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Article

Water Before Fish: Japan's Fundamental Fisheries Survey and the Currents of Empire, 1909–1918

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Abstract: This paper examines changing scientific understandings of ocean space from the perspective of the Fundamental Fisheries Survey (1909–1918), the first state-supported program of oceanographic fisheries research in Japan. Over the course of the 1910s, survey members mapped the dynamics of major Pacific ocean currents, notably the Kuroshio and Oyashio, off the coasts of the Japanese archipelago. Survey leader Kitahara Tasaku and a network of observers examined links between saltwater and the locations of finfish by using toolkits and methods inspired by those employed in the North Atlantic-focused International Council for the Exploration of the Sea. The history of the Fundamental Fisheries Survey suggests that in an early twentieth century era of emergent Japanese fisheries expansionism, fish-finding became a powerful justification for oceanographic work.

Keywords: Japan, Fisheries, Oceanography, Currents, Kitahara Tasaku

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The Kyoto prefectural Rekisaikan archive holds one of the few publicly accessible original editions of a slim 1918 report called *Kaiyō chōsa to gyozoku no kaiyū*（海洋調査ト魚族ノ廻游）, a title that can be translated as *Oceanographic Surveys and Fish Migration*. Each of the report's five charts illustrates currents and coastlines in different parts of the Japanese archipelago. All mark areas where "huge schools"（*taigun* 大群）, "big catches"（*tairyō* 大漁）, or "bountiful catches"（*hōryō* 豊漁）might be found. One map presents the results of a survey around the Kinkasan coast, an area of the western Pacific just off the northeastern prefectures of Fukushima and Miyagi (Figure 1). It depicts lightly shaded "cold current" areas massed above a darkly shaded "warm current," with a large school of bonito（*katsuo* 鰹）labeled in between. Here as elsewhere, the report's author insists on the indispensability of oceanographic study to Japan's early twentieth century fisheries industry. Knowing water, we are told again and again, is the key to finding fish.

Oceanographic Surveys and Fish Migration was the culmination of nearly a decade of research under a program known as the Fundamental Fisheries Survey（*gyogyō kihon chōsa* 漁業基本調査）. The survey began in 1909 amid a period of Japanese territorial and maritime expansion.[1] It was one of several contemporaneous efforts to map land, sea, and air in and around the Japanese empire (Kim 2007; Zaiki and Tsukahara 2007; Miyagawa 2008; Fedman 2012). Even with policies designed to promote the mechanization of fishing vessels and the implementation of high-volume catch techniques, a question persisted: where exactly were fishers and their hunting machines supposed to go? Akin to (and often drawing upon) European and American investigations into processes of oceanic circulation (Meek 1916; Mills 1989; Mills 2011), Japanese surveys would find answers in studies of the western Pacific and its major boundary currents: the northbound, warmer Kuroshio（黒潮, also referred to at times in contemporaneous English-language sources as the "Japan Current"[2]）and the southbound, colder Oyashio（親

[1] A dramatic reconfiguration of the Japanese empire took place on land and sea between 1895 and 1914. These two decades left a congeries of newly claimed territories and areas of extraterritorial treaty privilege extending from Micronesian "South Seas" or Nan'yō islands (seized from Germany in 1914; declared the South Pacific Mandate by the League of Nations in 1919) to the colony of Taiwan (1895) to the leased territories on the Shandong Peninsula (seized from Germany in 1914), and from the Korean Peninsula (formally annexed in 1910) to the Kuriles or Chishima Islands (1905), southern Sakhalin Island or Karafuto (1905) and onward to areas where the Treaty of Portsmouth allowed Japanese vessels to fish in waters "along the coasts of the Russian possession in the Japan, Okhotsk and Bering Seas" (1905).

[2] For a conceptual survey of the waters that would become known as the Kuroshio, see Kawai 1998. The ethnographer Yanagita Kunio famously postulated the Kuroshio as a driving force behind the origins of "Japanese" culture. Yanagita envisioned the Kuroshio as an "ocean road"（*kaijō no michi* 海上の道）that connected the Japanese archipelago to the Ryūkyū Islands and points southward (Yanagita 1961).

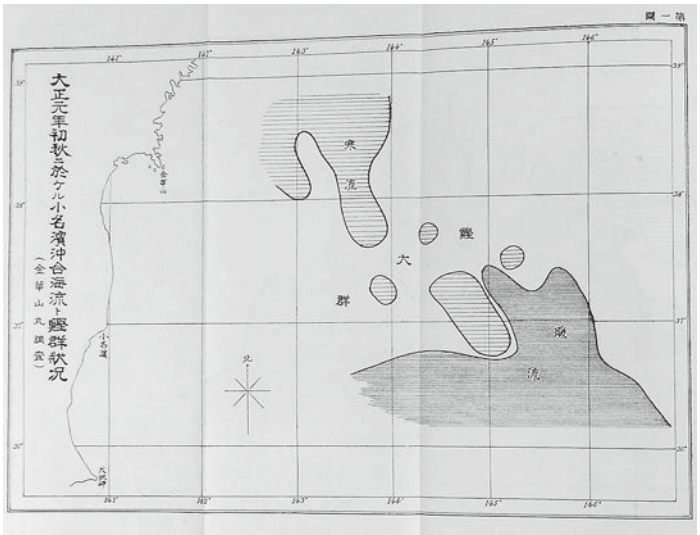

Figure 1. The Kinkasan bonito fishery and current survey in *Oceanic Surveys and Fish Migration* (*Kaiyō chōsa to gyozoku no kaiyū* 1918). Used with permission of the Kyoto Institute, Library, and Archives (*Kyōto-gaku Rekisaikan* 京都学・歴彩館).

