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The Influences on Tokyo’s Post-War Marine Seafood Consumption Patterns

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Abstract

Marine ecosystems are experiencing declines in fish stock. These declines relate to a number of factors, most important of which is over-fishing (Pauly & Alder 2005). Seafood demand, driven by population growth, human migration to coastal areas and rising incomes has lead to a total global supply of some 80 million tons of seafood annually (Watson & Pauly 2001). The result is that human consumption of seafood is having a global impact on marine natural capital (fish stock abundance and diversity). Cities, particularly in the developed world, are large consumers of seafood (Folke et al. 1997). Citizens of Tokyo, for example, appropriate more seafood than all of Canada, twice that of those in the Netherlands, almost three times the consumption of Sweden and 6 times that of Switzerland (Gadda 2006). This was not always the case, however, as Tokyo’s consumption increased rapidly since the 1940s. We use the ecological footprint and trophic level analyses to calculate the historical patterns of Tokyo’s seafood consumption over the last fifty years and relate these findings to increasing wealth, fisheries production and related policies in Japan and Tokyo. The paper has three main findings and one prognosis. First, we find that shifts in wealth were related to increasing consumption up until a point (in the 1970s), and thereafter levels of seafood intake remained stable while economic growth continued. Second, the levelling of seafood consumption rates do not correlate with changes in policy, as Japanese fishing efforts increased with emphasis on maintaining some level of food “self-sufficiency”. Rather we find that the stabilized EF pattern relates more to changes in global fish stock availability. That is, despite the status of world city, extended international trade linkages and high levels of affluence, those in the city of Tokyo cannot overcome the degradation of the global fisheries commons. Tokyoites are “eating down the food chain” not because they want to, but because they must. Finally, both Japan and Tokyo have recently addressed consumption issues that have global impact (such as CO₂ emissions), but have only begun to address seafood consumption. We suggest that maintaining marine seafood stocks requires more than local and national policies to address consumption. Given the state of fisheries, managing our marine biodiversity stocks sustainably implicates efforts at all level of governance, including international.

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1. Introduction

Marine ecosystems are under threat of degradation through coastal pollution and overfishing (Pauly & Alder 2005). The Living Planet Index for 267 species of marine mammal, bird, reptile and fish species declined by 30 per cent between 1970 and 2000 (2004, p. 309). Indeed, global fishery catches from marine ecosystems peaked in the late 1980s and are now declining despite increasing fishing effort (Millennium Ecosystem Assessment 2005). Recent estimations suggest that approximately 9 per cent of ocean fisheries are depleted, 18 per cent over-fished and 47 per cent fully fished, leaving only 21 per cent of world stocks moderately fished and 4 per cent underexploited (Schiermeier 2002).

Within East Asia, total fish catch is the largest of the world. In the region, the peak catch occurred in the second part of the 1980s, largely due to high catches of sardine and Alaskan Pollack. Populations of both species, however, continue to decline. In the early 1990s, the biomass of these pelagic fishes dropped by 15 million tons in Russian Pacific waters. This decrease in fish stock has continued. At present, virtually all of the major commercially valuable pelagic fish stocks, including walleye Pollack, sardine, Pacific cod, yellow croaker and Japanese jack mackerel, are either fully exploited or depleted (Fu et al. 2002).

The decline and degradation of fish stocks are due to a number of trends. Importantly, fishing pressure in some marine systems has reduced the biomass of fish (of both targeted species, especially larger fishes, and those caught incidentally and usually discarded - the bycatch) by one or more orders of magnitudes relative to levels prior to the onset of industrial fishing.

Fishing pressure directly relates to marine seafood demand. Currently, more than a billion people rely on fish as their main or sole source of animal protein (Pauly & Alder 2005). This
is particularly true in Asia, as 27.7 per cent of total animal protein derives from fish products. This same share is as low as 11.5 per cent in North America, 10.9 per cent in South America and 10.6 per cent in Europe (Pauly & Alder 2005). While seafood is especially important for satisfying basic nutritional requirements in developing countries, demand also is strong in developed countries and particularly within cities. Folke, et al, (1997) for example, calculated that 20 per cent of the global human population living in 744 cities appropriate 20 per cent of the globally available marine seafood supplied.

Tokyo, Japan is a “world city” known for its international linkages in trade, finance, investments and high levels of affluence. It is also a city well known for its seafood appetite. Citizens of Tokyo, for example, consume more seafood than all of Canada, twice that of the Netherlands, almost three times the consumption of Sweden and 6 times that of Switzerland (Gadda 2006). While seafood has been an important food source throughout the island country’s history, rapid expansion of consumption has only been recent. Moreover, as calculated using the ecological footprint method, the increase in consumption levelled off within the city of Tokyo during the 1970s, despite continuing economic growth. This changing pattern, however, does not relate to policies for controlling consumption, but data suggests that consumption has shifted with the availability of fish. That is, as we have “fished down the seafood web,” (Pauly et al. 1998) Tokyo’s citizens have also “eaten down the seafood web.” Although recent national policies to reduce seafood waste are encouraging, we see little institutionalized incentives to control either supply or demand and little to no pressure from civil society to make fishing and trade in fisheries more sustainable. At the same time, however, there are examples of local policies that address consumption. Tokyo has begun to do within the energy sector. The results of this paper suggest the need for efforts in other areas as well, such as marine seafood consumption. If we are to maintain
global marine fisheries sustainably, however, we suggest a variety of complementary efforts at the local, national and global scales.

In the next section, the paper presents the trends in seafood consumption using two indicators: the marine seafood ecological footprint and average trophic level of total fish consumed. Following this, the third section presents a brief economic history of Japan and Tokyo concentrating on fisheries production, nutrition and government policies related to marine seafood. The fourth section provides an analysis of the trends described. The fifth section summarizes the results and concludes the paper.

2. Urban Marine Seafood Ecological Footprint and Trophic Level Analyses

In this section, we introduce two measures used to analyze the impact of Tokyo’s seafood appetite: the Ecological Footprint (EF) and average trophic level of fish consumed. The first sub-section defines terms and reviews the important elements incorporated in the EF analysis. The second sub-section presents an application of the EF to marine seafood consumption in Tokyo and the historical analysis of changing patterns. The third sub-section discusses the historical analysis of changing trophic levels of Tokyo’s seafood consumption. The fourth sub-section summarizes the analyses.

2.1 Background to the Ecological Footprint Analysis

Every living thing has an impact on the Earth because they consume the products and services of nature. Humans, however, have a particularly important place in the Earth’s various ecosystems for, at least, two reasons: 1) we have appropriated energy for exo-somatic purposes (those outside of our bodily metabolism); and 2) we tend to create more things (that is, move and concentrate resources) than we destroy (that is, facilitate entropic processes).
One measure of our ecological impact is the amount of nature we appropriate in order to live our current lifestyles, or the quantity of natural capital required in order to function as we do.

