of atolls were accepted long before SIM expeditions “demonstrated” their validity. SIM, through Arno and the atoll macro-experiment, confirmed what administrators and physicists already knew, camouflaging assumptions and biases with ecologists’ conclusions. The isolation of the atoll, confirmed by atomic testing, was never questioned.

**Applied Research in a Strategic Trust**

The inherent biases of the macro-experiment do not explain a lack of individual agency among several highly educated scientists. Instead, this uniformity resulted from a combination of the limitations set on the macro-experiment by the Arno expedition and funding from the U.S. Navy. While trying to guarantee continued funding by relating ecological studies to modernization efforts, ecologists—especially those participating in the Arno expedition—compromised early attempts to investigate atoll ecology, instead

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68 Of all the researchers who participated in SIM’s Arno expedition, the one who expressed the greatest distaste towards atolls was hydrologist Doak C. Cox, who stated, “The islands of the atoll are mere heaps of sand and “reef platform.” Doak C. Cox, “The Hydrology of Arno Atoll, Marshall Islands.” *Atoll Research Bulletin* 8 (Dec. 15, 1951): 11.
subscribing to existing assumptions about the nature of atolls generated by Cold War physicists.

During and after WWII, the Navy was the wealthiest of several groups with a vested interest in coral atolls, which led to a slew of military-funded academic programs, including SIM, designed to investigate every aspect of atolls. The purpose of CIMA and SIM was to provide information necessary for modernizing Micronesia, but Navy officials paradoxically advertised the programs as a chance to perform basic research unrelated to administration. Philip Drucker, the field, social, and scientific affairs advisor to the Department of the High Commissioner of the Trust Territory of the Pacific Islands from 1948-1951, wrote in *Scientific Monthly*, “The TTPI administration has deliberately avoided any suggestion that it wanted studies aimed at some specific application.”

Drucker deftly ignored critiques of applied research, instead portraying Navy-funded research as a demonstration of patriotism and humanitarianism:

> Anthropology has demonstrated that it can have great utility in carrying out the obligations of our government in administering for the well-being of the native peoples of the Trust Territory; whether it does or does not is between the individual anthropologist and his conscience.

Drucker placed a moral impetus on researchers: they could advance the field, help their fellow man, and advance their country’s goals by offering their skills to the Navy. Or they could ardently defy any moral imperative and remain critical of military-academe programs. The choice, and the guilt, was the anthropologist’s.

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Although Drucker’s powerful indictment was reserved for the critics of CIMA, his defense also applied to SIM, which was similarly organized. While the Navy encouraged basic research, researchers were well aware that funding could evaporate if the results proved inapplicable to administration. The result was constant attempts to cater to Navy interests throughout SIM and the PSB’s long history. For instance, the PSB supported the Insect Control Committee for Micronesia, which studied malarial mosquitoes and invasive species like the Giant African Snail that endangered copra production, while slowly discontinuing support for the Conservation Committee for Micronesia, whose work would have hindered economic development on several atolls. 72

SIM ecological studies devoted incredible attention to managerial concerns. Any perceived need to satisfy the Navy was augmented by the ONR administrative boards’ heavy involvement in the publication process. A SIM report, once compiled, was submitted to a Navy review panel. The panel ensured the report did not contain sensitive or classified information—again, a symptom of every atoll’s similarities to Bikini—and that the report was fit for publication in the official SIM journal: the Atoll Research Bulletin (ARB). 73 Naval administrators and reviewers, both highly educated but certainly not academics, were the first to read the article, were the first to judge the work’s successes and failures, and ultimately decided whether an article was submitted to ARB’s editors for review. To avoid long intervals between submission and publication, and to ensure future chances to explore Micronesia, authors needed to tailor their articles to the

73 The Atoll Research Bulletin was founded by Raymond Fosberg and Marie-Helene Sachet and published every SIM study once Navy officials reviewed the report. The first 117 issues were subsidized by the PSB; the journal was a free subscription journal.
Navy’s expectations. An article produced under SIM needed to impress and answer the Navy’s questions, not just the scientific community’s.

SIM’s earlier expeditions had little trouble catering to the Navy by producing information on topics of mutual interest to administrators and ecologists. There was considerable overlap since both scientists and administrators desired more information on topics like pests, soil health, and water availability. Scientists, however, merely intended to observe these facets of atoll ecology and hypothesize what connections existed between disjointed subjects. The Navy, however, hoped to take advantage of those invisible connections during modernization efforts. However, as SIM accumulated more information and researchers began to ask more specific questions, conflict between these groups and their separate motivations was inevitable.

Evidence of the Navy’s influence appears in several SIM reports. The third report compiled for SIM, “Field Study of Rats—Marianas and Palaus” by Robert Enders, focuses on the three species of rat that consume sugar and coconuts throughout the TTPI, eventually recommending poisons and tight import control. The choice to focus on a widespread pest, as well as concluding remarks, indicate this study was meant to inform policy as much as ecological research.

Navy funding also greatly influenced studies in hydrology on Arno Atoll. Doak C. Cox, the hydrologist who participated in the Arno expedition, focused primarily on water catchment technology. The report, in twenty pages, devotes four to discussing “Tides” and “Climate,” citing a lack of instruments due to shipment delays as the cause for

brevity. Lacking sufficient data to describe two fundamental aspects of atoll hydrology, Cox turns his attention to "Rain Catchment." He notes the Arnoese collect water for drinking and cooking using corrugated roofs, observing only 6,000 of 12,000 available square feet of roof are used to collect rain water; additionally, he notes twenty-two total cisterns exist on Arno, but only seventeen are in use. Cox’s intense focus on catchment would be an attempt to draw attention from the absence of tidal data if not for the section’s conclusion, which rather explicitly offers advice to improve catchment techniques to avoid drought. Instead of focusing attention to the atoll environment, Cox is offering a first step towards economic improvement of Arno and hundreds of other atolls.

Cox’s discussion of groundwater follows a similar pattern. After devoting several pages to explaining the Ghyben-Herzberg principle—due to a lack of turbulence, a lens of freshwater forms on top of ocean water underneath an atoll’s soil—he concludes his work by studying islanders’ utilization of this unlikely water source. Overall, the article awards an unnerving amount of attention to Marshallese water use and hints at potential improvements to agriculture and production. By focusing on human water use, and by offering improvements, Cox disregards the atoll’s complex hydrology in favor of factors directly applicable to his funder’s ambitions.

The other members of the Arno expedition also focused on human activity in order to aid the Navy’s administrative efforts. The entirety of Hiatt’s report discusses islanders’ use of marine organisms—what fish they eat, whether census data on dietary habits can be discovered, how the islanders fish, and what customs surround fishing—

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76 Ibid, 6-7.
before concluding, “The marine environment of Arno is of great importance to the people, but is underutilized by the present population. This is a significant fact because Arno is considered to be a heavily populated atoll...it is not the supply of marine resources which exerts the regulatory effect [on population].”

Hiatt, like Cox, leaves no doubt: this research relates directly to administrative concerns (i.e. population control and food availability) and will aid governance of an exotic environment.

Other Arno reports’ adaptations to the Navy’s silent requirements are less prominent. The articles compiled by the anthropologists Leonard Mason and John Tobin (both rather prominent figures in Micronesian Anthropology and the PSB), discuss land tenure and housing patterns, but in ways directly relevant to anthropological research.

Similarly, geologist Earl Stone Jr.’s report on Arno’s soil assembles an impressive array of data but only makes passing reference to the soil’s economic worth or potential. His second report titled “The Agriculture of Arno Atoll,” bears greater similarity to Cox and Hiatt’s work—agricultural techniques are criticized, pests are examined, and potential avenues towards increased efficiency are offered. Unlike Cox and Hiatt’s reports though, Stone’s article proclaims itself a study in applied research. Based on these varied approaches, it is apparent that studies performed on Arno Atoll did not oscillate between the two extremes of basic or applied research. Instead, each study was a mixture. Some studies were simply more upfront about their nature.