潮).

Early twentieth-century calls for new oceanographic surveys in Japan stressed that the study of the sea, and more specifically ocean currents, had implications for the future growth of the fishing industry. At the center of such appeals was Fundamental Fisheries Survey director Kitahara Tasaku (北原多作 1870–1922), who wrote *Oceanographic Surveys and Fish Migration* while serving on the faculty of the state-run Imperial Fisheries Institute (the *Suisan kōshūjo* 水産講習所).[3] Kitahara placed the Fundamental Fisheries Survey within a longer, European-focused history of oceanographic survey work that began with the "incomplete" 1860s dredging expeditions of the British HMS *Lightning* (*Kaiyō chōsa to gyozoku no kaiyū* 1918, 1). He saw a turning point with the then-recently established International Council for the Exploration of the Sea (ICES), a Copenhagen-based scientific organization that began coordinated investigations of the North Sea and

[3] The Imperial Fisheries Institute (formed in 1897–1898 after the closing of the Imperial Fisheries Association's private Fisheries Training School (*Suisan denshūjo* 水産伝習所 1889–1897)) was reorganized in 1949 as the Tokyo University of Fisheries (*Tokyo Suisan Daigaku* 東京水産大学), which in turn became part of the Tokyo University of Marine Science and Technology (*Tokyo Kaiyō Daigaku* 東京海洋大学) in 2003.

North Atlantic from 1902 onward. The eight founding ICES member countries, several of them heavily dependent on fisheries, promoted oceanographic study as a way to learn more about economically valuable marine creatures, understand their reproduction and movement, and address the nebulous problem of overfishing (Rozwadowski 2002; Smith 1994; Mills 1989). Outside Europe, ICES left intellectual and material imprints on projects like the Fundamental Fisheries Survey. To Kitahara, ICES members had "employed systematic methods and made their primary goal the elucidation of fisheries"; the Fundamental Fisheries Survey was a preliminary effort at a similar type of "comprehensive study" (*sōgō kōkyū* 綜合講究) (*Kaiyō chōsa to gyozoku no kaiyū* 1918, 1–2).

The Fundamental Fisheries Survey, housed first in the Japanese Fisheries Bureau (*Suisankyoku* 水産局) and after 1914 in the Imperial Fisheries Institute, disseminated standardized methods of instrumental observation and visual representation to dozens of institutions across Japan, notably prefectural fisheries experiment stations, thirty-five of which would open between 1894 and 1918 (Nakano 2011, 27).[4] Throughout most of the 1910s, Kitahara directed a group of survey members in Tokyo and a network of observers across the archipelago. Among the surveyors was the former owner of the Kyoto prefectural archive's copy of *Oceanographic Surveys and Fish Migration,* Ninagawa Torazō (蜷川虎三 1897–1981), who would later become a professor of resource economics at Kyoto University and serve seven consecutive four-year terms as the first elected postwar governor of Kyoto prefecture (Kageyama 1999).

The Fundamental Fisheries Survey has featured in multiple generations of Japanese-language writing on the history of oceanography, some of it by people who worked on the survey and its successor projects. Chroniclers of the survey included original survey members like Ninagawa and Marukawa Hisatoshi (丸川久俊 1882–1958) (Ninagawa 1920; Marukawa 1933; Marukawa 1943). Most prominent among the post-Fundamental Fisheries Survey generation was Uda Michitaka (宇田道隆 1905–1982), a marine scientist and Imperial Fisheries Institute professor who became a prolific historian of oceanography (Uda 1978; Uda 1971/1972). More recently, Nakano Hiroshi has written about the Fundamental Fisheries Survey and Uda's subsequent work as part of a Japanese tradition of ocean measurement (Nakano 2011).

This essay highlights the Fundamental Fisheries Survey at an early twentieth century moment of burgeoning institutional overlaps between fisheries expansionism and oceanographic knowledge production. Japanese fisheries expansion was not simply a centrifugal scattering into the farthest seas. Instead, expansion became an ongoing problem of spatial knowledge, near and far from shore. The Fundamental Fisheries Survey made waters

[4] For more on the history of fisheries education in Meiji Japan, see Kageyama 1990 and Sasaki 2018.

around the Japanese archipelago legible not as a single sheet of water, but rather in terms of moving currents and the big catches that might be found in, around, and between them.