Scientific studies designed to identify how much “nature” humans need in order to survive in our current manner can be divided into, at least, two types: the measures of human appropriation of net primary production (see for example, Vitousek et al. 1997), and measures of a population’s Ecological Footprint (Rees & Wackernagel 1996; Wackernagel & Rees 1996).\(^1\) The EF is “the area of biologically productive land and water required to produce the resources consumed and to assimilate the wastes generated by that population using prevailing technology” (Wackernagel & Rees 1996). The concept turns the need to identify “carrying capacity” of a human system on its ear by providing a method for estimating the biologically productive area necessary to support current consumption and waste patterns. It is important to remember, however, that the EF is not a piece of real estate; it does not exist outside of our imaginations. It is a representation of demands upon the natural world. One can think of the EF, however, as being the sum up of specific real locations, the “distant elsewheres” that support us (Rees 2002).

The promoters of the EF intend it to serve as a comprehensive indicator for ecological sustainability (Wackernagel et al. 1999). In order to do so, the value of the EF in any spatial area compares to what is available within that area. That is, the EF indicator is only useful when compared to a second measure: the available bio-productive area (supply), called the “biocapacity” of the area. The level of appropriation of nature above the biocapacity available for the area of residence is the ecological deficit of that particular spatial unit and indicates the degree to which a population is living beyond nature’s means. An easy way to visualize

\(^1\) For a comparison of these two types see (Haberl et al. 2004).
the ecological deficit is to think of a city covered by a large dome that lets nothing but light in (see, Wackernagel & Rees 1996). How long can people in this city stay alive without external inputs and the removal of wastes? If the spatial extent of a given population’s footprint continually exceeds the biocapacity of the area under consideration, the society enters a state of “overshoot,” or a state of transactions between humans and natural capital that will ultimately lead to a drastic reduction or organizational capacity (not least of which is a crash of the population) (Catton 1980). Being able to identify “overshoot,” and promoting an understanding of its relevance, are at the core of the Ecological Footprint efforts (Wackernagel et al. 2004). This is often easier at the global level than at the national or local level, because the latter spatial units can trade. Trade between areas can diminish the impacts of “overshoot,” unless the population considered is global and the global EF exceeds the biocapacity of the Earth.

For most industrial regions, the ecological footprint of a significant share of the total resources (including traditionally crop and pasture land; built-up land; forest; fish and carbon assimilation) exceeds the capacity available locally. This leads to that population’s appropriation of ecosystem goods and services from that of the global system. In order to demonstrate this outcome the EF uses spatial units that are mutually exclusive from all others. Thus, the concept suggests “people are competing for ecological space” (Wackernagel et al. 1999). In this manner, it is possible to calculate not only the overshoot of a population, but also that of the entire world. In fact, recent work indicates that the total global ecological deficit is rising and that it now takes the global biosphere 1.2 years to regenerate what humans use in one year (Wackernagel et al. 2002). That is, the global population is in a state of “overshoot.”
2.2 Application of the EF to the Marine Seafood Consumption Patterns in Tokyo

The marine seafood EF, like the national EF, requires the differentiation between two essential variables: 1) the space needed to appropriate the resources from the ocean and area needed to assimilate wastes from that appropriation (ha/capita); and, 2) the ecological area available for supply of the resources and assimilation of wastes (ha/capita) at the same scale. The Tokyo Metropolitan Government collects data on the volume of a great variety of seafood that lands in the city’s wholesale markets. We use these data, organized by species, and supplement them with retail data for the entire country. We then calculate the values needed to perform the EF analysis as defined by Figure 1. This figure also demonstrates how we compare the EF of the city to the biocapacity available. As shown the Japanese system of seafood distribution is significantly complex. A given marine resource may land in the city through different channels (arriving at either retail or wholesale markets). Once it arrives within the city’s boundaries, it can supply the resident population or, suppliers may transport the product to a location outside the city. This unrestricted flow to and from an urban centre makes it necessary to estimate how much of the seafood sold within markets of the city actually stays in the city.

**Figure1: Calculation of Tokyo’s Marine Ecological**
The ecological supply, or the biocapacity of a marine area, is the maximum yield of a renewable resource per unit area. One way to measure biocapacity is through the Primary Productivity (PP) of the spatial unit, or the amount of biomass per unit area. PP equates to the mass of living organisms, most of which are those lower in the food chain: the producers. By definition, PP is the total amount of inorganic carbon fixed by producers through photosynthesis per unit area of the aquatic or terrestrial ecosystem. The immediate resources from cropland, pasture and forests are simply the productivity of plants in those ecosystems, since the products (crops, pastures and forests) are the primary producers. There are enough data available to estimate their yields (see for example, Schlesinger 1997). In the case of fisheries, the concept of PP includes the biomass of seaweed and single-cell algae (marine diatoms).

Primary Productivity relies primarily on light, but also depends on other factors such as, water, carbon dioxide, temperature and soil/water nutrients. Because of these other variables, different geographic regions (within aquatic or terrestrial ecosystems) present different primary productivities. We use the primary productivity of the continental shelf as that available to Tokyo in the Tokyo Bay.

We note that in calculating the EF “double counting” is an important concern (Best Foot Forward 2002). For this study there was one important potential area for double counting, which may be inherent in the datasets used (for example, when wholesale markets sell directly to retail markets). To be as conservative as possible, we calculate total retail by subtracting total wholesale from total supply. The total supply for Tokyo equals that of the population proportion of the Japanese population. We also estimate the distribution, by species, of retail supply as that of the wholesale market supply.
To calculate marine seafood ecological footprints, we adopted a formula developed by Wada (1999) after Pauly and Christensen (1995), as shown below.

\[ \text{Seafood EF} = \frac{\text{(Total Supply + Bycatch)}/9 \times 10^{TL-1}}{\text{Primary Productivity of the area}} \]

Total Supply includes the sum of “real wholesale supply” and “retail supply” of seafood for Tokyo in tons of live fish. Bycatch, or discard, added to the Total Supply results in the Total Appropriation of Seafood by Tokyo. The figures used for discarded bycatch correspond to a volume of catch per ecosystem (Alverson et al. 1994). In our calculations, however, we used seafood supply instead of catch. Therefore, in order to estimate appropriate volumes, we applied the rate of bycatch to the Total Supply converted into tons of live fish weight using Japanese conversion rates whenever possible. We assumed the rate of Bycatch for individual species to be constant during the study period.\(^2\)

The Total Consumption of Seafood by Tokyo is then divided by nine to convert wet weight into tons of carbon (tC) (Pauly & Christensen 1995; Strathmann 1967; Wada 1999). We then multiply the carbon value for each fish species by \(10^{TL-1}\). This is because biomass energy transfers up the food web with efficiencies between five and 20 per cent. A widely accepted mean is 10 per cent energy transfer efficiency. This implies that an organism in a given trophic level (hierarchical niche within the food web), on average, incorporates 10 times more

\(^2\) We understand, however, that technology is a driver of change in marine systems. Historically, global expansion of fisheries has been driven by waves of technological innovation, much of it developed for naval warfare following the Industrial Revolution, two World Wars and the Cold War. These innovations included the invention of steam, later followed by diesel engines and onboard manufacturing of ice later followed by blast freezing, which greatly expanded the range of industrial fishing vessels. This was followed by the incorporation into fishing of an enormous range of electronic devices that started with the post World War II introduction of radar and acoustic fish finders onboard fishing vessels culminating at the close of the Cold War with the introduction of GPS technology and detailed seabed mapping which enabled fishers to aim for specific small places with high fish abundances, which until then were protected by the depth and vastness of the oceans. Moreover, net technology has changed dramatically allowing for deeper and wider castings. All of this impacts the bycatch rates. We follow, however, the common understanding and calculations presented by the fisheries scientists.
primary production than does one with the same mass in the tropic level immediately below (Wada 1999). Finally, the entire value is divided by the primary productivity of the marine area (also in tons carbon – tC). The final values are the Seafood Ecological Footprint in hectares. We calculate the total marine seafood EF and the per capita EF by adding up the individual EFs for over 400 species for each year within our database.

