Consumer perceptions and behaviors related to radionuclide contaminated food: an exploratory study from Kansai, Japan

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Abstract

The Fukushima Daiichi Nuclear Power Plant disasters were triggered by a magnitude 9.0 earthquake and subsequent tsunami on March 11, 2011, ultimately resulting in a large scale release of anthropogenic radionuclides into the environment. Since the disasters, the Japanese government has been trying to ease public worries about food safety; however, many concerned consumers feel that the government is creating policies and taking actions that do not address their underlying apprehensions. With the aim of gaining empirical insights into these concerns, this paper uses data from a survey of 111 consumers in the Kansai region of Japan, located approximately 600 km from the disasters, to explore consumer perceptions and behaviors related to the risk of consuming radionuclide contaminated food. The results of the study reveal three consumer profiles present in the region in the aftermath of the nuclear disasters: the active concerned consumer, the passive concerned consumer, and the young consumer. Women with children living in their homes were the dominant demographic in the most concerned consumer profiles, and consumer concerns related to radionuclide contaminated food were found to be complex and multidimensional, associated with health and human illness, the environment, future generations, the economy, societal wellbeing and self image. Results indicated that all groups tend to lack trust in the national government as an information source and actor to ensure food contains safe levels of radionuclides, putting more trust in independent sources and food system actors in close proximity to consumers (city/local government; citizens groups; themselves) or to food sources (farmers). While all groups felt that food from south-western Japan was safest for consumption, the active concerned consumers were the only ones who were very active in changing their eating habits. In addition, the nation-wide project to dispose of disaster debris produced in the March 11th earthquake and tsunami—possibly contaminated with radionuclides and other pollutants—stands out as a major threat to food safety in the minds of the active and passive concerned citizens, provoking a collective political response from many of the active concerned consumers who feel the project threatens their ability to choose 'safe' foods.

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Abbreviations and acronyms

ECRR	European Committee on Radiation Risk
FD1-NPP	Fukushima Daiichi Nuclear Power Plant
HUS	university students in Hyogo prefecture
ICRP	International Commission on Radiation Protection
KCC	Kyoto City concerned consumer group
MAFF	Japanese Ministry of Agriculture, Forestry and Fisheries
MEXT	Japanese Ministry of Education, Culture, Sports, Science and Technology
MHLW	Japanese Ministry of Health, Labour and Welfare
MOE	Japanese Ministry of the Environment
NGO	non-governmental organization
PCA	principle components analysis
SFP	spent fuel pool
WCC	Wakayama City concerned consumer group
WNA	Wakayama City non-activist group

1. Introduction

1.1. *The Fukushima disasters and food systems*

On March 11, 2011, a magnitude 9.0 earthquake and subsequent tsunami devastated the north-eastern Japanese prefectures of Miyagi, Iwate and Fukushima, ultimately triggering the Fukushima Daiichi Nuclear Power Plant (FD1-NPP) disasters which resulted in a large scale release of anthropogenic radionuclides into the atmosphere. Once in the atmosphere, these radionuclides were deposited back on Earth through dry and wet fallout. Current estimations indicate that 80% of the FD1-NPP fallout went into the ocean, and 18% fell on Japan, concentrating mostly in the north-eastern part of the country (Section 2.1).

In nuclear disaster scenarios, plants are usually the first part of the food chain to receive radioactive contamination as radionuclides can contaminate agricultural lands directly through fallout, or indirectly through later absorption by plant roots (UNSCEAR, 2000). When terrestrial and aquatic animals live in an environment or consume plants or algae contaminated with fallout, the radionuclides can bioaccumulate within their bodies. Biomagnifications can possibly occur up the food chain (especially in closed systems) where radionuclides increase in concentration as they move through trophic levels (from plants and algae, to herbivores, to carnivores, to humans) (Gray, 2002). Once humans consume these plants or animals, the radionuclides can also bioaccumulate in their bodies, and have the power to damage DNA and can lead to cancer (ACS, 2010) or non-cancer diseases—many of which take years or decades to appear in the body (Ozaka et al., 2012). Research by the National Academy of Science reveals that there is a direct linear relationship between radiation dose (both natural and anthropogenic) and the development of solid tumors, indicating that there is no safe dose of radiation, even at low levels (National Research Council, 2006). The study also indicates an increased health risk for children, especially females. As anthropogenic radionuclides such as Cs-137 have a hazardous physical life of 300 to 600 years (Section 2.2) they have the ability to persist in the environment for many generations, infiltrating the food system as they bioaccumulate in plants and animals.