Knowing Fisheries

Meiji state investigations of marine flora and fauna along the Japanese archipelago's coasts increased with the 1885 establishment of a Fisheries Bureau in Japan's Ministry of Agriculture and Commerce.[5] Fisheries funding, however, was a relatively low priority for the central government, which eliminated the Fisheries Bureau and replaced it with a smaller survey office (*chōsajo* 調査所) between 1890 and 1897 (Ninohei 1981, 73–75).[6] Amid uncertain state budgets for fisheries work in the 1880s and 1890s, boosters associated with the Imperial Fisheries Association (*Dai Nihon suisankai* 大日本水産会) began to argue that the regulation of "coastal fisheries" (*engan gyogō* 沿岸漁業) could and should be delegated to coastal communities, subject to prefectural and central oversight (Takahashi 2007). All the while, well-placed Association leaders like Imperial Diet member Murata Tamotsu made bids to rekindle national interest in fisheries policy by pushing for "fisheries expansion" (*suisan kakuchō* 水産拡張)—both in order to find new places for imperial subjects to fish and to keep foreign vessels away from what officials were beginning to formulate as Japanese territorial waters (Murata 1890). In order to expand, bureaucrats and boosters called for the exploitation of "distant-water fisheries" (*en'yō gyogyō* 遠洋漁業).[7]

By the early twentieth century, the head of the reconstituted Fisheries Bureau's survey department, Kishinoue Kamakichi (岸上鎌吉 1867–1929), was proposing systematic,

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[5] The Fisheries Bureau undertook an ambitious coastal study with the modest title of "preliminary survey" (*suisan yosatsu chōsa* 水産予察調査 1888–1892). The survey followed (and at times made reference to) surveys by the Imperial Navy's Hydrographic Department (*Suirobu* 水路部) that had been undertaken since the early 1870s.

[6] Despite a shoestring budget, the survey office initiated a number of individual investigations. Among these studies was official Wada Yūji's early 1890s work to chart the Kuroshio "warm" and Oyashio "cold" currents. Wada inferred current movements by tracking the locations of glass bottles thrown overboard from a fixed location and collected by ordinary people along the shore. He would continue these studies both as a colonial meteorology official in the Korean peninsula and as part of a series of investigations sponsored by the *Ōsaka Mainichi* newspaper (Nakano 2011; see also Miyagawa 2008).

[7] As Sasaki Takafumi has noted, the spatial definition of "distant waters" in relation to Japanese territorial seas or Exclusive Economic Zones was a post-1945 development. Throughout the late nineteenth and early twentieth century, expansion to "distant waters" could at different times refer to coastal (including coasts outside Japanese territorial waters) as well as pelagic seas (Sasaki 2018, 32–34).

long-term observations of the waters around the Japanese archipelago. Kishinoue visited Christiania (present-day Oslo) in 1901 as an outside observer at a planning conference that would lead, in the following year, to the formal establishment of the International Council for the Exploration of the Sea. Upon his return, Kishinoue and other members of the Fisheries Bureau investigated the quantitative marine surveying techniques then being employed in Europe: "I thought that if we were to construct the same kinds of instruments and use the same kinds of methods, it would be valuable for making comparisons" (Kishinoue 1903, 165). Yet the problem in Japan remained "meager funding and meager manpower" (*wazuka na kane, wazuka na hito* 僅かな金、僅かな人) (Kishinoue 1903, 166).

In 1909, Kishinoue joined the faculty of the then newly established fisheries science program at Tokyo Imperial University.[8] One of his former subordinates in the Fisheries Bureau's survey department, Kitahara Tasaku, led efforts for an oceanographic fisheries survey from that point onward. Like fellow Tokyo Imperial University zoology graduate Kishinoue, Kitahara was convinced of the importance of the instrumental observation of ocean conditions.[9] Kitahara put forth plans for a Fundamental Fisheries Survey by citing Meiji-era concerns about nearshore fisheries and visions of pelagic expansion: "On average, for each mile of coastline there are fifty fishing vessels. There is very little room in these coastal fisheries. In most of the fisheries there are too many boats. This leads to overfishing and as a result fish propagation is hindered." He set out a stark choice for imperial fisheries policy: support the propagation of fish along a crowded, narrow continental shelf around the Japanese archipelago, or send fishers farther out to sea. State-supported investigations of the sea would be necessary, modeled on practices in "civilized Western countries" where "officials make use of the latest surveys and push the opening up (*kaitaku* 開拓) of the oceans." Kitahara described the Fundamental Fisheries Survey's three main goals as follows: "to know the characteristics of important fished animals"; "to clarify the fishing areas for important fished animals"; and, in a gesture toward interlinked Japanese fisheries discourses of conservation and expansion, "to set policy for fisheries protection (*hogo* 保護) and growth (*hatten* 発展)" (Kitahara 1912, reprinted in Nakano 2011, 15). The survey reflected both a widely shared sense of fisheries crisis and a desire for new modes of state-led knowledge production.

The intellectual underpinnings of oceanographic fisheries surveying took shape through Kitahara Tasaku's collaboration with early twentieth century Japan's foremost marine botanist, Okamura Kintarō (岡村金太郎 1867–1935). Kitahara and Okamura introduced the

[8] See Ericson, forthcoming.

[9] Nevertheless, Kishinoue and Kitahara appear to have had a poor working relationship while both were at the Fisheries Bureau (Okamura 1934, 19).

Fundamental Fisheries Survey alongside what they termed "hydrobiology" (*suiri seibutsugaku* 水理生物学). Hydrobiology incorporated elements from oceanography (*kaiyōgaku* 海洋学), biology (*seibutsugaku* 生物学), hydrography (*suirigaku* 水理学), and fisheries science (*suisangaku* 水産学). Kitahara and Okamura's self-published 1910 textbook *Essentials of Hydrobiology* (*Suiri seibutsugaku yōkō* 水理生物学要綱) drew heavily on the hydrography presented in German geographer Otto Krümmel's *Handbuch der Ozeanographie* (published between 1907 and 1911) and the University of Kiel-inspired planktonology introduced in British biologist and oceanographer James Johnstone's 1908 *Conditions of Life in the Sea: A Short Account of Marine Biological Research* (Okamura 1934, 21). For Krümmel and Johnstone as for Kitahara and Okamura, instrumental techniques mediated knowledge about the dynamics, properties, and contents of seawater. Above all, Kitahara and Okamura saw the immediate value of surveys in their potential applications to Japan's fisheries industry. As the pair phrased it, "research must be done from an academic perspective in order to clear up a number of questions related to fisheries matters and to make fisheries profits more predictable" (Kitahara and Okamura 1910, 52).