Guided by the Navy’s interests, researchers on Arno inevitably confirmed WWII-era assumptions about the atoll space. Research to aid in trust governance confirmed little

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infrastructure existed, and, even if atolls were developed, the natural environment would severely limit any commercial worth. Atolls could harbor strategic worth, and little else. Although the Navy's influence over SIM would wane, the macro-experiment started on Arno never challenged the legitimacy of early SIM reports. Subsequent expeditions constructed a portrait of atoll ecology with exquisite detail, but assumed throughout that the simple atoll was an isolate possessing meager resources, never challenging established biases.

In conclusion, nuclear testing on Bikini informed ecologists how to view atolls. Once underway, any chance for scientists to challenge their own biases was undermined by a need to cater to Navy financiers. With the conclusions from the Arno expedition predetermined, it was impossible for the macro-experiment to ever challenge what administrators, physicists, and several ecologists 'knew.' Only studies with minimal connection to the Arno expedition, the extraneous expeditions that occurred alongside the intensive atoll investigations, could challenge SIM's fundamental assumptions.

The SIM macro-experiment is representative of both the successes and failures of the military-academe partnership Americans exported to Micronesia. The Navy's wealth and organizational expertise made SIM—an incredibly ambitious project in an understudied and difficult to access region—possible. SIM remains the most intensive investigation on atoll ecology ever conducted. But SIM also confirms that applied research generated by a partnership between the military and academics only reinforces itself without questioning basic assumptions. The rigorous self-questioning definitive of academic research is noticeably absent from SIM, both because scientists desired continued Navy funding and because American's conception of a unique environment—
the atoll, a militarized, worthless, isolated, perfect microcosm and model of Earth—
created an ineluctable bias.
CHANGE ON THE FRINGE
THE EVOLUTION OF SIM

SIM was a massive undertaking, and the macro-experiment represents less than a third of the work performed by SIM.81 In actuality, SIM’s goals were threefold: assemble existing literature, perform novel investigations, and apply that information to the problems of atoll modernization.82 To achieve the first goal, Marie Helene-Sachét, a French botanist and Fosberg’s primary collaborator,83 compiled a massive bibliography entitled Island Bibliographies: Micronesian botany, land environment and ecology of coral atolls, vegetation of tropical Pacific islands.84 The annotated bibliography, published in 1954, was over five hundred pages in length and assembled every previously published source on atolls.

The second goal—novel investigations—was attained through both the macro experiment and a slew of smaller expeditions and investigations. These smaller expeditions account for approximately one half of the studies published in ARB; were undertaken by SIM veterans like Fosberg, Helene-Sachét, and newcomers like Harold J. Wiens; and often received less or no funding from the Navy. Originally, these smaller expeditions were supplementary to the macro-experiment. By 1966 though, the smaller reports represented the bulk of the studies.85 Based on this marked change over eight years, the smaller expeditions represented the next step in SIM’s evolution, a move away from the highly structured macro-experiment towards a more decentralized style of

84 Fosberg coauthored the work, though Sachét was the primary author.
scientific investigation. These smaller expeditions, less influenced by the Navy's money and ambitions, freely built upon the information gathered in previous expeditions. Without the Navy's guiding hand, the consensus exhibited in reports from early expeditions faltered. Instead, a chorus of disparate voices appeared, each pulling in different directions and even challenging physicists' most fundamental biases towards atolls.

**Atoll Research Bulletin: The Navy, SIM, and Atom Bombs on non-Atomic Atolls**

The latter half of the SIM project saw the dissolution of the previously successful Navy-academe partnership. This was in part due to tensions between the academics and the Navy's impression of ideal research. The ever-increasing amount of information available on Micronesia prompted new, specific questions on atoll ecology often divorced from the Navy's administrative concerns. Academics' interests were guided by outside events as well, such as the detonation of CASTLE Bravo shot. The spread of nuclear fallout from an atoll to several refuted the concept of the natural laboratory, creating an irreparable rupture: ecologists questioned fundamental assumptions about atolls, published ARB studies discussing radiation, and studied the atomic atolls themselves; the long-standing separation between atomic and normal atolls—long upheld as a distinguishing feature of the militarized TTPI—vanished. Increasing deviation from the Navy's interests (as well as implicit questions towards the validity of SIM itself) caused funding to evaporate. Ultimately, the program slowly disintegrated as a result of both its own evolution and an increasing indifference towards Navy interests.
One of the first ruptures between SIM and the Navy to appear in ARB was Ted Arnow’s “The Hydrology of the Northern Marshall Islands.” Arnow, who partook in the Ifaluk expedition, had the preliminary results of a field survey in the Marshalls published on May 31st, 1954 in the thirtieth edition of ARB. Notably, Arnow’s expedition was associated with the U.S. Geological Survey and no mention of Navy funding appears in the acknowledgements section. Of course, the U.S. Geological Survey’s interest in Micronesia was, to a large extent, an extension of the Navy’s administrative interests. However, the article’s publication marked the first definitive break between the Navy and SIM: the publication of a study not directly funded by the ONR in the ARB.

An even greater divergence was the publication of the fifty-eighth edition of ARB, Fosberg’s “The Maldive Islands, Indian Ocean.” The article, published in 1957, was the first article ever published in ARB not concerned with the TTPI (or the British and French islands). The Maldives, an atoll nation located in the Indian Ocean, held little relevance to administrators of the Trust Territory. Instead, Fosberg’s report, a mix of scientific observation and travel narrative, provides an intriguing case study on another secluded corner of the world, one completely unrelated to the TTPI.

The publication of articles not immediately concerned with Navy funded projects did not represent a total rupture between academics and their military sponsors. Instead, it represented the maturation of ARB as a scientific journal. The Atoll Research Bulletin, after generating sufficient interest by publishing earlier studies, was expanding to include

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87 The conversational tone Fosberg adopts in this source is an attempt to mask a lack of quantitative results. Rather, Fosberg attempts to introduce his reader to the Maldives, using qualitative observations to generate interest amongst ARB’s readers. The lack of substance may also be indicative of a lack of funding for investigations in the Maldives. F.R. Fosberg, “The Maldive Islands, Indian Ocean.” Atoll Research Bulletin. No. 58 (Sept. 15, 1957): 1-3.
every facet of all atolls. Any conflict generated between SIM’s official journal and the Navy was due to the Navy’s comparably limited interest in specific features of specific atolls.

The growing divide between ARB and the Navy accelerated due to two unrelated events: the transfer of control of the TTPI from the Navy to the Department of the Interior in 1951 and the detonation of CASTLE Bravo. The transfer of administrative rights did not immediately affect SIM; the Navy still provided for the project and encouraged new research for years. The Interior appears to have been receptive towards any information that could aid administrators, akin to the Navy in the early years of the TTPI. Annual reports written by the Trust’s High Commissioner and published by the Interior, called *Annual Report on The Trust Territory of the Pacific Islands*, gave minimal attention to the PSB. The reports from 1953, 1954, and 1955 are the only annual reports that directly mention SIM and the PSB. The reports’ focus, however, was the PSB’s, “Continuing expert assistance in the fight against the rhinoceros beetle,” the Giant African Snail, and rats. For the Interior, the PSB’s primary purpose was to assist in the eradication of pests. The Interior’s primary focus, rather than scientific investigations, was overcoming the logistical challenges posed by “2,130 separate islands...ranging in size from volcanic masses of 153 square miles to mere sand pits.”

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could aid farming or provide health services to scattered atolls with no pre-existing infrastructure was desired. Anything else was ultimately extraneous.

Nuclear fallout, which first received serious consideration following the Lucky Dragon incident and Bravo shot (1954), catalyzed dramatic changes to SIM research. 93 An atoll could not be perfectly isolated if radiation could travel between atolls. The physical rupture of the perfect isolate was mirrored in ARB, where articles discussing atomic testing or testing’s repercussions began to appear. The most direct was Fosberg’s “Long-Term Effects of Radioactive Fallout on Plants?” The article, published in 1959, compared results from several surveys, demonstrating a clear deleterious effect upon the vegetation which increased in severity the closer an atoll was to Bikini, with Rongelap in the worst condition. 94 Seven pages of data charting isotope levels in various plant species corroborate Fosberg’s qualitative assessment: these plants were affected by fallout from Bravo and are dying because of Bravo. The atoll is not self-contained.