A food system is a dynamic and complex organization of stakeholders (involved in food production, processing, marketing, regulation, distribution, consumption, disposal, etc.) which is created, governed, influenced and affected by social, economic, political and ecological processes (PHO, 2005). Human behavior is an important driving force within food systems as peoples' visions and demands are able to shape current and future directions the system takes (Francis et al., 2003). On the other hand, "any barrier, break, or weakness along the food system can undermine the ability of the population to access safe, nutritious food, which can then undermine their health and wellness" (PHO, 2005 p.47). Kjaernes and Dulsrud (1998, cited in Hansen et al., 2003 p. 119) describe how perceptions of weakness in food systems—such as lack of consumer trust in the ability of the government to provide levels of food safety they feel are adequate—can stimulate 'system oriented' distrust which can drive consumers toward individual or collective responses.

1.2. *Concerned consumers and the knowledge deficit model*

In Japanese, there are two words commonly used to describe food safety: *anzen* (foods 'proven to be safe' for consumption in a scientific sense) and *anshin* (foods one 'feels at ease' consuming). In an attempt to uphold the integrity of the national food system following the FD1-NPP disasters, the Japanese national government took action to prove foods were *anzen* through the creation of provisional regulations and measurement protocols for radioactive materials found in food and drink (Section 2.2). However, these regulations did not give everyone a sense of *anshin*, as some consumers began avoiding foods from some prefectures, such as Fukushima (Section 2.3), and some concerned consumer groups began speaking out against the government's food safety policies and regulations. In response to this trend, the national government became involved in rigorous campaigns to educate citizens on the health effects of radiation exposure and to promote the consumption of products from the most fallout-stricken areas to end what they refer to as *fuhyouhigai* ('financial damage due to harmful rumors or misinformation') (Section 2.4).

The knowledge deficit model in risk communication describes the tendency for experts to view the public's food safety concerns as "excessive, or unwarranted, or irrational" because they lack adequate knowledge on the subject at hand (Hansen et al., 2003 p.111; Hilgartner, 1990.). However, empirical research points to the contrary, indicating that assessments by the public are "complex, situationally sensitive expressions of personal value systems," and, in this nature, the public incorporates scientific data into their personal risk assessments in ways very different from experts (Hansen et al., 2003 p.111). Additionally, compared to calculated risks made by experts, consumer risk perceptions are usually influenced more by hazard characteristics they assign to certain risks. In the case of nuclear power, these characteristics include unfamiliarity, low controllability and severity (in relation to health effects) (Slovic, 1987). Successful risk communication is, therefore, able to overcome the knowledge deficit model's one-way transfer of information from 'knowledgeable' experts to the 'ignorant' public, instead aiming to further understand and incorporate the public's concerns and values into policies and messages.

More than one and a half years following the commencement of the FD1-NPP disasters, many concerned consumer groups feel that the Japanese government continues to create policies and take actions that do not address their underlying apprehensions. The home of one such concerned consumer group, Wakayama City, is located approximately 600 km from the FD1-NPPs in the Kansai region of south-western Japan, an area where fallout from the disasters is estimated to be low, but internal radiation from consuming foods containing radionuclides is a risk.

Through an exploratory analysis of data collected from a questionnaire survey and personal conversation with consumers in Wakayama City and surrounding areas in the Kansai region, this study aims to provide empirical insights into consumer perceptions and behaviors related to *houshyanou osensaseta tabemono* or 'radionuclide contaminated food.' More specifically, this study investigates the following three topics: (1) consumer concerns about and characteristics associated with radionuclide

contaminated food; (2) consumer satisfaction with regulation, monitoring and information concerning radionuclide contaminated food; and (3) actions taken by consumers to decrease their risk of consuming radionuclide contaminated food. The results of this research seek to aid in breaking the knowledge deficit based mode of risk communication by giving a hint as to possible ways that stakeholders in the Kansai region can take action to maintain the integrity of their food system.

2. Context

2.1. *Fallout patterns*

Fallout patterns following a nuclear disaster are complex and variable, and can impact ecosystems and agroecosystems hundreds or thousands of kilometers away from the site of a nuclear disaster (Richards and Hance, s.a.). As mentioned in Section 1.1, these impacts can then lead to disruptions in food systems, potentially impacting consumer eating habits and health. Although estimations on total releases of radioactive isotopes from the FD1-NPP vary among scientists and institutions, of the total Cs-137 released until April 20, 2011, it is estimated that 1.9% fell-out over land masses outside of Japan (detected around the world in both the northern and southern hemispheres), 80% was discharged into the ocean, and 18% fell-out over Japan itself (Stohl et al., 2012).