Official support for Kitahara's project was, nevertheless, not immediately forthcoming. Survey member Marukawa Hisatoshi later suggested that a turning point came in 1911, while Kitahara was serving as an assistant to Fisheries Bureau chief Dōke Hisashi (道家斉 1857–1925) on negotiations over what would become the North Pacific Fur Seal Convention. The Russo-American-British-Japanese treaty, which instituted a ban on pelagic sealing in the North Pacific, went into effect at a time when Japanese officials began to rethink the purpose of fishing vessel subsidies which had, since 1897, gone primarily to crews engaged in the slaughter of marine mammals. Redirecting the goal of "distant water" fisheries toward the capture of finfish seems to have made Kitahara's superiors, including Dōke, more amenable to the then-newly established survey project. As Marukawa would later write, "After the Bureau chief [Dōke] returned to Japan he became a more enthusiastic supporter of the Fundamental Fisheries Survey than anyone else" (Marukawa 1943, 31–32).

Taking the Measure of the Sea

The instrument-aided measurement of seawater supported the Fundamental Fisheries Survey's claims to oceanographic knowledge (*Gyogyō kihon chōsa junbihō* 1910, 94). The survey made use of European ICES methods and equipment, but incorporated alternative techniques and instrumentation then being developed within the Japanese Fisheries Bureau and Imperial Fisheries Institute community. Toolkits came to include Lucas sounding winches, checkered transparency- and turbidity-measuring Secchi disks, thermometers, water sampling bottles (including an instrument designed by Kitahara himself), salinity meters, quantitative plankton nets, Forel color scales, and Akanuma densometers (Marukawa 1943, 32;

Figures 2 and 3).[10]

Kitahara and other Tokyo-based surveyors coordinated methods for compiling and disseminating observations of ocean conditions.[11] Kitahara envisioned training and research that would involve dozens of regional collaborators throughout the Japanese empire, "establishing communication among the Imperial Fisheries Institute, fisheries experiment stations, and other government agencies and schools" (Kitahara 1912, reprinted in Nakano 2011, 15).[12] Kitahara and Okamura invited representatives from prefectural fisheries experiment stations to attend gatherings (*uchiawasekai* 打合会) that, at times, could last several weeks. Regular

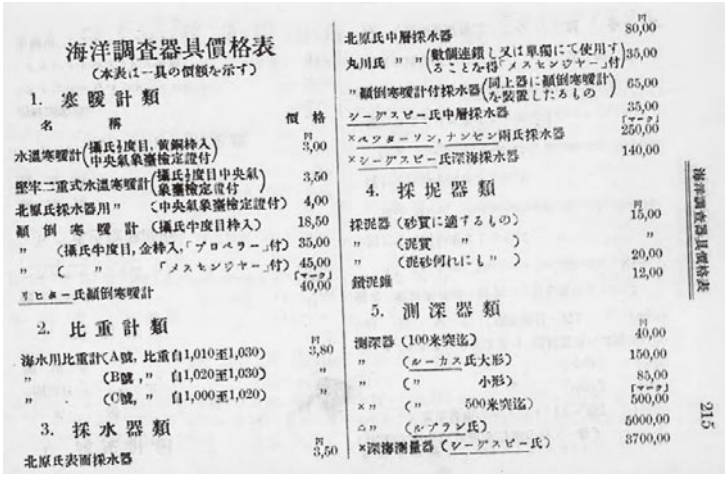
腑に中層採水器を下さんとする圖
（ルカス小型測深機を用ゐ）

Figure 2. Kitahara Tasaku working with a Lucas sounding winch attached to a submersible intermediate-depth water sampler of his design (Kitahara 1921).

[10] At the turn of the twentieth century, a densometer designed by fisheries official Akanuma Tokurō simplified a Kiel design from six parts to three. Marukawa Hisatoshi remarked on the Akanuma densometer's rapid spread among prefectural fisheries experiment stations (Marukawa 1933, 15).

[11] Aside from Kitahara and Okamura were Yanagi Naokatsu 柳直勝, Asano Hikotarō 浅野彦太郎, Senoo Hidemi 妹尾秀實, and Nakazawa Kiichi 中澤毅一, among others (Marukawa 1943, 32).

[12] This had already been happening on a limited basis since the turn of the twentieth century. Kishinoue Kamakichi, for one, was involved in delegating five prefectural fisheries experiment stations to take seasonal measurements of coastal waters—in effect a smaller-scale, nearshore counterpart to the quarterly survey cruises undertaken by European ICES members (Marukawa 1933, 15).