Once fallout breached the physical barrier between atomic and standard atolls, SIM studies began to bridge imagined gaps by studying atomic atolls. Although several studies, such as Arnow’s “Hydrology of the Northern Marshall Islands” relied on data gathered from laboratories on Eniwetok, no SIM study exclusively studied an atomic atoll before the seventy-first edition, titled “Microclimate Observations on Eniwetok.” Published in 1960 and authored by David Blumenstock and Daniel Rex, the article sought

93 A piece of administrative history is essential here. The Atomic Energy Commission was in command of the atomic atolls of Eniwetok and Bikini following Operation Crossroads. Therefore, the Navy’s role in atomic testing was concluded eight years before Bravo shot (though it was the Navy that provided the military might necessary for the Pacific Islands to be considered restricted).

to answer whether an atoll created a microclimate. The paper presented over one hundred pages of data collected during the summer of 1957 though it hesitated to draw any conclusions towards the nature of atoll microclimates. The report did, however, represent another breakdown in the mental barrier that isolated atomic atolls from the world. For the first time since 1946, an atomic atoll was not an exceptional space isolated from everything, but was instead treated as a part of Micronesia.

Not every SIM ecologist embraced the concept of fallout, but several began to debate the merits of U.S. administration. Researcher Harold J. Wiens displayed a conflicted attitude in the fifty-fourth edition of ARB (1957) when writing about the Bikinians after they were relocated to Kili Island—an island with less than a square mile of land and no lagoon. When discussing the miserable state of Kili’s population, Wiens criticized the Bikinians for not tending to agriculture, but also blamed American administrators for providing poor housing. William Hatheway was more defensive of U.S. administrators in the fifty-fifth ARB (1957), writing that the people of Kili “neglected” agriculture. Hatheway’s assumption that Kili, as an island with richer soil, should serve as a superior replacement for Bikini is a reiteration of the military’s interpretation of atolls: the rings of coral are worth little and interchangeable. The ideals that climaxed during SIM’s creation were still alive, but were waning in the latter half of the decade. That researchers felt the need to defend (or in Wien’s case softly critique) the

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95 David I. Blumenstock and Daniel F. Rex “Microclimatic Observations on Eniwetok.” *Atoll Research Bulletin* 71 (June 30, 1959): 4. It is worth noting neither author is ready to reincorporate the atoll into larger visions of the world. The term microclimate itself implies the authors were uncomfortable declaring an atoll could possess anything other than a “tiny,” isolated climate.


Americans as administrators demonstrates a lack of confidence in American policy towards Micronesia.

The end result of the growing distance between ecologists and the SIM's initial, Navy-sponsored mission was termination. Starting in 1959, ARB sporadically published an edition dedicated to "Atoll News and Comments." Although the News and Comments sections were reportedly intended to draw attention to the region and highlight studies too short to publish in a full edition, they also exposed a weakening SIM. The journal could no longer attract researchers performing ambitious studies, and lacked enough material to publish full editions. Whether this lack of articles was due to researchers abandoning SIM or a lack of available funds is not entirely clear. Whatever the cause, subsequent editions of News and Comments further hinted at SIM's debilitated state as there were delays in releasing editions of ARB, researchers began to venture to other oceans, or published their work in books or other journals. Finally, the one hundred seventeenth edition, published early in 1966, stated that after fifteen years of support the ARB would no longer be subsidized by the ONR.

The Atoll News and Comments sections demonstrate that by the 1960s the program was limping towards its end. Increased knowledge of atoll ecology had created several new avenues for researchers to explore, making it near impossible for SIM to

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100 F.R. Fosberg and Editors, "Atoll News and Comments." *Atoll Research Bulletin.* No. 117: 1. The Smithsonian Institution decided to subsidize the ARB soon after and continues to do so to this day. Fosberg and Sachet were both hired by the institution as well and became curators in the Natural History Museum. The continuation of SIM's mission to comprehend atoll ecology through the Smithsonian implies the U.S., rather than abandoning its ambition to fully understand atolls, reorganized its efforts. The faltering military-academe partnership demonstrated a need to separate research from military application, and civil government (with notably less money) took control of basic scientific investigations.
focus their efforts on providing effective ways to modernize coral atoll societies. Instead, researchers explored atolls beyond the Pacific or began to study and integrate hitherto isolated atomic atolls back into Micronesia. As a natural consequence, the Navy eventually ceased funding a program that did not produce useful information. However, based on the diversity of reports published with and without Navy finances, the years between Bravo shot and 1966 represent a unique period in Scientific Investigations in Micronesia where investigators grew bolder and began to perform basic rather than applied research. For a brief period, SIM grew independent from its military origins without repercussion, producing studies that challenged traditional assumptions towards the atoll environment while generating new information on atoll ecology. This temporary respite from the Navy’s priorities would allow for the development of a new model for interpreting atolls and the environment at large: ecosystem theory.

Atoll to Atolls

In the wake of the Onotoa and Raroia expeditions of the macro-experiment, researchers scrambled to assemble the newfound mass of information and data into digestible formats. This rush produced the *Handbook for Atoll Research* and a slew of other articles that were all published simultaneously (May 15, 1953). These articles greatly differed from previous SIM studies. They considered all atolls simultaneously as opposed to focusing on a single landmass. This departure—the product of a gradual shift

101 A first edition of this handbook was drafted and distributed following the Arno expedition in 1951. The second edition, which was widely distributed through *ARB*, was written in 1953 by a series of authors and edited by E.H. Bryan. Raymond Fosberg and Marie Helene-Sachet, as editors of the *ARB*, also had a role in crafting the handbook. The second edition was ultimately published in the 17th edition of *ARB*. For more, see F.R. Fosberg, and Marie-Helene Sachet, Ed. *Handbook for Atoll Research* (Washington D.C.: National Research Council, 1953), 4.
in SIM that resulted from an accumulation of information over three expeditions—
produced several articles and indices that focused on a singular feature of atoll ecology,
highlighting commonalities rather than distinctions and allowing researchers to envision
several atolls, not just one generalized atoll. This gradual revolution caused researchers to
abandon administrators’ pragmatic concerns discussions on modernization in favor of
articulating the subtle connections between atolls.

Articles discussing multiple atolls understandably focused their research on one
particular feature. The articles’ titles reflected their author’s ambition, with some articles
boasting understanding of a phenomenon in the Central Pacific or the Northern
Marshalls, or, on numerous occasions, the entirety of the Pacific. Based on their titles
alone, eighteen (out of one hundred seventeen) articles were published concerning either
a region of the Marshall Islands or Micronesia as a whole. Serious consideration will only
be given to a few representatives, which are purposefully dispersed throughout the 1950s
and even 1960s to fully illuminate how researchers studied atolls as opposed to an atoll
and how this sparked divergence from administrative ambitions.

Articles authored by Marie Helene-Sachét addressed topics essential to ecologists
but only tangential to administrators. Her first research paper to appear in ARB,
“Scorpions on Coral Atolls,” while her second was titled “Pumice and Other Extraneous
Volcanic Materials on Coral Atolls.” While both articles ostensibly address “practical
concerns,” neither report dedicates more than a page to the implications of Sachét’s

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research for administrators. Instead, “Scorpions on Coral Atolls” lists species of scorpions encountered on each atoll chain and the specific atolls where researchers witnessed a scorpion in the last century, producing an index to aid entomologists. Similarly, in “Pumice and Other Extraneous Materials,” Sachét lists the atolls where pumice has been found and offers potential mechanisms by which pumice could arrive on a volcanically inactive atoll.103 Again, Sachét’s purpose was to inform fellow researchers, this time about the distribution of a unique rock-type across several atolls.104 It is doubtful any administrator would find non-existent scorpions or pumice, which was not plentiful enough to generate newfound revenue in Micronesia, relevant to modernization efforts. Information on these topics was only valuable to ecologists.