Regarding the fallout into the ocean, in July 2011, the levels of Cs-137 off the coastal waters of Japan were more than 10,000 times higher than the levels found in 2010, indicating the largest accidental discharge of radionuclides into the ocean when measured in radionuclide concentrations (Buesseler, Aoyama and Fukasawa, 2011). This is a particular concern for food safety because many Japanese people consume seafood in their everyday diets. Concerning fallout onto Japan, airborne surveys of cesium deposition throughout the country made by Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT), estimate the amount of Cs-134 and Cs-137 accumulated in the air (one meter above ground) and on the ground surface. Surveys of ground surface contamination depict the highest concentrations of Cs-134 and Cs-137 (between 60,000 and 100,000 Bq[1]/m^2) in some prefectures of the Tohoku (Fukushima, Miyagi and Iwate) and Kanto (Tochigi, Ibaraki, Gunma and Chiba) regions (MEXT, 2012). Other studies investigating soil deposition of radionuclides throughout Japan find similar results, but also estimate high levels of fallout in Yamagata Prefecture (Tohoku) (Yasunari et al., 2011). A radiation air dose map made by Professor Hayakawa of Gunma University (2012) –popular among activist groups—shows radiation doses of Cs-134 and Cs-137 in the air extending further than the prefectures mentioned above, with the highest levels in the same prefectures found in the MEXT soil surveys, and detection of lower doses in prefectures within the Tohoku (Yamagata), Kanto (Tokyo and

[1] A Becquerel indicates the amount of disintegrations of a radionuclide per second in a measured substance (ATSDR, 2010).

Saitama) and Chubu (Niigata) regions. Hot spots in or around prefectural borders were also discovered in other prefectures in Kanto (Kanagawa) and Chubu (Yamanashi and Nagano).

When compared to north-eastern and central Japan, estimates show that south-western regions (Kansai, Chugoku, Shikoku and Kyushu) were not as seriously affected by fallout from the FD1-NPP disaster—although some probably were to some extent—, most likely due to the topography and weather patterns during the first days of the disasters (Stohl et al., 2012; Yasunari et al., 2011). However, current estimations of fallout cannot account for all of the complexities associated with the transport of anthropogenic radionuclides. Therefore, true soil contamination is probably much more variable than estimated, including hot spots in less contaminated areas, and clean patches in areas expected to have experienced a high amount of fallout (Yasunari et al., 2011).

2.2. *The government's food safety regulations*

It is possible to measure over 300 radionuclides in food products following a nuclear emergency (IAEA, 2011). However, food safety regulations usually deal with only a few of these including Cs-134, Cs-137, I-131, Sr-90 and Pu-239. Table A1 in Appendix A depicts some of the main characteristics of these radionuclides which are expanded upon below. Each of these radionuclides has a physical half life which describes the amount of time it takes for its activity to decrease to one-half of its original value (ATSDR, 2010), and a hazardous life (at least ten to twenty half-lives) which describes the amount of time it takes for the original radioactivity to decay to 1/1000 or 1/1,000,000 of its original state (NIRS, 2009). Hazardous lives can vary from minutes or days, to thousands of years (for example, the hazardous life of I-131 is 80-160 days, Cs-134 20-40 years, Cs-137 300-600 years, and Pu-239 244,000-488,000 years). In addition, these radionuclides can incorporate themselves into plants, animals and human bodies because they mimic basic elements such as K (Cs-134 and Cs-137), I (I-131), Ca (Sr-90), and Fe (P-239). Radionuclides with alpha (α) (Pu-239) and beta (β) (Cs-134, Cs-137, I-131, Sr-90) emissions are of particular concern for food safety because, when ingested, they can possibly become lodged in different parts of the body and irradiate nearby cells (NDDHRC, s.a.).

To deal with the risks posed by anthropogenic radionuclides, on March 17, 2011, the Japanese Ministry of Health, Labour and Welfare's (MHLW's) Department of Food Safety established 'provisional regulation values' for radioactive materials found in food and drink (referred to hereafter as food). Any food that surpassed provisional levels fell under the regulation of the Food Sanitation Act's Article 6, Item 2, not to be made available for human consumption (MHLW, 2011). In their monitoring, the government used Cs-134 and Cs-137 as indicators for the radiocesium group (Sr-89, Sr-90, Cs-134 and Cs-137) and I-131 as an indicator for the radioiodine group (I-131, I-132, I-133, I-134, 1-135 and Te-123) (Hamada and Ogino, 2012). Under these regulations, beginning in April, 2011, foods were spot-tested at least once a week in the following 11 prefectures: Fukushima, Yamagata and Miyagi in Tohoku; Ibaraki, Tochigi, Gunma, Saitama, Chiba and Tokyo in Kanto; and Niigata and Nagano in Chubu (MHLW, 2011).