海洋調査器具價格表

（本表は一具の價額を示す）

1. 寒暖計類

名稱	價格
水温寒暖計（攝氏1度目，黄銅枠入／中央氣象臺檢定證付）	円 3,00
堅牢二重式水温寒暖計（攝氏1度目中央氣象臺檢定證付）	3,50
北原氏採水器用〃（中央氣象臺檢定證付）	4,00
顛倒寒暖計（攝氏中度目枠入）	18,50
〃（攝氏中度目，金枠入，「プロペラー」付）	35,00
〃（〃「メスセンジヤー」付）	45,00
ネヒヤー氏顛倒寒暖計	マーク 40,00

2. 比重計類

海水用比重計	（A號，比重自1,010至1,030）	円 3,80
〃	（B號，〃 自1,020至1,030）	〃
〃	（C號，〃 自1,000至1,020）	〃

3. 採水器類

北原氏表面採水器	円 3,50
北原氏中層採水器	円 80,00
丸川氏〃〃（數個連鎖し又は單獨にて使用すること出來「メスセンジヤー」付）	35,00
〃顛倒寒暖計付採水器（同上器に顛倒寒暖計を裝置したるもの）	65,00
シーアスピー氏中層採水器	35,00
×ハタートソン，ナンセン兩氏採水器	マーク 250,00
×シーアスピー氏深海採水器	140,00

4. 採泥器類

採泥器（砂質に適するもの）	円 15,00
〃（泥質〃）	〃
〃（混砂何れにも〃）	20,00
鐵泥錘	12,00

5. 測深器類

測深器（100米突迄）	円 40,00
〃（ルーカス氏大形）	150,00
〃（〃 小形）	85,00
××〃（〃 500米突迄）	マーク 500,00
△〃（ルブラン氏）	5000,00
×深海測量器（シーアスピー氏）	3700,00

海洋調査器具價格表 215

Figure 3. A page from a 1916 price list for oceanographic survey equipment, including several varieties of Kitahara water samplers and Lucas winches (“Kaiyō chōsa kigu kakaku hyō” 1916, 251).

meetings facilitated communication between Tokyo fisheries officials and counterparts elsewhere in the empire, initially during the Fundamental Fisheries Survey but extending in other forms into the 1940s (Marukawa 1943, 33). The first gathering took place in Chiba prefecture in August 1909, the second in Hiroshima prefecture in October 1910 (Nakano 2011, 16). Attendees received training in quantitative measurement and its visual representation. Survey instructors introduced methods for making observations using ICES-inspired (but sometimes redesigned) instruments. Observation forms detailed the substantial duties of coastal surveyors, including records of water temperatures, density, color, and clarity, at the surface and at various depths (*Gyogyō kihon chōsa junbihō* 1910, 8–9). At the same time, empire-wide standardization and methodological transformation were competing elements of the Fundamental Fisheries Survey. The investigation of the sea was a constantly changing practice, and as such Kitahara emphasized that “the survey of the ocean must be carried out alongside investigations into new survey methods” (Kitahara 1921, 276). Fisheries Bureau and Imperial Fisheries Institute survey members used gatherings to update the basic methods with which surveys proceeded.

As survey member Ninagawa Torazō described it, oceanographic research involved either “measurement at a point” or “measurement along a line” (Ninagawa 1920, 22). The former involved the training of surveyors through *uchiawasekai* gatherings and the compilation of monthly reports from dozens of ongoing fixed-point observation activities. Coastal surveying became part of the curriculum at the Imperial Fisheries Institute, particularly

after it began to house the Fundamental Fisheries Survey from 1914; as a result, students (like Ninagawa around that time) and faculty had regular opportunities to work with prefectural fisheries experiment stations. The latter referred to ship-based survey cruises, which moved farther afield as the 1910s progressed: to the Kurile Islands or Chishima (1912), the coast of the Korean Peninsula (1912), the coast off Shanghai (1913), the Yellow Sea (1915), and the Sea of Okhotsk (1915, 1916). Some expeditions made use of prefectural and national training vessels, including the Imperial Fisheries Institute's *Un'yō Maru*（雲鷹丸）. Others involved fishing and whaling vessels hired for short-term surveying. Shipboard surveys took measurements at different depths from the surface down to 200 meters or more (see Asano and Ninagawa 1919).

Over time, the study of lines and points produced a fragmentary but three-dimensional archive of saltwater observations. The visualization of this data was at the heart of the Fundamental Fisheries Survey. As Kitahara put it, "in research it is vital to show numbers and shapes in order to make comparisons" (Kitahara 1921, 4). Reports—there would be eight volumes in all—featured standardized graphical representations of measurements taken at coastal observation spots, along with charts mapping the trajectories of longer-distance survey cruises (Marukawa 1933, 16). A dozen or more images found a place in each report (Figure 4).

Less visible were ordinary fishers, whose saltwater knowledge David Howell has described in terms of "unwritten maps" (Howell 2014, 301). Kitahara claimed to have deep respect for such unlettered mastery, writing at one point that "we must never forget fishers." Nevertheless, he saw the Fundamental Fisheries Survey as a better way of knowing the water than relying on coastal fishers, whom Kitahara criticized as both unwilling and unable to explore new waters (Kitahara 1921, 1–3). Kitahara chided fishers who tried to gauge water temperatures by dipping a bare hand into the water, arguing that the rule of thumb was no substitute for instrumental measurement (Kitahara 1921, 13).[13] As his frequent collaborator Okamura Kintarō later wrote, Kitahara proposed that every fishing vessel, large and small, should have a thermometer and densometer (Okamura 1934, 21). Kitahara saw personal experience with the sea as meaningless to those who had invested in the thousands of motorized vessels and dozens of trawlers that were moving into distant waters. Instead, he presented projects like the Fundamental Fisheries Survey as a way to open up fisheries to "capitalists" who had not spent a lifetime on the sea (Kitahara 1921, 5–12).