Ted Arnow’s “Hydrology of the Northern Marshall Islands” is similar to both of Sachét’s articles. Its title claims a full understanding of a region with limited focus on modernization efforts. In the article, Arnow discusses trends in the pH and salinity of freshwater, devotes a half page to rain catchment, and offers an in-depth discussion of the Ghyben-Herzberg lens—how it forms, what factors affect it, and how an atoll’s shape and size affect those critical factors.105 Like Sachét, Arnow avoids broad statements and instead relies on meticulous research and an abundance of data to draw connections between disparate atolls (see Figure 21). Just as important, Arnow, unlike his predecessor Doak Cox, focuses on a single feature of atoll environments while devoting little space to discussing the practical implications of his research. In Arnow’s report, a single facet of

103 Pumice is an igneous rock commonly associated with volcanic eruptions. It is incredibly porous (it resembles a sponge and is actually used for grafting skin). Pumice contains so many air pockets it is buoyant in water, allowing it to travel from volcanic isles to distant continents and atolls.


atoll ecology, how that feature affects, and how that feature is affected by physical events receives more attention than how that feature affects humans. Arnow's research is not dominated by administrative concerns.

Several indices in ARB reports are also demonstrative of the growing divorce between SIM studies and the Navy's original ambitions. Indices, which formed either a significant portion or the entirety of multiple editions of SIM, are data organized in a rubric. The information enclosed, as long as the reader is well educated, is accessible for reference. Among the indices published under SIM was "Bryophytes Collected by F.R. Fosberg in the Marshall Islands" by Harvey Alfred Miller (1955). Miller's article lists several bryophytes—simple plants like moss that lack the vascular tissues, xylem and phloem, responsible for the transport of minerals and water throughout an organism—in alphabetical order based on their Latin name while also listing where they were collected. Fosberg employs an identical format to discuss vascular plants collected in the Marshalls (ARB 39, 1955). Aside from choosing an organizational scheme, both authors' input is limited.

Neither study bore relevance to administrators' concerns. Presuming a member of the Department of the Interior possessed the necessary background to interpret the full

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108 Although it is not the focus of this particular essay, SIM shared a confused relationship with the Marshallese, who were both research subjects inhabiting the "total environment" formed by coral atolls, but were also intended to benefit from SIM's investigations. The Marshallese, and all Micronesians, were both test subjects and humans. Only a Marshallese guide could provide a Marshallese name for a plant. Furthermore researchers like Cox and Fosberg routinely relied on islanders to gather data (and encouraged others to do the same). And yet, data was organized by Western names rather than Marshallese; this action implies the Western name is more correct, that Latin holds greater authority than the Marshallese language.
109 Some indices were unique either due to their organization or content. Fosberg, when discussing land biota with a focus on birds (ARB 114, 1966), provides an index with a previously unseen organization, listing the birds encountered in the Northern Marshalls based on the atoll where they were witnessed. Isabella A. Abbott, a researcher who visited Ifaluk, provided an un-annotated "checklist" of algae types
list of bryophytes found throughout the Marshall Islands, the knowledge would serve, at best, as unremarkable dinner conversation. The index was prepared for a botanist. Such indices collected information from an entire region rather than a single atoll. This shift in focus reflects scientists’ newfound focus on the observable trends of a single facet of atoll ecology across a swath of territory rather than all the possible ramifications of a single feature on a single atoll. A combination of variation across atolls and greater availability of information on Pacific ecology freed individual ecologists from commenting on the potential applicability of their research in modernizing Micronesia. The ramifications of the SIM studies were no longer the concern of the scientists, but instead the administrators who had to interpret and apply the results.

Ecologists, no longer complicit with physicists or the Navy, were free to observe and define the atoll environment as they saw fit (often by subscribing to their personal biases). The catastrophe spawned by Bravo Shot, which forcefully exposed interconnections between atolls and the wider world, however, would dramatically influence several SIM ecologists. The end result was the application of a new model for environments, the ecosystem. This novel conception of environments would borrow from nuclear and military influences to redefine the atoll environment.

Witnessed during her research trip (ARB 77, 1961). And, in a particularly ambitious move, E.H. Bryan authored “Check List of Atolls,” an article listing the four hundred low islands that qualified as atolls based on a definition conceived during a conference in St. Louis. The lengthy list provided an “Accepted Name” and “(Alternative Name),” along with the atoll’s latitude and longitude and, if necessary, additional notes. F.R. Fosberg, “Northern Marshall Islands Land Biota: Birds,” Atoll Research Bulletin 114 (March 31, 1966): 3. See E.H. Bryan Jr. “Check List of Atolls.” Atoll Research Bulletin. No. 19 (1953): 1. This checklist was defined at the Coral Atoll Symposium of 1951. Bryan writes, “Included are non-elevated limestone structures with dry land, with or without a lagoon, and not associated closely with high land. Excluded are elevated atolls (height more than 25 feet above the sea), sunken atolls (without dry land), barrier reefs surrounding high islands (such as the Truk group),” and other reef structures found in the Java region. Ibid, 2-30.
ECOSYSTEMS

AN ENVIRONMENTAL MODEL FOR THE ATOMIC AGE

In the concluding years of the SIM program, a novel word appeared in ARB articles: ecosystem. The term soon found tremendous traction and several SIM scientists and anthropologists participated in a symposium at the 10th Pacific Science Conference titled *Man’s Place in the Atoll Ecosystem* (1961). The shift in terminology from ecology to ecosystem represented an evolution in SIM’s perception of the atoll environment, one that emphasized interconnectivity between spaces, usually through microscopic pathways.

The term ecosystem, which enjoys high popularity in the 21st century and is associated with terms like “food web” and “cycle,” was coined in a 1935 article by famed ecologist Sir Arthur Tansley. The article, “The Use and Abuse of Vegetational Concepts and Terms,” was a response to Tansley’s contemporaries’ attempts to describe the dynamic connections between organisms responsible for producing a relatively static and stable community in nature. After rejecting existing terminologies, Tansley proposed his own:

“I have already given my reasons for rejecting the terms ‘complex organism’ and ‘biotic community.’ Clements’ earlier term ‘biome’ for the whole complex of organisms inhabiting a single region is unobjectionable, and for some purposes convenient. But the more fundamental conception is, as it seems to me, the whole system (in the sense of physics)… Though the organisms may claim our primary interest, when we are trying to think fundamentally we cannot separate them from their special environment, with which they form one physical system… These ecosystems, as we may call them, are of the most various kinds and sizes. They form one category of the multitudinous physical systems of the universe, which range from the universe as a whole down to the atom.”

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The very term ecosystem, by Tansley’s definition, borrows heavily from physics, especially by employing the term “system” to describe the unique interrelations between organisms and their environment. System refers to a system as defined by physics, and implies both progression and feedback. Military strategists, when describing the complex machinery governing nuclear missiles, also employed the term systems. Environmental disciplines employed ecosystems to borrow from the authority physicists enjoyed. The term construes the ecological sciences as a direct product of the inorganic, microscopic, and atomic processes described by quantum mechanics. It dresses environmental theory in the language of atomic research.

Tansley stresses throughout his article that the system is not rigid nor a progression, but a cycle where a change in any portion can and will affect the whole. The goal of the ecologist, by Tansley’s estimation, was to study and eventually predict how one change would precipitate another. Tansley’s “ecosystem,” at a cursory glance, does not appear too different from SIM’s “ecology.” SIM intended, through its research, to map out the pathways and connections between the biome (organisms, both plant and animal) and the atoll environment and then apply that knowledge to modernization and administration efforts. The difference lay in SIM’s basic approach to studying atolls.