The EF as calculated remains a partial account of the city’s impact on the marine environment through the appropriation of seafood. While it includes Bycatch, our figure neglects other wastes and impacts that affect seafood stocks such as eutrophication, loss of habitat, changes in the marine food chain, climate change, or biodiversity implications. Moreover, it does not include impacts that are associated with all the appropriation of seafood stocks, as defined by Wackernagel and Rees (1996, p 68), “the embodied energy and resources of the commodity.” These include, for example, the energy and materials used for its catch (or farming), transportation, stock, packaging, and disposal. Further, the study does not include the other impacts of technologies employed in catching fish and fish farming (Loh 2004). For these reasons, we believe that the estimates are conservative.

2.3 Application of the Trophic Level Analysis to the Marine Seafood Consumption Patterns in Tokyo

As mentioned, the trophic level (TL) of fish relate to hierarchical niches within the marine food chain. Lower TLs imply positions closer to the primary producers and higher TLs imply carnivores on top of the web. Most species of fish fall between a TL from 2.1 to 4.6 according to its position within the food chain. Herbivores locate at a TL between 2.0 and 2.19, omnivores’ TLs range from 2.2 and 2.79 and the TLs of carnivores are equal or greater
than 2.8 (Palomares 2000). Pauly et al (1998) analyzed the diet of 220 species of fish and shellfish to assign each species a TL. Using these data, available on the internet (see Pauly and Christensen 1997), we calculate the average annual TL for the species consumed in Tokyo. When the TL data for a species was unobtainable the TL for its next taxonomic category was sought; first genus, and, if unsuccessful, family category. We calculate the mean trophic level of the seafood consumed in Tokyo from 1953 to 2003 from volume and TL of each seafood species consumed in the city for each year.

Given our database of marine seafood appropriated by Tokyo, we selected specific seafood products for the TL analyses. First, we excluded fresh water fish and shellfish, marine mammals and fish roe. In order to be conservative, we excluded all primary products (algae). We also excluded all species and products which TL level could not be obtained. The resultant range of species supplied to the city live in TL niches from 2.1 to 4.6.

Two important limitations of our analyses include accounting for shifts in TLs with life stage of the fish and the aggregation of cultured and wild species supply. In the first case, adult and juvenile fish of the same species may have different diets and therefore different TLs (Pauly & Christensen 1997). Approximately 86 per cent of the worldwide marine catch is comprised of species that either maintain a constant diet throughout life or increase in trophic level as they grow. For example, some larvae feed on herbivorous zooplankton (TL= 2.0) consequently have a trophic level of about 3.0, but as they grow they consume larger, predatory zooplankton and small fishes or benthic invertebrates. This leads to an increase in

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3 Top predators (such as tuna, billfish and shark) have a trophic level equal to or above 3.75.
4 The consumption of algae in Tokyo has been growing remarkably (3,613% only from wholesale markets) since 1953. Over 90 per cent of the seaweed supplied in Japan is from aquaculture (Japanese Ministry of Agriculture Forestry and Fisheries 2004).
5 Within our database, these fish represent 6 per cent of total volume in 1953, 15 per cent of total volume in 1963, 18 per cent of total volume in 1973, 19 per cent of total volume in 1983, 17 per cent of total volume in 1993 and 18 per cent of total volume in 2003.
trophic level, often culminating in values around 4.5 in purely piscivorous, large fishes (Pauly et al. 1998). The Tokyo Metropolitan Government aggregates the volume of adult and juvenile fish of the same taxa. Therefore, we treat juveniles as adult fish. We believe, however, that disregarding shifts in life stage only make the estimates more conservative. Another important limitation of our database concerns the aggregation of the volume of cultured and wild taxa. While this does not undermine the results in the changes of mean trophic level that composes Tokyo’s meals, it might hide other consequences for the marine environment.

2.4 Summary of the Results

As demonstrated in Table 1, in 1953, the marine seafood EF per capita for Tokyo was approximately 0.6 hectares per capita. This level, for the total population eating in Tokyo was approximately 4.5 million and the seafood appropriation was under that of the Tokyo’s region to supply seafood. Hence, the ratio of marine seafood EF to biocapacity was under 1.0. From 1953 to 1963, however, the population eating within the city increased by over 50 per cent and the amount of seafood appropriated increased by over 150 per cent. The marine seafood EF per capita jumped to 1.21 hectares and the city entered the state of “overshoot.” Appropriation continued to increase over the next decades as total population increased by 15 per cent and total supply of seafood increased by approximately 40 per cent. The result was that the marine seafood EF of the city reached its highest level of 1.31 hectares per capita. Moreover, the city was appropriating over 30 per cent more than the marine area around Tokyo could supply. The general changes in the EF over the 50 years period are shown in Figure 2.

6 The exceptions are: Japanese amberjack (Seriola quinqueradiata), Greater amberjack (Seriola dumerili) and Red sea beam (Pagrus major).
### Table 1

Annual changes in Tokyo's total marine seafood supply, bycatch, total and per capita consumption, EF, average TL and ratio of EF to biocapacity, 1953-2003

<table>
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</thead>
<tbody>
<tr>
<td>Total Supply (tons carbon live fish) (per cent wholesale)</td>
<td>225,190</td>
<td>602,490</td>
<td>846,213</td>
<td>846,857</td>
<td>872,520</td>
<td>866,497</td>
</tr>
<tr>
<td>(per cent retail)</td>
<td>100</td>
<td>83</td>
<td>68</td>
<td>69</td>
<td>63</td>
<td>41</td>
</tr>
<tr>
<td>Bycatch (tons carbon live fish)</td>
<td>66,136</td>
<td>172,832</td>
<td>243,214</td>
<td>248,244</td>
<td>258,380</td>
<td>254,665</td>
</tr>
<tr>
<td>Total appropriation (tons carbon live fish)</td>
<td>291,326</td>
<td>775,321</td>
<td>1,083,427</td>
<td>1,094,101</td>
<td>1,130,900</td>
<td>1,123,163</td>
</tr>
<tr>
<td>Tokyo's total population (thousands)</td>
<td>6,656</td>
<td>10,355</td>
<td>11,981</td>
<td>12,299</td>
<td>12,724</td>
<td>13,135</td>
</tr>
<tr>
<td>Tokyo's real GDP per capita (US$)*</td>
<td>2,130</td>
<td>3,475</td>
<td>8,382</td>
<td>20,031</td>
<td>57,082</td>
<td>54,165</td>
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<tr>
<td>Tokyo's per capita consumption of seafood (kg/person)</td>
<td>31.6</td>
<td>48.4</td>
<td>54.0</td>
<td>51.8</td>
<td>50.9</td>
<td>37.1</td>
</tr>
<tr>
<td>Total EF (ha)</td>
<td>4,201,652</td>
<td>12,532,039</td>
<td>15,739,667</td>
<td>13,472,147</td>
<td>13,346,486</td>
<td>14,972,613</td>
</tr>
<tr>
<td>EF per capita</td>
<td>0.63</td>
<td>1.21</td>
<td>1.31</td>
<td>1.10</td>
<td>1.05</td>
<td>1.14</td>
</tr>
<tr>
<td>Ratio of Tokyo's EF to Tokyo's biocapacity</td>
<td>0.56</td>
<td>1.17</td>
<td>1.28</td>
<td>1.06</td>
<td>1.01</td>
<td>1.10</td>
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<tr>
<td>Average trophic level of Total Supply (per cent carnivores)</td>
<td>3.40</td>
<td>3.35</td>
<td>3.30</td>
<td>3.23</td>
<td>3.19</td>
<td>3.24</td>
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<tr>
<td>(per cent omnivores)</td>
<td>95</td>
<td>86</td>
<td>82</td>
<td>78</td>
<td>75</td>
<td>76</td>
</tr>
<tr>
<td>(per cent herbivores)</td>
<td>3</td>
<td>5</td>
<td>9</td>
<td>8</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Notes:</td>
<td></td>
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<td>§ This figure refers to the first year available for GDP, 1955.</td>
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<tr>
<td>‡ This figure refers to the last year available for GDP, 2002. Year 2003 data will be released in December 2005.</td>
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<td>We calculated Tokyo's population based on how many people eats in Tokyo daily. Therefore night-time and daytime population follows the formula: (Night time population*2/3) + (daytime population *1/3)). The data from night-time population is based on TMG statistics on population (from 1st October of each year). Daytime population is based on the national census conducted every five years (from 1st October of each year).</td>
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### Figure 2: Tokyo's Changing Marine Seafood Ecological Footprint