From the start, Kitahara Tasaku treated ocean currents as objects of knowledge for an

[13] Indeed, these were the very terms by which Uda Michitaka later evaluated the results of the survey: "In the past before [Kitahara], fishers were in the primitive situation of sticking their hands in the water to find the right temperature for the fishery, or tasting seawater to check its salinity" (Uda 1936, 33).

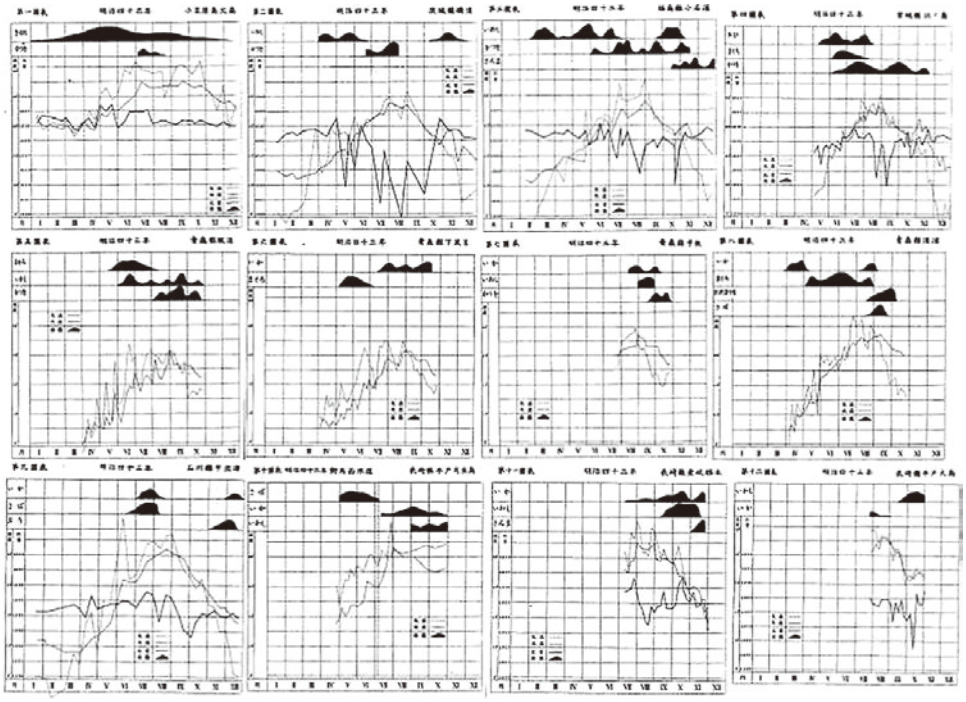


Figure 4. An array of twelve fixed-point observation graphs, including water temperature and density lines below and black shaded estimates of fishing conditions for specific fish varieties on top (“Chihō suisan shikenjo chōsa hōkoku ni kansuru zuhyō” 1912). The graphs were originally displayed one per page.

increasingly mechanized Japanese fishing fleet:

> In recent years fisheries for migratory fish have grown without limit, but because [these fisheries] are always influenced by ocean currents, fishers constantly need clarity about the currents' conditions and their changes. These days, it is accepted that this [information] is necessary when using engine-equipped and steam engine-equipped fishing vessels. We have still not seen any accurate surveys of the condition of currents in our coastal waters, their changes, and their relationship to the schooling of fish (Kitahara 1912, reprinted in Nakano 2011, 15).

Throughout the 1910s, the Fundamental Fisheries Survey tracked the areas where currents met off the coasts of the Japanese archipelago. For several years, Kitahara chartered the privately owned whaling vessel *Kinkasan Maru*（金華山丸）to take temperature, salin-

ity, and density measurements in the waters off the Pacific coast where the Kuroshio and Oyashio currents flowed into each other (Kitahara 1913, 70). This area of contact, which Kitahara often referred to as the *shioai*（潮合）and Uda Michitaka later called the *shiome*（潮目）or "current rip," became a focal point of the survey's activities (Uda 1941; Figure 5). Kitahara viewed the *shioai* as a space in flux. Where currents met, temperatures, densities, and salinities could change unpredictably. The *shioai* was a mixing zone for creatures that usually lived either in warmer or colder environments (Kitahara 1921, 306).

Ideas about Pacific current interactions reached wider audiences in Japan. From 1915 to 1921, Kitahara wrote "Popular Accounts of Oceanographic Research"（*Tsūzoku kaiyō kenkyū dan* 通俗海洋研究談）, a series of forty-seven articles in the fisheries journal *Suisankai*（水産界）that was later republished as a stand-alone volume. Several articles in the series introduced processes of current formation, mixing, and upwelling. Kitahara pointed out to readers that currents came together not only in the farthest seas, but also near the coasts of northeastern Japan where the Fundamental Fisheries Survey and substantial fishing activity were already taking place (Kitahara 1921, 308).