When discussing atoll soils or reefs, researchers often—for convenience and to highlight the distinctions they personally observed—divided atolls into zones (see Figures 22 and 23). The unintended consequence of this approach—referred to as zonal theory—is that each zone is treated as entirely distinct and separate from the others. The biases of zonal theory were amplified by the very nature of SIM studies, which either sent

several scientists from several disciplines to a single atoll or a scientist from a single
discipline to several atolls; in either case, each individual focused on their specialty,
rarely venturing into other fields or attempting to describe their focus’ effect on the whole
atoll.

In comparison, ecosystem theory requires that the researcher remember his
discipline’s context. According to ecosystem theory, a hydrologist like Cox or Arnow
will still only investigate water in a demarcated area, but will then attempt to assign water
a role in larger systems. The size of the system may vary according to the researcher’s
prerogative. The system can be a tiny atoll, an ocean, a planet, or even the universe.
Although the impact of an atoll on the ocean—let alone the universe—is minimal, the
atoll is a part of larger systems. Atolls consume and supply matter that will eventually
circulate through the system. As a corollary, no part of a system is isolated from the
whole, and a change anywhere will precipitate changes everywhere. Micronesia and
especially the Marshall Islands, the region where weapons testing occurred, provided
physical evidence (i.e. fallout) of the subtle microscopic pathways that linked atolls
separated by vast distances. The unique mixture of military and nuclear influences that
defined the TTPI catalyzed ecologists’ efforts to envision atolls as parts of a system. As a
result, ecologists who applied ecosystem theory to atolls became strong advocates for
ecosystem theory, capable of clearly articulating and defending an idea that proved
essential to the emergence of modern environmentalism.
SIM Concludes as Fosberg Adopts Ecosystem Theory

SIM, in its concluding years, grappled with ecosystem theory and the question of whether the microscopic and macroscopic world continually relayed material back and forth like a system. The final five years of SIM (1961-1966) saw the publication of two separate attempts to summarize the results of every previous SIM investigation and produce a coherent picture of the atoll environment. One, “Qualitative Description of the Coral Atoll Ecosystem,” was a short article published by Fosberg in ARB (1961). The other was Harold J. Wiens’ Atoll Environment and Ecology. As their titles imply, Fosberg’s works utilized ecosystem theory to describe the atoll environment, while Wiens employed traditional ecology. Fosberg’s individual adoption and adaptation of a novel theory to describe atolls—a result of his development and maturation in the TTPI—was the most significant decision of SIM, and guaranteed the program would influence the development of modern environmentalism.

Prior to SIM, Raymond Fosberg was already an established name in government-funded science. He first came to the attention of the nascent PSB due to his previous experience in the Pacific and his contributions to Harold Coolidge’s conference on Conservation in Micronesia. Fosberg’s entry into Pacific Ecology was a result of his assistantship to Prof. Harold St. John, a well-regarded Pacific ecologist at the University of Hawaii, which allowed him to participate in the Mangarevan Expedition—one of the most complete investigations of Pacific botany performed prior to SIM—in the 1930s. After obtaining his masters at Hawaii, Fosberg received his PhD from the University of

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Pennsylvania in Botany in 1939.\textsuperscript{113} Any future work in the Pacific was delayed, however, by the start of WWII. Fosberg, after a brief hiatus in South America, returned to Pacific botany in 1946, when he took part in the US Commercial Company Expedition, a vast preliminary economic survey of Micronesia organized at the behest of the Navy. This expedition, and his earlier work in South America as a senior botanist assisting the U.S. in producing quinine to combat malaria, established him as a force in ecology.

Fosberg soon became part of a cadre of ecologists surrounding Coolidge with strong interest in Micronesia and America’s ability to influence environments through rigorous scientific investigations. His presentation, titled “Island Flora,” was therefore included in Coolidge’s \textit{Conservation in Micronesia} conferences. These conferences, held in 1948 in both Honolulu and Washington, D.C., were both an appeal to researchers and administrators to use ecological studies to avoid “Indiscriminate exploitation of the meager natural resources of the area…”\textsuperscript{114} Fosberg concluded his presentation with an appeal to preserve island environments, linking conservation to the Cold War to generate urgency while emphasizing science’s ability to advance American interests:

\textit{In conclusion, it is well to emphasize the fact that constant vigilance is needed in a conservation program. The forces which tend to destroy natural resources, natural phenomena, and natural beauty are much like those of Communism in that they can lose battle after battle, or election after election, without being seriously weakened, but if they win just once, the forces for conservation or democracy are finished. Natural wealth once destroyed is gone. Given time, a people under the yoke of a dictatorship may manage to throw it off with outside help; but a species or natural environment once lost is lost forever.}\textsuperscript{115}

\textsuperscript{113} Fosberg, born in 1908, obtained his B.A. at Pomona in 1930. See “Introduction,” \textit{Fosberg Commemorative Issue}, ii.
Conservation is fused to the United States. By linking the destruction of environments to the forces of Communism, Fosberg utilizes the dichotomy between communism and capitalism—the U.S. and the U.S.S.R.—to identify conservation with democracy, with America. Unlike Communism, he argues environmental destruction is permanent, and therefore a primary threat to the U.S. Implicit in this argument is that science, which determines conservation policy, and the United States are natural partners, even allies. Science will guide and direct the raw power of the United States to preserve, even save, the world.

Fosberg carried his unmitigated faith in the U.S. and science into SIM, a program predicated on science’s ability to direct and improve U.S. administration. He saw SIM as a model for future collaboration between the U.S. and ecologists in more geo-politically significant environments. Writing in “Ecological Research on Atolls” in the first edition of ARB, Fosberg called the atoll “a natural laboratory” for “research in tropical ecology,” citing the atoll environment’s simplicity as “almost ideal for studies of total environment and of human adaptation to and effects upon an environment.”116 Drawing on the biases of physicists, Fosberg does not ascribe much worth to the unique atoll environment. The simplistic environment’s value lies in its ability to serve as a model, a microcosm, of more complex continental environments that fascinated ecologists and the U.S. alike.117

The atoll is a laboratory for ecologists and their U.S. sponsors, a place to test theories and their partnership without fearing repercussions.

In the years following the expedition to Arno, Fosberg’s view of atoll environments evolved alongside SIM. His contributions to ARB, particularly the Atoll

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117 Ibid, 7.
Research Handbook and "Vegetation of Central Pacific Atolls, A Brief Summary,"\(^{118}\) demonstrate a growing appreciation of connectivity between atolls.\(^{119}\) These gradual developments, the product of ten years of Fosberg's career, were fully expressed in "Qualitative Description of the Coral Atoll Ecosystem" in 1961.

Fosberg was the first SIM researcher to adopt ecosystem theory, and became one of the earliest proponents of the theory among ecologists at large. The article "Qualitative Description of the Coral Atoll Ecosystem" was the eighty-first edition of the magazine. The paper, published in ARB in 1961, was originally delivered at the 9th Pacific Science Conference in 1957. To introduce his readers—many of whom were traditional ecologists—to ecosystem theory, Fosberg referred to Tansley's definition before writing, "Such a system is, of course, an abstraction constructed to facilitate understanding of the complex processes involved in a segment or class of segments of the biosphere. As such its extent is only limited by selection and definition of the segment or segments under study."\(^{120}\) Having stated that an ecosystem is an invention imposed on an environment, Fosberg delivers a lengthy description of the coral atoll ecosystem lasting a page and a half. The emphasis, however, is not on singular organisms. Instead, "In this paper, the coral atoll ecosystem will be described in terms of processes involving transfer or transformation of energy or material, with only incidental reference to the actual organisms involved in the system or to the physical structures found in the environment."