![Figure 2: Tokyo's Changing Marine Seafood Ecological Footprint](image-url)
The next two decades saw a drop in marine seafood EF per capita of the city, as population increased faster than total marine seafood supply. With this drop came an appropriate level close to that of what the Tokyo marine area could provide. During the most recent decade, however, while population growth has slowed and total supply has decreased the marine seafood EF of the city increased. This was due to the slight increase in average trophic level of the fish consumed in the city.

Table 1 and Figure 2 present the trend in average TLs. It demonstrates that while citizens consumed species at the higher TL, such as tuna, in abundance, lower trophic species have been increasingly more prevalent on Tokyoite’s plates. The mean TL of seafood appropriated by Tokyo decreased steadily from 3.40 in 1953 to 3.19 in 1993. During the last decade the mean TL grew 2 per cent, reaching an average TL of 3.24 therefore contradicting the overall trend.

We identified the main groups pushing the trend down as well as the reason for a TL increase in the last decade. An aggregation of Trophic Levels for species with similar functional niches within the food web (herbivores = TL 2.1, omnivores = TLs from 2.2 to 2.7, carnivores = TLs from 2.8 to 4.6) demonstrates that the proportion of carnivores appropriated by the city has been decreasing. For example, by volume carnivores represented 95 per cent of the total volume in 1953. Thereafter its share decreased steadily till 1993 to 74 per cent of total volume consumed, but increased slightly to 76 per cent during the last decade. On the other hand, the appropriated volume of herbivores and omnivores increased from 1953 to 1993. Between 1993 and 2003 the share of herbivores out of the total seafood consumed in
Tokyo stabilized at 14 per cent while omnivore’s share declined from 12 to 10 per cent\textsuperscript{7}. The question remains as to what influenced these trends. In order to explore this question, we turn to the history of seafood consumption, nutrition and government fisheries policies.

3. History of Economic Growth, and Seafood Production and Consumption in Japan and Tokyo

The Japanese, as inhabitants of an island have historically attributed an important practical and symbolic value to seafood. Japan waters are among the most productive and diverse fishing grounds in the world (Bergin & Haward 1996; Bestor 2004; Matsuda 2000). Excavations of shell mounds and discoveries of objects for fish trapping demonstrates that in the Jounan period (10,000-300 B.C.E) inhabitants of the Japanese islands had seafood as an important part of their diet (Bestor 2004). With the transition from hunting and gathering to farming, the bulk of the diet (including protein supply) shifted to rice. Fish retained the status

\textsuperscript{7} Within the omnivores all trophic level groups experienced an increase in the volume consumed per capita from 1953 to 1993 followed by a decline in the last decade. The exception is the trophic level 2.6 that declined earlier (from 1973 to 1983) driven by decline in the consumption of Konoshiro gizzard shad (Konosirus punctatus) – a species which population from Tokyo Bay have recently been found to be suffering from endocrine disruption.
of delicacy, eaten on special occasions due to its relatively high price. In quantitative terms, the Japanese consumption of seafood only became significant in the 30’s and widespread in the 50’s and 60’s (Bergin & Haward 1996). This section outlines the seafood consumption history of Japan and Tokyo beginning at this time. The section divides into three subsections; the period after the war until the mid-1970s; the period from the 1970s to the early 1990s; early 1990s to the present period.

3.1 From 1945 to the Mid-1970s

Directly after World War II, Japan floundered economically. Conditions for people around the country were difficult, which reflect in nutrition statistics. In 1946, for example, the average caloric intake of the Japanese was 1,400 cal a day. The lack of a merchant marine system closed Japan off from export markets and complicated imports of needed materials including seafood.

By the early 1950s, however, American involvement in the Korean War and the WWII peace treaty helped to remove obstructions to growth (Honjo 1998). Japan began rebuilding its industrial and commercial machinery, as the United States opted to rely on Japanese suppliers for many wartime needs. After regaining sovereignty in 1952, the Japanese government lifted post-war restrictions on fishing imposed by General McArthur. Thereafter the fisheries sector expanded (Bestor 2004). In 1954, the Self-Defence Law established a 150,000-man force, and therefore a coastguard, which facilitated exports and imports. By 1955 total production output surpassed wartime peak levels and by 1956, the government declared, “the post-war era is over.”
Government policies facilitated national economic growth. Japan’s priorities, at the time, focused on the development of energy resources and the re-establishment of the industrial base that had been badly damaged during the war. The first National Five-Year Economic Plan of 1955 proposed an annual growth rate of 5 per cent, through the promotion of industrial development and foreign trade. In 1960, Prime Minister Hayato Ikeda instituted the Ten-Year Income Doubling Plan that aimed at 9.1 per cent annual growth and proposed the quadrupling of annual production levels. Exceeding the original goals, the Ten-Year Income-Doubling Plan achieved 10.7 per cent average growth and during 1961 growth peaked at 14.5 per cent. Rising incomes led to increased spending that further stimulated the domestic market. This period was the time of greatest growth for the country and is often referred to as the “rapid economic growth period.”

The impact of these changes on seafood production and consumption were multi-fold. As the country regained its economy, the primary sector grew, encouraged by the need for more food. The fisheries sector expanded to its greatest levels in early 1960s. During these years the fisheries industry accounted for approximately 1.5 per cent of the nation’s employment (over 67,000 workers). In 1963, domestic marine fish catch (excluding whale) grew to 6.2 million tons. In the following year, Japan achieved its highest mark in “self-sufficiency” for fish and shellfish: 113 per cent.8

Increased food production was also evident in other agricultural and industrial sectors. By the mid-1950s, farm output reached pre-war highs. The processed food industry within the country also grew steadily introducing instant food (instant coffee in 1960, instant curry in

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8 Self sufficiency of seafood within Japan is defined as the total value of seafood produced domestically divided by the total value of seafood consumed domestically multiplied by 100 (MAFF, various years).
1968, instant cup noodles in 1971) and frozen food. The increasing accessibility to electric appliances such as the freezer and the microwave supported this growth (Watanabe 2005).