This brings us back to the Kyoto prefectural archive's edition of the 1918 *Oceanographic Surveys and Fish Migration*, which distilled three rules derived from the survey's activities. The first rule was that fish were numerous where currents flowed into each other. Kitahara cited a 1912 cruise undertaken by the whaling ship *Kinkasan Maru*, in which huge schools of ostensibly warm-water bonito had been found in the area where the warmer Kuroshio and colder Oyashio converged (*Kaiyō chōsa to gyozoku no kaiyū* 1918; Figure 1).

The second rule was that currents helped pack fish close to the shore. Along many coastlines were areas of freshwater mixed with saltwater, which Kitahara termed "coastal water"（*engansui* 沿岸水）. Kitahara noted that sardines often reproduced in coastal water. Where currents passed close to the shoreline they tended to reduce the area of coastal water and in turn keep schools of sardines pinned along the coast. Kitahara brought up a 1913 survey of the sardine fishery off the coast of Chiba prefecture when conditions were such that "if you had a net you could simply scoop out sardines from the shore" (*Kaiyō chōsa to gyozoku no kaiyū 1918*).

The third rule was that when currents met along a channel（*suidō* 水道）, fish tended

Figure 5. Kitahara Tasaku's schematic view of the *shioai*, with the Oyashio "cold current" on the left meeting and (initially) flowing underneath the Kuroshio "warm current" on the right. The top horizontal line represents the surface of the sea (Kitahara 1921, 306).

to concentrate in that area. Kitahara's example was the waters around the Tsushima Strait, which were usually characterized by "coastal water" but which could at times be buffeted by a westerly branch of the Kuroshio from the south and by currents coming down the Japan Sea from the north. Harking back to a 1915 survey of the currents around Tsushima Island, Kitahara noted that where currents flowed together fish tended to school closer to shore (*Kaiyō chōsa to gyozoku no kaiyū* 1918).

These forecasting rules, later dubbed "Kitahara's Laws" (*Kitahara no hōsoku* 北原の法則) by oceanographer Uda Michitaka, were not absolute predictions (Uda 1936, 33–34). Moreover, the "laws" themselves were derived from the study of places like the Kinkasan coast, which generations of fishers had recognized to be productive. Nevertheless, the survey made the case that instrumental measurement was a way to judge the locations of currents. And where currents interacted with the shore and other currents, fish were likely to be found.

The Fundamental Fisheries Survey's findings informed subsequent understandings of water and fish. Traces of the survey can be seen in places like Aquamarine Fukushima, an aquarium sited near the Kinkasan waters where Kitahara's survey members took shipboard measurements a century ago. Visitors can walk between two enormous tanks in an exhibit entitled "The Sea of the Current Rip" (*shiome no umi* 潮目の海), which makes use of Kitahara's (and Uda's) language to describe the hydrobiological convergence of warmer Kuroshio and colder Oyashio environments (Figure 6). In the aftermath of the March 11th, 2011 Tōhoku earthquake and Fukushima nuclear disaster, the moni-

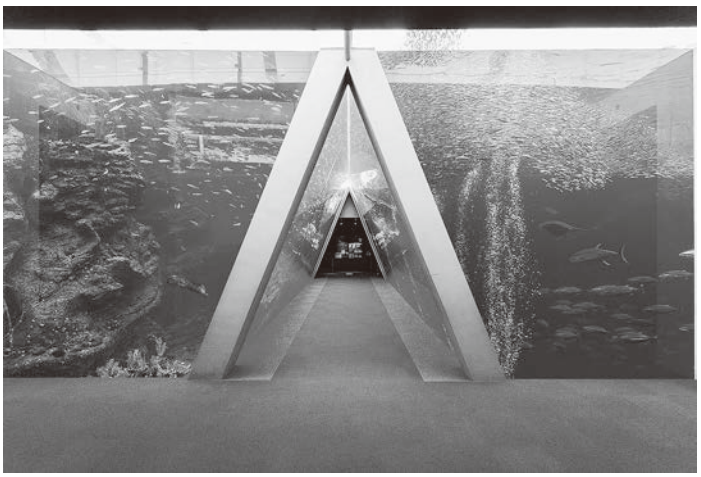


Figure 6. Aquamarine Fukushima's "Sea of the Current Rip" exhibit. The 550-ton "Oyashio" tank is on the left and the 1,500-ton "Kuroshio" tank, stocked with bonito, is on the right. Used with permission of Aquamarine Fukushima.

toring of Kuroshio and Oyashio interactions has also taken on new importance as a way to track radioactive effluents and their effects on future fisheries activities (Kudō 2014).

A Kuroshio Empire?

The Fundamental Fisheries Survey emerged at a moment when marine science began to be justified through its potential to find places to catch fish. Its end in 1918 signaled to Kitahara the beginning of new possibilities for exploring the sea:

> If future surveys of the ocean are carried out to clarify relationships between important fish and shellfish, fisheries can be built upon a scientific basis. Catches will become reliable, capital investment will flow, and this industry will achieve healthy growth. We can expect vast gains in national wealth. Oceanographic surveys are truly of fundamental significance to fisheries management (*Kaiyō chōsa to gyozoku no kaiyū* 1918).