Production, Transformation, Decomposition, and Balance among others), which all took place in the media, the ocean and the air. These media were ever changing and therefore linked the atoll to the larger world.\textsuperscript{121}

Successful application of ecosystem theory to atolls simultaneously represented the completion and refutation of SIM’s mission. Any atoll could now be described based on defined categories. Fosberg had produced a general picture of the atoll that accounted for and predicted all potential variations responsible for producing distinct masses of land—or in Fosberg’s words, “The resultant of all the factors at work on the segment of the universe (or of nature) occupied by the atoll ecosystem is the atoll itself.”\textsuperscript{122} But the atoll ecosystem also directly contradicted the most fundamental assumption of SIM. The media that surrounded the atoll, the ocean and the air, was constantly in flux. The dynamic system of currents, prevalent from the deep sea to the highest reaches of the atmosphere, meant the media was constantly circulating, traveling across the globe. Global routes only accessible to microscopic particles connected everything on Earth, even the atoll. Bravo Shot was the first time these pathways were made visible, as radioactive particles travelled unexpectedly far, and continued tests demonstrated that nuclear activity could influence these global pathways. By adopting ecosystem theory, Fosberg was accounting for new discoveries brought about by weapons testing, and in the process challenged the idea of isolated atolls birthed during Crossroads. Events on Bikini once again determined how SIM researchers interpreted atolls. Even as researchers established increasing independence from physicists and the Navy, the legacy of

\textsuperscript{121} Ibid, 1-2, 3, 10.
\textsuperscript{122} Ibid, 9.
militarized science persisted in a theory that was inseparable from the TTPI and weapons testing.

Although Fosberg’s belief in the atoll microcosm had expired by 1961, his staunch faith in science’s ability to comprehend the world had not. When hosting *Man’s Place in the Island Ecosystem: A Symposium* (1961), Fosberg launched the conference with a carefully worded introduction stressing that knowledge of ecosystems would influence economies, allowing “intelligent manipulation” rather than “blundering” development of the environment. The implied fragility of the island environment, first articulated in 1948, remains, as does Fosberg’s belief that these islands are microcosms of the continents. However, any overt claim that these islands are natural laboratories is noticeably absent, as is any link between the studies performed and contemporary politics. The segregation of science from political statements is likely a dual product of Fosberg’s maturation as a researcher and the growing rift between scientists and the military that grew throughout the later ‘50s. Regardless of the cause, Fosberg’s new position, markedly more humble but still quite assured, directly challenged the founding assumptions of SIM.

Fosberg’s early adoption of ecosystem theory left him intellectually isolated amongst SIM researchers, which Harold J. Wiens makes evident in *Atoll Environment*

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123 Fosberg’s opening lines stress the necessity of holistic approach to ecological studies. He decries the limits of partial concepts and the arbitrary boundaries commonly set in studies of ecology, writing, “The study of one component of an ecological situation, assuming that all other components remain constant, has long been an accepted procedure, but one that is manifestly unsound.” Following this critique, Fosberg introduces Tansley’s term, ecosystem, and argues for its value in discussing environments. He also offers his reader a brief history of the term, as well as the term microcosm. See F.R. Fosberg, “The Island Ecosystem” in *Man’s Place in the Island Ecosystem: A Symposium*, edited by F.R. Fosberg (Honolulu: University of Hawaii, 1965): 1.

124 Ibid, 1, 4.

125 The highly publicized Oppenheimer trial was the first of many independent ruptures that hindered a military-academe complex. By the 1960s, government funded scientific studies became heavily criticized. For more, see Roy MacLeod, “‘Strictly for the Birds’: Science, the Military and the Smithsonian’s Pacific Ocean Biological Survey Program,” *Journal of the History of Biology* 34, no. 2 (2001): 352.
and Ecology, an attempt to summarize SIM’s results using traditional ecological models. The preface includes a brief note on disagreements over the compilation: “Some authorities on coral atolls no doubt feel, with F.R. Fosberg, that investigations in the special fields of atoll study have not been nearly thorough enough as yet to permit a comprehensive exposition of atoll ecology.” 126 Wiens’ stated disagreement with Fosberg foreshadows a distinct approach when discussing atolls. While Fosberg contextualized atolls as parts of global systems through ecosystem theory, Wiens relied on zonal theory to describe atolls. Each subject is treated in its own separate chapter, obfuscating the reader’s ability to draw connections between disciplines. 127 In Wiens’s narrative, the physical processes determine the nature of the atoll and the life forms that inhabit it, but the macroscopic does not affect the microscopic. The key difference between Fosberg and Wiens’ reports is Fosberg’s assertion that both the macro and micro perpetuate each other. 128 However, since Wiens was officially tasked with assembling a summation of SIM, Atoll Environment and Ecology became representative of the program and its conclusions.

SIM concluded without embracing or rejecting ecosystem models. This debate on theory—whatever its influence and implications for SIM—had no impact on TTPI administrators. Instead, this intellectual dispute between researchers likely confused

127 Wiens does, however, devote serious attention to ocean currents and their ability to connect the Marshall’s to distant locations like Guadalupe, evidence that even traditional ecologists could no longer claim atolls were isolated. *Ibid.*, 186, 189.
128 It is worth noting that the Ifaluk report, which was also published in 1961, presented information in a similar manner to Wiens. For the researchers, all of whom were geologists and oceanographers, the physical processes were critical in determining the biome, but the relationship was one-sided. See J.I. Tracey, D.P. Abbott, and T. Arnow. *Natural History of Ifaluk Atoll: Physical Environment in Scientific Investigations in Micronesia*. 26: 1-86
administrators looking for potential ways to modernize Micronesia. Therefore, when funding to the program was terminated in 1966, the project was deemed a failure.

Despite its lackluster conclusion, SIM greatly influenced environmental science through Fosberg and his strong connection to Rachel Carson. Fosberg and Carson first interacted (to this author’s knowledge) in 1948 and 1949, when Fosberg aided Carson’s research on island formation for a chapter of *The Sea Around Us*, one of Carson’s earlier works. Fosberg apparently held great respect for Carson and her work, later describing a draft of her chapter on island formation as “‘the finest account of the creation and colonization of an oceanic island’ he ever read.” 129 The two maintained close contact throughout their careers—so close that Fosberg would be interviewed for *Rachel Carson: Witness for Nature*, a biography by Linda Lear.130 Additionally, it was Fosberg who introduced Carson to Frank Egler, another botanist who assisted Carson when she wrote *Silent Spring*.131 After Carson’s death, Fosberg was one of several who honored her memory by helping to found the Rachel Carson Center in 1965, which operates to this day.132

Fosberg and Carson’s friendly relationship undoubtedly included trading ideas and theories. Carson was a researcher who gathered scientific treatises and reports to write her award-winning books, and Fosberg was one of many researchers who influenced her work. Carson’s *Silent Spring*—a discussion of how aggressive DDT spraying was affecting the environment because molecules were cycling around the Earth

131 Egler and Fosberg met in the Pacific, and travelled to atolls together during the latter half of the 1940s. See Ibid, 554.
via invisible pathways in a manner similar to radiation—echoes Fosberg’s “Qualitative Description of an Atoll Ecosystem.” Carson certainly impacted Fosberg as well, since her early work in oceanography, including *The Sea Around Us*, contextualized atolls in the wider ocean. Rather than considering the atoll as a tiny raft in a grand ocean, Carson’s *The Sea Around Us* portrays islands and atolls as features of a whole ocean. Both researchers produced intellectual frameworks that proved indispensable to the other’s theories. Through their friendship, SIM entered one of the more significant scientific conversations of the twentieth century. Even if SIM’s impact is difficult to quantify, the program proved indispensable to our present understanding of the environment.

Thus the foundations of modern environmentalism were, in part, generated in Micronesia by a Navy-funded program that struggled to define itself as independent of the military body that created it. While publishing its findings, SIM never quite achieved independence from nuclear research or the militarized nature of the TTPI. Incorporating the aftereffects of powerful hydrogen bombs into their worldview, select SIM researchers robustly articulated and applied ecosystem theory to the atoll environment, taking inspiration from both physicists and the military superstructure definitive of the region in the process. This idea returned to the United States, eventually gaining traction with one of the most important figures in all of environmental science, and is now indispensable to contemporary understandings of all environments. Of all the places on Earth, the Micronesian atoll proves central to environmental sciences and our view of the world. Just as SIM once construed atolls as tiny and flimsy isolates always on the brink of an apocalypse, we now discuss the Earth as a fragile isolate in space on the cusp of catastrophe.
HOW TO MODERNIZE MICRONESIA?