The result of these changes was increased caloric intake. By the mid-1950s, the Japanese caloric intake had surpassed the levels prior to the war achieving a daily average of 2,100 cal. per capita. By the mid-sixties, the per capita daily caloric value of food supply in Japan reached 2,500 calories (Watanabe 2005).

In 1961, the Japanese government abolished the import quotas applied directly after the war for most fish products (Swartz 2004). With increasing household incomes, the result was an increase for seafood demand, which imports provided. In a little over a decade, the Japanese appetite for fish surpassed what the country’s fisheries could provide. By 1973, Japanese seafood imports exceeded exports (Japan Ministry of Agriculture Forestry and Fisheries 1978; Matsuda 2000).

During this period, Tokyo was undergoing massive changes. Recovery accompanied a large in-migration to the country’s major metropolitan centers (Tokyo, Osaka and Nagoya), which even outpaced the rate of economic growth. The Tokyo Prefecture, after losing population during the war, grew to 8 million in 1955 and to 9.6 million in 1960 (Honjo 1998). At the same time, the city was also growing economically. Between 1953 and 1963, the GDP per capita in Tokyo increased 63 per cent.

Within the city, the seafood market, located in Tsukiji, east of Ginza at the mouth of the Sumida River, grew to become the home of the world’s largest. Officially called the Central Produce Market (because more than fish is sold there), the center has a long history.
Originally, the market was the mercantile center of re-Meiji Edo era (Edo is the traditional name for Tokyo) and was located at the base of Nihombashi Bridge, where it stood since the Tokugawa shogunate period. The earthquake of 1923 caused the dealers to move temporarily to Shibaura before settling in Tsukiji, which was officially inaugurated in 1935 (Bestor 2004; Seidensticker 1991). Two other smaller markets, Adachi and Ota, were opened in 1945 and 1989, respectively. Together these markets account for all the wholesale seafood sold within the city.

Tsukiji stood almost intact during the war. Between 1945 and 1955 the occupation forces took part of Tsukiji Market, but the flow of seafood and the markets role as a centre of seafood distribution were not affected (Bestor 2004). What did affect distribution however, were periodic food shortages. The government imposed controls over food distribution until 1950. In general, restrictions on consumption of goods and the post-war recovery kept living standards low. For example, one struggling middle-class family bought its first radio in 1956 and the purchase reduced the father’s retirement savings by 10 per cent (Allinson 1997).

During the late 1960s, given the expansion of production and wealth, living standards began to show for the city’s residents. Families began to buy extravagant items such as cameras. Purchases that are more discretionary followed in the seventies: stereos, cassette recorders, colour television sets, cars and room air-conditioners. By the mid-seventies, nearly every urban household owned a washing machine, refrigerator, colour television, and vacuum cleaner (Allinson, 1997).

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9 Adachi market is since its opening (in 1945) exclusive for aquatic products (both marine and freshwater) while Ota handles not only aquatic products (since 1989) but vegetable and fruits (since 1989), and flowers (since 1990).
3.2 Mid-1970s to the Early 1990s

From 1974 to 1989, the speed of economic growth changed and so did consumption patterns. Economic adjustments, emanating from the international global system, forced Japan to undertake painful industrial structural changes. The foundations of global commerce that sped development during the 1950s and 1960s eroded in the 1970s, leaving a less stable setting for international trade relations. Among the most crucial fundamental change was the first oil crisis, provoked by the Organization of Petroleum Exporting Countries (OPEC) in 1973 when it placed an embargo on oil exports, quickly driving up crude oil prices on international markets. This lead, domestically, to higher costs for raw materials, higher energy bills, inflation, consumer anxieties, industrial cutback and, internationally, to a global economic slowdown. These “oil shocks” combined with the USA’s decision to abandon the gold standard, which signalled a more flexible global system of exchange rates, forced painful economic restructuring within the country (Kidokoro et al. 2001). As the Japanese yen would rise and fall in value largely in conjunction with balance-of-payments surpluses and deficits, its successful exporting strategies needed to compensate for these changes. National attention focused on the exportation of its primary industries goods.

The fisheries sector, however, continued to increase production. In 1973, fisheries production topped 10.6 million tons (Japan Ministry of Agriculture Forestry and Fisheries 1978). In 1983, the fishing industry’s harvest (excluding aquaculture and whaling) exceeded 10 million and by 1984 reached a peak of approximately 12 million tons (Japan Ministry of Agriculture Forestry and Fisheries 1986). This increase, however, was not due to more persons employed in the industry. The number of fisheries employment was around 47,000 people, a significant drop from the 1960s. The increase in domestic production was due to increased fishing effort, defined by the number of and size of the fishing fleet. From 1973 to
1983, the number of Japanese fishing boats increased from approximately 300,000 to approximately 400,000. The total gross tonnage of these vessels increased from 2.6 to 2.8 million (Japan Ministry of Agriculture Forestry and Fisheries 1981, 1986).

It was during the mid-1980s that Japan reached its highest levels of domestic fisheries production. Previously, China, Japan and the former USSR were the three top fishing countries of the world. Japan, which had been the top fishing country for many years slipped to second place in 1989. Yet, in terms of world total, its fishery production remains high. In the late 1980s, for example, Japanese production remained between 10-12 million tons. This accounted for over 10 per cent of total world fish catch (Japan Ministry of Agriculture Forestry and Fisheries 1997).

During the period Tokyo continued to grow in population and economic activity. While Osaka and Nagoya lost population after 1970, the Tokyo Metropolitan Area continued to increase in population. And due to the in-migration of people of reproductive age, the population growth rate of the Tokyo Metropolitan Area during the 1980s was far greater than any other area in the nation.

The anomaly of Tokyo’s continued population growth can be explained by the concomitant growth of, at first, new techno-economic based industries, and then the rise of the service sector within the city. At one point the Tokyo Metropolitan accumulated the largest manufacturing agglomeration in the nation. Like its national counterpart large cities, Tokyo lost factories from 1975 to 1984. However, it remained a center of high-tech industrial development and R&D investments (Takahashi & Sugiura 1996).
The service sector had also traditionally been an important part of the city’s economy, but during the late 1970s onward it took on a special significance for the Tokyo Metropolitan Area. The service sector includes those activities associated with public, private and not for profit services. These includes the activities of banks, securities firms, investment banking offices, real estate development offices, accounting firms, advertising, law firms, research and development organizations, trucking, warehousing, and retail and wholesale trade among other things.

Tokyo became the center of international business and financing and the nation’s largest enterprises (as defined by capital holding of over Yen 5 billion). It was also the center of information service and education in Japan. The processes of economic re-structuring were enhanced by the globalization of Japan’s economic activity and resulted in the ascendance of Tokyo as a premier world city (Sassen 1991).