A coalition of Japanese politicians and bureaucrats agreed. After several years of debate in the Japanese Imperial Diet, in 1918 the state allocated funding for a new oceanographic survey（*kaiyō chōsa* 海洋調査）to succeed the Fundamental Fisheries Survey (Marukawa 1943, 33; Nakano 2011). The new survey remained connected to fisheries concerns. It was still based at the Imperial Fisheries Institute, albeit in a division with a purview that was "oceanographic" rather than limited to "fisheries" matters alone.[14]

After 1918, oceanographic fisheries surveys took place across the Japanese empire on a far larger scale than before. Institutions throughout the empire began to order new stand-alone survey ships during and after the First World War (Marukawa 1943). By the 1920s, colonial fisheries experiment stations had become nodes of oceanographic work in their own right.[15] Kitahara awaited next-generation studies as an intra-imperial endeavor that would examine ocean current dynamics across the Pacific. He envisioned Taiwan in particular as a southern center for examining relationships between the Kuroshio current and northward movements of bonito and tuna. As he wrote, "Japanese prefectures are working on surveys and have revealed new aspects of the Kuroshio, but have not reached [the current's] source" (Kitahara 1921, 296). Kitahara argued that the Kuroshio would literally and figuratively connect Taiwan to "coastal fisheries in Japan" (Kitahara 1921, 296).

By the 1930s, Japanese-flagged fishing vessels plied waters from the East China Sea to

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[14] *Oceanographic Surveys and Fish Migration* was itself published within the new oceanography division.

[15] Imperial fisheries experiment stations would open in Korea (1921), Taiwan (1929), and the South Pacific Mandate.

the South China Sea to the South Pacific, and from the Sea of Okhotsk to the Bering Sea and onward toward the coasts of North America (Tsutsui 2013; Muscolino 2013; Finley 2011).[16] In a series of pathbreaking articles, William Tsutsui has described this growth of imperial Japan's long-distance, export-focused Pacific fisheries industry in the evocative terms of "pelagic empire" (Tsutsui 2013; Tsutsui and Vuorisalo 2017). The adjective "pelagic" highlights the advance of Japanese maritime ambitions into the farthest and deepest seas. It also spotlights the important roles of Japan's imperial state, which fanned fisheries expansionism through subsidies for motorized vessels, the promotion of marine product exports, and the support of institutions for fisheries education. Yet the pelagic, and its association with long distances from shore, is not the only way to think about imperial Japan's maritime geographies. The transformation of Japan's early twentieth century fisheries—in the farthest pelagic, in the coastal littoral, and in waters between—took place amid changing scientific understandings of saltwater environments.

Across the 1930s Pacific, Japanese vessels gathered and processed information about watery conditions in order to pursue fish. Anyone with a radio license (and, likely, some without one) could listen to weekly oceanographic fisheries forecasts over Japanese airwaves from the mid-1930s onward ("Rajio no gyokyō hōsō" 1935, 120). Uda Michitaka, then directing a program of multi-ship imperial oceanographic surveys, remarked at how methods of sensing ocean conditions had spread: "Among the countless bonito and mackerel fishing boats that are active in the huge fishery that extends two thousand nautical miles into the Pacific, there is not a single vessel today that does not make use of thermometers to measure water temperatures" (Uda 1936, 33).

Uda and a handful of others saw the starting point of systematic Japanese oceanographic research, including widely employed methods of measurement and forecasting, in the Fundamental Fisheries Survey (Uda 1936; Marukawa 1943; Okamura 1934). Former survey member Marukawa Hisatoshi claimed that "the predecessor to our country's current fisheries-related oceanographic survey work was once called the Fundamental Fisheries Survey, which undertook observations of coastal fisheries and studied marine fauna" (Marukawa 1933, 15). Although the Fundamental Fisheries Survey stayed (for the most part) close to shore, Japan's nascent oceanographic community saw its legacies deep in the Pacific.

Moving forward, more work can be done in order to probe historical relationships between Japanese fisheries expansion and scientific understandings of the Pacific. Both dovetail with histories of oceanographic knowledge production across the twentieth century

[16] For most of the period between the 1920s and late 1980s (with the notable exception of the 1940s), imperial and post-imperial Japan accounted for a greater share of the world's yearly marine catch than any other twentieth century state (Sahrhage and Lundbeck 1992, 172; Tsutsui and Vuorisalo 2017, 270).

and beyond.[17] One point of entry is the Fundamental Fisheries Survey. The survey made knowledge of ocean currents part of, and an ongoing product of, how people understood fisheries around the Japanese archipelago and elsewhere in the Pacific. Surveyors and fishers both began to keep a closer eye on instruments and images in order to monitor the shifting positions of currents and the fish that swam along with them. If the sheer extent of Japan's subsequent maritime expansion made the empire a "pelagic" one, institutions for understanding the movements of ocean water and the locations of finfish rendered it no less a Kuroshio empire.

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[17] Strands of oceanographic internationalism intertwined along the Pacific coasts of late twentieth century Asia, as seen in projects like the eleven-member (the Republic of Korea, Thailand, Hong Kong, Malaysia, Singapore, the Philippines, the Republic of China, Japan, the Soviet Union, and Indonesia) UNESCO/FAO Cooperative Study of the Kuroshio and Adjacent Regions (usually abbreviated CSK, 1965–1977) and the Sino-Japanese Joint Kuroshio Survey (*Nit-Chū kyōdō kuroshio chōsa* 日中共同黒潮調査, 1986–1992) (Kai 1991). The question of empire will, moreover, require engagement with issues of nationalism and internationalism in oceanography and fisheries science that have hitherto been explored primarily in European and American contexts (Rozwadowski 2004, Hamblin 2005, Hubbard 2014, and Wille 2016).

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