SIM'S INGLORIOUS CONCLUSION

Neither fierce debates on environmental theory nor conversations between prominent figures in environmental science bore any relevance to modernizing the TTPI. While SIM never entirely freed itself from the influence of nuclear weapons testing—the debate between ecology and ecosystem was an argument between theories based on Crossroads and Bravo respectively—the program had grown distant from its Navy financiers by the 1960s. Decreased funding reflected how superfluous SIM was to the Navy and the Interior's administrators. The release of a UN report on American administration of the TTPI in 1960, though, marked the beginning of SIM's end.

The report was nothing short of scathing, asserting that the United States, rather than modernizing the TTPI, had created an "anthropological zoo." The report's publication coincided with a larger shift in American policy prioritizing the development of Third World nations (the latest battlefield of the Cold War). Given the new emphasis on development, the condition of Micronesia—the American Lake—was more than a national disgrace; it undermined the war against Communism itself. The result was a sudden influx of money to Micronesia meant to rapidly produce a modern society in the Pacific. The abrupt shift in administrative policy entirely ignored SIM, CIMA, and most previous investigations in favor of recreating a Pacific metropolis. The assumptions towards the atoll environment that guided development efforts, however, were nearly identical to the founding assumptions of SIM.

The late '50s and the '60s, as is well-studied in several histories, witnessed a paradigm shift in the Cold War, a change in emphasis from nuclear superiority to

influence over the developing world. The emergent doctrine representative of this policy ‘revolution’ was modernization theory—the idea birthed by nascent political science that argued all nations, regardless of culture, exist in separate stages of development that are marked by common traits (these stages range from traditional to modern). According to modernization theory, the United States and the U.S.S.R. represented two competing models of modernity, and the Cold War was an ideological struggle between capitalist and communist development methods. Whichever model attracted more developing nations would ultimately win.

American foreign policy towards the conclusion of the 1950s reflected the growing influence of modernization theory in the Cold War. Eisenhower invested hundreds of millions in foreign aid and development programs starting in 1957, while Kennedy proved a devout believer in modernization theory. As a candidate in 1960, Kennedy spoke of the importance of developing nations in the Cold War: “More energy is released by the awakening of these new nations than by the fission of the atom itself. Meanwhile Communist influence has penetrated farther into Asia, stood astride the Middle East, and now festers some ninety miles off the coast of Florida.” Kennedy’s statement reflects two important developments: the decreased influence of science on politics and the growing sense that America was losing the Cold War. Based on these gains, atomic deterrence could not contain communism. The Cold War was waged for the hearts and minds of the developing world, and neither the atomic bomb nor science as a

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135 Ibid, 42.  
136 Quoted in Ibid, 43.
whole proved sufficient.\textsuperscript{137} By 1960, the atom was superseded by economic theory; the social sciences overtook the natural sciences.

Given the evolving American conception of the Cold War, the UN report was more than an international scandal. The front lines of the Cold War—Southeast Asia, the Middle East, and Latin America—were all determining which model to follow. Yet the American model, already associated with imperialist Western European nations,\textsuperscript{138} had failed in Micronesia. Instead of modernity, Americans had given Micronesians radioactive fallout.\textsuperscript{139} The situation required immediate action, and science, although it had ceded its previously unchallenged political influence, still enjoyed unquestioned confidence. Scientists and citizens alike believed anything was possible. Atoms could be split, insects annihilated, and the very forces of nature subdued.\textsuperscript{140} Surely science and technology, guided by modernization theory, could develop the atoll.

Development in the Marshall Islands was swift, heavily influenced by modernization theory, and based on assumptions about the atoll environment grounded in logistics. Rather than develop every atoll in Micronesia, administrators selected atolls that already bolstered large communities and were developed to some extent—in the Marshalls, Kwajalein (a highly militarized atoll and the administrative center of the Ralik Chain) and Majuro (the administrative center of the Ratak chain). Islanders from several outlying islands were encouraged to move to either Majuro or Kwajalein, whose

\begin{footnotesize}
\begin{enumerate}
\item[138] Latham, \textit{The Right Kind of Revolution}, 41.
\item[139] The exiled communities from Bikini, Eniwetok, and Rongelap were developing an international profile in the 1960s. In the 1970s, the ‘atomic refugees’ would be indispensable to Marshallese arguments for independence. These incipient political groups still lacked influence in the early 1960s. Instead, the plight of the Bikinians was only part of international debate in this period due to growing concerns over the duration of radioactive isotopes. See Jack Niedenthal. \textit{For the Good of Mankind}.
\item[140] “The expansion of knowledge about the Earth in the 1950s fed an irresistible belief that humans could manipulate nature.” Jacob Darwin Hamblin, \textit{Arming Mother Nature}, 100, 130, 137.
\end{enumerate}
\end{footnotesize}
infrastructure would be restructured to model an American city. On Kwajalein Atoll, the vast majority of the population was concentrated on the island of Ebeye. Majuro, unlike Kwajalein, lacked a massive military base, so the entirety of the atoll was developed. The gaps between three neighboring islands in the southeast corner of Majuro—Delap, Uliga, and Darrit—were filled. This section, referred to as the D-U-D, became the commercial center, while Long Island and Laura (both to the west of Delap) became residential islands. This approximation of a downtown and suburbs was completed with the addition of a two-lane highway, Lagoon Road.

The influence of modernization and development theories on American efforts to modernize the Marshalls is obvious. By consolidating the Marshallese on two atolls, administrators were imitating American cities. The rationale for this, in hindsight, nearly ludicrous act was a central tenet of modernization theory: a society could be forcefully accelerated from one societal phase to the next through intense development of infrastructure. By developing certain atolls and creating modern cities, Americans would force the Marshallese into the American modern phase.

Just as apparent in American modernization of Micronesia is the complete disregard for the ecological research produced by SIM. Rather than attempting to manipulate the atoll environment, administrators disregarded the atoll’s natural limitations. Industrializing each atoll was impractical, as was maintaining connections between each atoll and the continents. Instead, Americans avoided a logistical nightmare by focusing on two atolls. Kwajalein and Majuro enjoyed intensive development,

\[\text{141 The name Darrit has fallen out of favor in Majuro. Instead, the last island is referred to as Rita.}\]
\[\text{142 By road, Laura Island is about thirty miles from Delap (the closest island in the D-U-D). By lagoon, Laura is approximately twenty miles from Delap.}\]
\[\text{143 Latham, The Right Kind of Revolution, 58.}\]
ultimately acquiring a modern infrastructure that the atoll could not sustain with its limited natural resources; copra does not fuel a diesel engine, nor does an industrial space produce food. While modernization in the short term proved effective and technologically possible, it could not be sustained. Despite the warnings of SIM scientists in 1951, administrators elected “blundering development” over “intelligent manipulation.”

Although modernization efforts were heavily influenced by modernization theory, presumptions about the atoll environment also played a fundamental role. Administrators, well aware of how unsuited the atoll environment was for a modern urban space, chose to modify the Micronesian environment. Populations were concentrated on the largest islands of the largest atolls; if such an island did not exist, as was the case on Majuro, a large island was created. These islands—not atolls—were then modeled after American cities to create Western cities transplanted to the Pacific Ocean. The implicit assumption guiding this strategy is that the atoll is inferior to the island, that the atoll has natural limitations that cannot be surpassed. In order to acquire commercial worth, the atoll was converted to an island.

The act of consolidating populations also reiterated the Navy’s initial assumptions about waging warfare on atolls. Atolls were too dispersed to justify the logistical challenge of connecting each atoll to the mainland. Instead, select atolls with large airstrips or previous development were prioritized. The atolls chosen, Kwajalein and Majuro, were the same ones initially selected by the Navy for their strategic value. Concentrating populations on these already militarized spaces was intended to reduce the drain of maintaining with outer atolls, but also consolidated American control of

Micronesia while reinforcing the military character of the Strategic Trust. SIM, the former mechanism of ensuring U.S. control of the atoll environment, had been replaced.