With all these activities, the city was generating a disproportionate amount of wealth within the country. Between 1973 and 1983, Tokyo’s GDP per capita grew 139 per cent, faster than the national average. The result was that with approximately 9 per cent of the population, the Tokyo Prefecture was generating over 18 per cent of the national GDP. The large volume and concentration of productive energy made Tokyo a powerful consumptive market.

Affluence became visible for many families within the country, but more so for those in Tokyo. The average monthly income of urban workers’ households increased more than sixteen times between 1955 and 1989. Discretionary income facilitated changes in food purchases, which differed in significant ways from a generation before. The consumption of rice and sugar dropped off, quite significantly in the case of rice. In contrast, people
consumed more meat, fruit, milk and dairy products. The most pronounced shift in dietary preferences was between generations. Older people continued with a diet based heavily on rice, vegetables, and fish. Younger people increased protein intake by eating more meat and dairy products. The result was that adolescents in 1989 were on average four inches taller than earlier generations (Allinson 1997).

With increasing wealth, families also began to change food-purchasing practices and in particular eat out at restaurants. Restaurant dinning in the 1950s and 1960s was a luxury saved for holidays or special occasions. During the 1970s, many families went out to dinner once or even twice a week (Allinson 1997).

3.3 Early 1990s to the Present

At the end of the previous period, in the late 1980s, a real estate “bubble” that centred on the country’s cities and largely in Tokyo burst sending economic repercussions to other sectors. The country descended into a recession, which would last for over a decade. The recession forced domestic changes. For the next decade, growth slowed dramatically and a host of problems surfaced. The long bust of the 1990s sapped the buoyant confidence of the country that was evident during the 1980s. Economic growth, even in the city of Tokyo stagnated.

The patterns for fish production followed that of the general economy, but for different reasons. In the early 1990s, Fisheries production began its continuous decline. In 1992, Japan’s total fish production was approximately 9.3 million tons (marine catch fell to 7.8 million tons). In 1993, the country’s production fell again to 8.7 million tons. In 1999, Japan’s fish catch decreased to 6.6 million tons equivalent to its catch back in 1963. In 2000, the Japanese self-sufficiency ratio for fishes and shellfishes (the share of the amount of fish
and shellfish supplied by domestic production for domestic consumption as food) was 53 per cent. By 2002, fisheries production was 5.8 million tons, of which deep seas (large pelagic) fishing accounted for 0.7 million tons. (Statistical Research Training Institute, 2006).

The drop in domestic production reflects a number of changes in the international and domestic situation. First, the change in the 1980s reflects the move by many countries to enforce 200-nautical-mile exclusive economic zones (EEZ) in accordance with the Convention on the Law of the Sea (see below). Thereafter, Japanese fishing boats could no longer ply the waters close to other nations for their fish. Hence, Japanese catch of larger vessels operating at a distance from Japan decreased. This change caused domestic fishers to increasingly depend upon their own coastal waters for fish (Cortazzi 1994). The catch of offshore and coastal fishing efforts has meanwhile increased and until recently there had been a significant growth in fish farming. The more intensive fishing efforts, however, have yielded decreasing volumes of fish. An examination of the trends by major varieties of fish indicates that harvest of sardines, Alaska Pollack and mackerel have declined. This general trend in production volume is due to an accelerated degree of over fishing in coastal waters and reflects improved efficiencies of fishing vessels (Japan Environment Agency 1995).  

As domestic fishery production decreased, imports increased, keeping the consumption of seafood at more than 11 million tons annually (Foreign Press Center Japan 2004). In 1992, Japan imported 4.7 million tons (Asahi Shimbun 1995). The domestic fisheries industry sector continued to loose strength as employment dropped to only 0.4 per cent of the nation’s employed population. By 2002, imports reached a record of 6.7 million tons, worth 1.76 trillion Yen. The fish and shellfish self-sufficiency ratio capture the country’s dependence on

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10 According to the Japanese Ministry of Agriculture, Forestry and Fisheries (2002a; 2003; 2004), the assessments conducted from 2002 to 2004 on major fishery resources in the waters surrounding Japan revealed low resource levels for half of the species.
outside sources of seafood. In the early part of the 21st Century it had dropped to approximately 46 per cent.11

The government responded to these changes by promoting seafood consumption and particularly domestic fisheries products. As this track was not effective, in 2000, it enacted the Basic Fishery Law designed to secure stable supplies of fishery products and to promote the sound development of the fishing industry. As fish catch continued to decline, the law was supplemented in March 2002, by the Fishery Basic Plan, which sets a target of 65 per cent for the seafood self-sufficiency ratio by 2012 (Foreign Press Center Japan 2004). In order to meet these targets the Japanese government has focused attention on both supply and demand. On the supply side, efforts to increase domestic production continued and included a resource restoration plan, management controls such as Total Allowance Catch and Total Allowable Effort (including no-fishing periods and bans on catches of small fish), releases of seedlings and incentives to those willing to work in the fisheries business. Moreover, although tariff rate reductions have been accepted in the World Trade Organization fishery negotiations Japan is the only country maintaining an Import Quota system among major countries (Japanese Ministry of Agriculture Forestry and Fisheries 2002b).

On the demand side, there are no policies in Japan directly attempting to reduce consumption of seafood (pers. com. Hisashi Endo). Japan’s efforts to reduce marine consumption focus on reducing seafood waste. The Food Recycling Law, which began in May 2001 in a graduated manner and will take full effect in 2006, encourages food wholesalers, retailers and manufacturers to reduce and recycle food waste (for use as fertilizer or feed). Under this law, all food-related businesses must cut food waste by over 20 per cent by fiscal 2006 (see

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11 The self-sufficiency ratio for seaweeds was about 90 per cent in the 60s. By 2002, it was approximately 66 per cent.
http://www.env.go.jp/en/lar/wastelaw/10.pdf). National campaigns encouraging a recycling-based society have been promoted to control food waste from households, which represent another 7.7 per cent of all food discards.

Moreover, rather than allowing prices to increase, the government, eschewing domestic seafood price controls, has opted for restructuring of the seafood distribution system. The argument is that by rationalizing the complicated seafood distribution system currently in use, seafood prices will decrease while domestic production revenues can increase. This will certainly be an incentive to increase seafood consumption.

On the nutrition and food consumption front, as the Japanese diet has changed, new health problems have arisen. The perceived villain in this scenario is red meat, which contributes to high cholesterol. In an attempt to control meat intake, the Japanese government is promoting campaigns such as “A meat diet causes high cholesterol and obesity. Return to traditional eating habits with rice and fish”. This together with the “slow food movement” (see http://www.slowfood.com/) is part of the so-called, “Food Education” strategy of the government. Again, the idea is to promote greater seafood consumption.

The main concern regarding food consumption (including seafood), however, is the focus on food safety. In July 2000, labelling became mandatory in Japan for all fresh food. These labels must include the product name and place of origin. From April 2001, the label law also included all processed food, for which the name of product, expiration date, raw material and storage method description became mandatory. Since this time, labelling of genetic modified food is also mandatory. These types of measures allow consumers to link their consumption habits to the biophysical world. They are being experimented with abroad. For example, the
Organization for Economic Co-operation and Development (OECD) suggests the use of certified seafood\(^{12}\) to influence household food consumption patterns (OECD 2002). The WTO negotiations have started to consider labelling for environmental purposes (Japanese Ministry of Agriculture Forestry and Fisheries 2002b). Since March of 2005, the FAO has promoted its “Guidelines for the Ecolabelling of Fish and Fishery Products from Marine Capture Fisheries” (ftp://ftp.fao.org/docrep/fao/008/a0116t/a0116t00.pdf). Within Japan, there is currently insufficient information on the labels that guide consumers towards a responsible consumption choice of fisheries products.