Just as importantly, modernization theory dramatically reduced the influence of atomic testing on perceptions of the atoll space. Atolls were distant and removed, but no longer microcosms or natural laboratories. This marked change was a product of both modernization theory’s emphasis on humans (not environments) and the Atmospheric Test Ban Treaty of 1963. Once atmospheric testing was banned, testing on atolls ceased. The Pacific Proving Grounds were retired, and the perception of atolls as laboratories declined. SIM, an idea rooted in the natural laboratory and weapons testing, had no place in the Micronesia of the ‘60s.

SIM silently concluded in 1966 with the release of a final bibliography from the PSB and Harold Coolidge. The direct impact of the science was minimal, though SIM studies did provide qualified language to critique the atoll environment, which persists in some Micronesian publications today. More importantly, however, SIM influenced research in environmental science by exposing researchers like Fosberg to a unique Pacific environment, one that catalyzed the development of new theories on connectivity in the environment. Through these researchers, SIM influenced environmental science up to the early ‘60s, helping to herald in modern environmentalism. As historians continue to trace the origins of environmentalism back to the Pacific and weapons testing, SIM proves the indispensable intermediary, linking developing theories on ecosystems with massive explosions. And, by providing that link, SIM demonstrates the centrality of Micronesian atolls—the laboratories of the American Century.

APPENDIX

Figure 1

Map of the Republic of the Marshall Islands

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This signpost is just outside the capitol building in Majuro, where it serves as a small reminder of the vast stretches of ocean between Majuro, a relatively urbanized atoll, and the larger world. The post itself is located on a traffic island on Majuro’s divided highway.
Figure 3
Sketch of Japanese Bomb Shelter on Kwajalein Atoll

This particular sketch was created in celebration of an anniversary of the Battle of Kwajalein. "Japanese Bomb Shelter." (Alele National Archives. PVC 0005, Folder 1), 1.
Figure 4 is a similar sketch to Figure 3, this time depicting a Japanese Pill Box. Note the use of sea logs and deep entrenchment to produce natural camouflage and protection for the position. The American solution was heavy artillery. “Jap Pill Box With Compartments” (Alele National Archives. PVC 0005, Folder 1), 3.
The bomber field depicted above, as mentioned in the photo's caption, was constructed over the Japanese field, symbolic of possession of the atoll. U.S. Army Air Forces, "Seventh Air Force bomber field constructed on top of Japanese field on Kwajalein Island." (Alele National Archives. PVC 0005, Folder 1), 10.
Figure 6

Baker Shot’s Mushroom Cloud\textsuperscript{151}

\textsuperscript{151} The colossal mushroom cloud presented by Baker, better defined than Able’s, tosses battleships into the sky and covers the rest in radioactive vapors and water. Historian of the Joint Task Force One, Operation Crossroads: The Official Pictorial Record, 188-189.
Figure 7

Baker Shot Superimposed on Manhattan\textsuperscript{152}

Figure 8

"This is Bikini"153

153 Historian of the Joint Task Force One, Operation Crossroads: The Official Pictorial Record, 11.
Figure 9

"Private Property Among the Young" 154

NATIVE GRAVEYARD. ABOVE. In this native cemetery lie the ancestors of the modern Bikinians who, in February 1946, agreed to give up their homes and memorials to permit the testing of the atomic bomb. Gravestones at Bikini are often shaped in the outline of a man's head and shoulders, as shown in the center of the above group. During the war Japanese sake bottles and colored glass beads, salvaged from Jap fishermen, became popular as grave decorations. RIGHT. Private property among the young is monitored by the lack of pock- et. OPPOSITE. ABOVE. With only supplies of pandan available for thatch, no housing of any sort exists anywhere in the Marshall Islands. The mild cli-

154 Above: the image of two visibly excited Bikinian children is accompanied by the pictorial history's caption. The pictorial history both romanticizes and trivializes life on Bikini, obscuring hardship in favor of creating a simplistic, exotic island culture. Historian of the Joint Task Force One, Operation Crossroads: The Official Pictorial Record, 15.
The rebuilt Bikini Community House on Rongerik Atoll with a Bikinian teen, now clothed, idly leaning against a palm tree. The photograph captures a sense of normalcy and, based on the state of the walled Community House that was glaringly absent on Bikini, implies life has improved substantially for the displaced natives. Historian of the Joint Task Force One, *Operation Crossroads: The Official Pictorial Record*, 24.
Figure 11

Clearing the Reef on Bikini Atoll

Figure 12

Bikini as a Laboratory

Figure 13

Bikini as a Playground\footnote{Ibid, 70-71 (Top three), 96 (Bottom).}

\begin{itemize}
  \item IS EVERYBODY HAPPY? Congressmen W. G. Andrews Jr. from Buffalo, New York, acts as master of ceremonies at a "Happy Hour" aboard the USCGC "Panamint," which transported many of the observers to Bikini. Featured on the Andrews Hour was a Quiz Program in which several of the ship’s members, previously well-coached in the difficult lore of nuclear physics, put to shame some of the professional scientists aboard, to the sincere delight of the audience. OPPOSITE, ABOVE. Army nurses stationed at Kwajalein relax with friends. There were 37 nurses in the Task Forces. BELOW. On the beach at Bikini, men of the Task Force for the Study of the Consequences of the explosion area.
  \item \textit{STUD’S SALOON}.
\end{itemize}
Figure 14

"Not an Atomic Playboy"159

Figure 15
Map of Micronesia with Four Atolls Highlighted

Key
Black Arrow: Arno
Red Arrow: Onotoa
Purple Arrow: Raroia
Yellow Arrow: Kapingamarangi

Figure 16

Map of Arno Atoll Presented in "The Coral Reefs of Arno Atoll"161

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Figure 17

Physiographic Diagram of Arno Atoll\textsuperscript{162}

\textsuperscript{162} Ibid, 16.
Figure 18
Generalized Cross Section of Arno Atoll

Figure 3. True Scale Cross Section, Arno Atoll.

Figure 19
Cross Section of Arno Before a Typhoon

Figure 5. Generalized Section of Island and Reef.

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163 Ibid, 17
Figure 20

Cross Section of Arno Post Typhoon\textsuperscript{165}

\textit{FIGURE 6. SECTION OF ISLAND SWEPT BY TYPHOON.}

\textsuperscript{165} Ibid, 21.
Figure 21
Arnow’s Link Between Latitude and Rainfall in the Marshalls

Figure 22

Ted Arnow, “Hydrology of the Northern Marshall Islands,” 4. The above figure is based on field data collected by Ted Arnow in the Northern Marshall Islands and compares annual rainfall to an island’s position relative to the equator. The figure maintains various tropes of SIM studies, such as islands reduced to relatively interchangeable data points. However, the emphasis here is on the connection between islands and an observable trend, not on the implications of annual rainfall for administration.
Stone's Zones of Soil on the Atoll\textsuperscript{167}

Figure 2. -- Synthetic sequence of soil development and soil properties.

167 Above is a demonstration of zonal theory where the atoll is segmented based on soil types that may be expected as an observer moves further inland. Again, this emphasizes uniformity between atolls and therefore interchangeability. Earl L. Stone Jr. "Summary of Information on Atoll Soils," 6.
Reef Zones\textsuperscript{168}

\textbf{FIGURE 2. COMMON SUBDIVISIONS OF UPPER REEF SURFACE SEEN IN PLAN VIEW}

\textsuperscript{168} This diagram divides the atoll into zones based on position relative to the central islands. The aerial view highlights change with distance from the atolls and, presumably, increasing ocean depth. J.I. Tracey, P.E. Cloud and K.O. Emery. "Conspicuous Features of Organic Reefs," 6.
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