At the city level, the Tokyo Metropolitan Government is promoting “sustainable development” policies, but these largely focus on energy consumption reduction (pers. com. Yuko Nishida). In the past, policies on sustainable development largely targeted long-term results, such as providing environmental education and awareness. Current policies focus on achieving shorter terms goals. For example, the TMG has started efforts to reduce energy consumption and is coordinating the creation of an eco-market-base society. To this end, TMG is making use of strategies that, focusing on promoting a cooperative dispatching system among companies can encourage less energy consumption.

The cooperative dispatching system has already reached small businesses in Shinjuku and Otemachi districts. Through this system, companies closely located engage in a joint system of saving on dispatching trips to and from their offices. For instance, the companies engaged can purchase paper from a stationary shop or dispatch used paper to recycling companies in partnership, eliminating extra travel. Unfortunately, however, the transportation of seafood in Tokyo, which could use these efforts, has not received attention from the implementers of the

\(^{12}\) The Marine Stewardship Council (MSC) Standard subjected by OECD is the only internationally recognized set of environmental principles for measuring fisheries to assess if they are well managed and sustainable (http://www.msc.org/).
dispatching system (daily congestion around Tsukiji market remains high and underpins the push to market to a different site).\textsuperscript{13}

On eco-labelling, the TMG has two initiatives. The first focuses on energy savings labels. Since July 2005, the local government requires retailers to display these labels on home appliances. The second initiative concerns housing unit sale. TMG enforced a mandatory system of transparent information concerning buildings and home appliances “sustainable rank”. Both of these policies target a decrease in energy consumption. There is currently insufficient information on the labels that guide consumers towards a responsible consumption choice of fisheries products.

Arguably, these efforts have been encouraged by a combination of global warming and heat island effects. The city has been experiencing increasingly warmer average temperatures since the 1940s. This direct feedback has facilitated governmental responses, which will have impact beyond the city’s borders. The impact of seafood consumption on marine fisheries, however, is not yet as visible to citizens. There are few incentives to encourage reduced consumption and no direct feedbacks between marine degradation and seafood consumption. Apparently, Japan has been successful in providing abundant, high quality and diversified seafood products to her population, even enhancing protein intake. Fish is abundant in every supermarket and restaurant. The questions about how long this will last and at what cost to marine ecosystems has not yet emerged as an environmental concern to civil society.

\textsuperscript{13} The Policy Research Institute of the Ministry of Agriculture, Forestry and Fisheries (PRIMAFF) has conducted research on the Japanese “food mileage” (see http://www.sustainweb.org/chain_fm_index.asp). The “food mile” is an indicator that evaluates the environmental load related to the transportation of food from production to consumption. By 2001, Japan’s mileage value for imported food was 900 billion ton-km (almost 1.6 times the total domestic freightage and more than 3 times bigger than the food mileage of South Korea and the United States (http://www.primaff.affrc.go.jp/en/publications/primaff-an-re/annual2003/an2003-9-1.pdf).
Further complicating matters, seafood consumption is politically sensitive as fish eating is an important part of Japanese culture. Perhaps the most sensitive issues is whale hunting. Since the 1980s, there has been a global moratorium on commercial hunting of "great whales", including the blue, sei and Bryde's. Japan continues to hunt these animals (although efforts are largely focused on minkes) for “scientific” purposes and as part of their cultural heritage. After experiments, most of the whale meat ends up in restaurants and in 2005, a scheme was initiated to distribute whale meat to schools, and a fast-food chain began selling whale burgers (Head 2005).

In general, the Japanese government perceives reducing seafood consumption directly as an unnecessary measure. The focus of regulation is currently on improved fisheries technology and management strategies (including aquaculture) and increased emphasis on waste reduction. Whether and how much these practices will change the impact of Tokyo on seafood marine resources remains an open question.


Given the trends, conditions and analyses presented in the previous sections, we attempt to synthesize and summarize relationships in this penultimate section. We return to the general question of what influenced the patterns of seafood consumption within Tokyo and specifically, did it have anything to do with policy changes.

The first relationship we analyze is that between growing wealth and marine seafood consumption. The paper outlines the economic development of Tokyo suggesting that it grew rapidly in the early years, continued to grow through the 1970s and 1980s, until the
1990s. Between 1993 and 2003, it recorded negative growth of 0.5 per cent for the decade. Neither the EF nor the TL analyses, however, follow this pattern. One might expect that with increasing wealth, the size of the footprint would grow, based upon both increased consumption of seafood and increased ability to purchase the higher value fish (such as Tuna, Salmon, etc). The EF for the city, decreased from 1973 to 1983, a period of economic expansion. It decreased again from 1983 to 1993, while the total GDP of the city increased. Finally, during the period 1993 to 2003, while the city experienced an economic stagnation, if not slight decline in growth, the EF increased slightly. Economic growth in the early decades was partly responsible for the changes in seafood consumption, but thereafter, other factors played a more significant role in defining the city’s marine seafood EF.

The second relationship of interest is that of government policy intervention and change in seafood consumption patterns. The descriptive history above emphasized, however, that until recently, there were no local policies aimed at guiding seafood consumption. This is the responsibility of the Ministry of Agriculture, Forestry and Fisheries (per. com. Ryuutarou Arai). The Ministry, on the other hand was largely interested in maintaining the self-sufficiency ratio, and in enhancing domestic production. While it was able to achieve this in the 1960s and early 1970s, domestic production dropped slowly thereafter until the 1990s, and precipitously after that. This change relates more to international agreements and the closing of offshore fishing waters in the late 1970s. With fewer coastal waters to fish in, increased Japanese fishing effort brought in less and less fish. Market demand focused on imports.

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14 We also note that not all “high value” fish are high TL niche fish. For example, sea urchins and bream are lower lever TL inhabitants. Higher TL fish, however, are known to tickle the palette of Tokyoites and are highly desirable. For example, according to Bestor (2004, p. 309) an extraordinary tuna will sell for 10 to 12 thousand yen per kg (or approximately US$9-10,000 for a 100 kg fish). An ordinary one will sell for three to four thousand yen per kg. But a tuna was sold in the first auction day of the new millennium for 100 thousand yen per kg (US$90,000 for a 100 kg fish)!
A third relationship is consumer preference. No doubt, the change in preference from fish to fish and red meat plays a role in the EF trends. This combined with higher prices for fish in the 1990s may be responsible for the fall in consumption of seafood per capita. In total the amount of seafood consumed within the country over the past few decades has remain fairly level, but the amount of meat (pork, beef and chicken) has increased.\textsuperscript{15} By 2003, within Tokyo the per capita consumption of marine seafood has dropped to 37 kg per capita. While increased wealth provides an opportunity for Tokyo’s citizens to increase their total protein intake with fish, they choose to do so with animal sources. Certainly, the educational programs that emphasize the important connection between Japanese culture and \textit{sushi} or that emphasize the health risks in meat consumption do not seem to be working. There is no reason to believe, however, that the reduction in volume of fish per capita, as animal meat consumption increases, should also accompany a change in the composition of seafood consumed.

Therefore, the EF trends over the last decades are a response to changing eating habits with growing wealth and introduction of foreign foods and preferences. Before concluding that the patterns of seafood consumption are moving onto a sustainable pathway, we need to refer to the TL analysis. What this demonstrates is a trend towards consumption of fish at decreasing TLs. That is, the average share of lower level seafood species has increased on the plates of citizens within the city. Arguably, the higher prices of higher value, higher TL fish, such as Tuna play a role in this outcome. While the imports of Tuna have increased over the past few decades, however, the drop in TL started very early, making this association unpersuasive.

\textsuperscript{15} Despite diversification of the Japanese diet, accompanied by increasing of meat consumption, to this day fish intake remains significant, providing over 40 per cent of the average Japanese daily animal protein intake (Japanese Ministry of Agriculture Forestry and Fisheries 2004).
More likely is the correlation between the fall in average TL of seafood consumption in Tokyo with global fisheries trends. The post World War II rapid expansion of fishing fleets throughout the world has lead to an increase in the volume of fish landed. This trend continued until the 1980s with global landings peaking at 80 million tonnes (Watson & Pauly 2001) and since then have declined (Hilborn et al. 2003). Scientists estimate that populations of predatory fish are 10 per cent of the pre-industrialized fishing levels (Myers & Worm 2003). The biomass of high TL fish in the North Atlantic declined by two-thirds during the second half of the 20th century and by a factor of around nine for the century as a whole (Christensen et al. 2003). The result of less biomass of the high value high TL fish is that the average TL in global fish landings has decreased. In theory, the implication of “fishing down the food web” is that it can result in the disruption of the marine food web. This theory suggest that the lower the TL appropriated, the greater the ecological impact (Pauly et al. 1998). It follows from this that Tokyo is also “eating down the web.” That is, the patterns of consumption relate more to the availability of marine fish stocks then to rising incomes, changing preferences or government policies.

4.1 The Way Forward

If our analyses and general conclusions are true, the importance of finding a solution to managing the world’s fisheries has become an urgent matter. One solution advocated for Japan has been increased efforts at aquaculture. Unfortunately, this is neither a practical nor a sustainable option. Currently all of the approximately 225,000 km² marine area available for aquaculture within Japan’s EEC is already developed (Honma 1993). Second, of the 220 commercially available fish for aquaculture Japan only uses 23 mostly high value carnivorous fish, which require fish feed. Hence, growing these fish will not lower fish demand in
general. Third, the total output of Japan’s current aquaculture program available for people is between 0.3-0.5 million tons annually (pers. com. Hiroshi Kohno).\(^\text{16}\) This amount will only satisfy at best 57 per cent of Tokyo’s 2003 demand. Finally, there are a number of other impacts of aquaculture related to chemical inputs, disease transfer from farmed to wild breeds, habitat destruction, etc.

To manage our fisheries, we will need aquaculture efforts, but we will also need other options, including efforts at all levels of governance. The barriers to the implementation of sustainable fisheries management are significant. These include, inter alia, the lack of incentives and the poor feedback loops established between consumers and the global marine commons as mentioned previously. In order to establish these linkages, governance will need to operate at multiple scales. At the global level, the marine situation is believed to be so critical that scientists suggest that the only way to achieve “sustainability” in world fisheries resources is to substantially reduce fishing capacity and zone the oceans into unfished marine reserves and areas with limited levels of fishing (Pauly \textit{et al}. 2002). At the national level, awareness campaigns and those recently implemented in Japan seem appropriate. There will also be a need to reduce subsidies for seafood production and consumption. At the local level, efforts at curbing consumption similar to those that are being put into effect to curb energy consumption are also needed. Addressing local fish consumption may require additional approaches, such as those related to taxes and prices adjustments. However, one of the most complicated issues includes the development of a property rights system, without which basic fisheries management tasks cannot be met (Hanna 2001). It may only be when policies at all levels of governance for countries around the world are put into effect that our global

\(^{16}\) Total output is approximately 1.25 to 1.35 million tons, which is less than 10 per cent of the country’s demand.
common fisheries may be managed successfully so that future generations may enjoy benefits from these ecosystems.

5. Conclusions

There are two general conclusions of this study. The first related to whether Tokyo is developing sustainably. The second relates more generally to seafood consumption. In terms of the first issue, a city can be associated with a sustainable pathway when the activities within the urban center provide clean and healthy conditions for citizens, reductions in emissions of local and metro-wide pollutants to diminish impact on the regional environment and ecosystems and reductions in consumption of global resources, ecosystem services and associated global emissions (Satterthwaite 1997). Most cities on “World System Cities” lists are economically advanced and have accomplished the first set of environmental challenges, by providing excellent environmental infrastructure. They have only partially succeeded in the second task (many are sources of regional air and water pollution, and regional acid rain precursors from industry and transport, heat island effects, etc) and none have achieved near levels of sustainable consumption and waste emissions. This third aspect is crucial to sustainable development, however, and no city can be called “sustainable” until it successfully addresses these issues. The difficulties of implementing policies at the local level that address cross-scale impacts are apparent. Incentives structures to encourage change have not developed either. As such, urban activities are wreaking havoc on ecosystems worldwide.

While there have been discussions of this third aspect of urban sustainability, it has rarely been quantified and even more rarely have these trends been studied historically. This study has attempted the later by using the ecological footprint and trophic level analyses for one
small arena (marine seafood consumption). Our analysis demonstrates that while Tokyo has addressed some cross-scale issues, it is on an unsustainable pathway in terms of seafood consumption. Leaving things to tradition and markets has not worked to create a sustainable trajectory for the city. Nor have government policies or civil society advocated policies in this direction.

In terms of the second conclusion, the use of the EF as the sole indicator for sustainable development is both powerful and limited. In terms of this study, the marine seafood EF of Tokyo over time demonstrated an early association with increasing wealth. At a point, however, there was a break between economic growth and the city’s EF. This change was not related to governmental policies, as there were none attempting to curb consumption or production of domestic fisheries. Indeed, the country was set on increasing consumption and achieving self-sufficiency. Nor can these trends be associated with increased civic awareness of marine degradation. Rather the trends probably mirror changes in eating habitats as the city globalized and turned to other sources of protein.

More importantly, however, the EF trends mask another tendency of even greater significance. As fishing efforts worldwide have increased, fish landings have stabilized and the average TL of fish caught has dropped. As we have fished down the seafood web, Tokyo has eaten down the seafood web. That is, even very wealthy cities cannot avoid the degradation of our common marine resources.

The theoretical implications of our findings suggest that other measures should supplement the use of the EF in order to provide a fuller picture of the impact of local activities on larger scale environments. Indeed, using the EF alone in this case would be misleading. Our
findings have also led us to prognosticate that until management efforts are implemented at all scales of governance, we will not be able to manage our common global resources effectively.
Referred Interviews


Yuko Nishida, 10 November 2005, Tokyo Metropolitan Government, Environment Division.

Hisashi Endo, 14 November 2005, Chief Policy Planner, Ministry of Agriculture, Forestry and Fisheries, Policy Planning Division.

Hiroshi Kohno, 4 June 2004, Professor, Tokyo University of Marine Science and Technology, Laboratory of Ichthyology.

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