From April 1, 2012, the MHLW enforced new, lower allowable levels for radiocesiums in items such as water, milk, vegetables and fish, with exceptions for beef and rice (enforceable in October 2012), soy beans (enforceable in January 2013) and foods processed before April 1, 2012 (not enforceable) (MHLW, 2012a). I-131 is no longer tested for due to its short half life. In addition, the testing area expanded to 17 prefectures, including those with a history of distribution restrictions for multiple items (Fukushima, Iwate and Miyagi in Tohoku; Ibaraki, Tochigi, Gunma and Chiba in Kanto) and for single items (Aomori, Akita and Yamagata in Tohoku; Saitama, Kanagawa and Tokyo in Kanto; and Niigata, Yamanashi, Nagano and Shizuoka in Chubu) (MHLW, 2012b). Sampling locations are selected based on the presence radioactive cesium in soils, environmental radiation monitoring results, and areas in which more than 50 Bq/kg of Cs-134+ Cs-137 was detected in products in 2011 (MHLW, 2012b). Table A2 in Appendix A outlines the allowable amount of radioiodines and radiocesiums permitted in foodstuffs in both provisional and new government regulations.

2.3. *Food contamination and consumer concerns*

The traditional Japanese diet consists mostly on grains (principally rice), soybeans, fish and vegetables, with an increase in red meat, dairy and wheat consumption beginning in the 1960s (Jussaume, Hisano and Taniguchi, 2000). Sea plants, fish and other seafood products are basic ingredients found in many regularly consumed dishes such as *miso* soup, noodle dishes *(udon* and *soba)*, sushi and *onigiri* (rice balls). Green tea is also regularly consumed in Japan, purchased as tea leaves and in drink form, or as an additive in many snacks and deserts. Following the FD1-NPP disasters, food monitoring found that a number of agricultural products produced in Japan were contaminated with I-131, Cs-134 and Cs-134, some at high levels. Table A3 in Appendix A lists some examples of radiation monitoring results taken from food and agriculture products which are discussed in more detail below.

Radionuclide monitoring results for food products are available online and can provide consumers with basic information on the levels of radionuclides in food and their place of origin; however, there are many complexities associated with the measurements which may make interpretation difficult. Foods are spot tested in various locations with different types of equipment, so absolute values from monitoring tests may be difficult to compare. Numbers can be affected by what forms food are tested in (for example, new standards consider tea to be a drink, while provisional standards tested tea leaves which tend to show higher levels of contamination), how the foods are prepared prior to testing (cleaned, peeled, raw, boiled), the type of equipment used, how long a sample is tested, among other aspects. Looking at food testing results, mushrooms, certain seafood, river fish, tea, and beef have stood out as having shown relatively high amounts of Cs-134 and Cs-137. Some spinach and dairy products also showed high contamination of I-131, Cs-134 and Cs-137 in the early days of the disasters. It is important to note that some forms of processing can help to reduce radionuclide concentrations in food (for example, milled rice seems to have a much lower radionuclide content than brown) or increase them if a part of processing or production

involves contaminated inputs (for example, noodles processed in Okinawa using firewood from Fukushima; cows raised in Shizuoka and Miyagi possibly fed rice straw from Fukushima). There are even some agricultural products not included in government testing, such as tobacco, which have shown some level of contamination.

The Japanese Ministry of Agriculture, Forestry and Fisheries (MAFF) (2009) labeling laws require fresh foods (agricultural products, marine products, livestock products and brown or milled rice) sold in Japan to be labeled with the prefecture or country (if imported) of origin. Processed food labels must list the raw materials, but it is not necessary to include their place of origin. Following the FD1-NPP, some consumers have used these labels as a means to avoid foods from certain prefectures, especially those labeled as coming from Fukushima (MacKinnon, 2011). Picking up on consumer concerns, some food retail shops and restaurants began selling foods from south-western Japan and Hokkaido, and testing foods for radionuclides, some creating their own safety levels which are lower than those set by the national government (Furukawa, 2012; Radish Boya, 2012). Citizen groups, non-governmental organizations (NGOs) and private companies have also begun setting up testing centers where citizens can test their own food for radionuclide contamination, and members can share data with each other (O'Brien, 2012).

2.4. *The government's role in dispelling harmful rumors and rehabilitating disaster-afflicted areas*

Noticing consumer radiation fears and trends in avoiding foods from certain prefectures, the national government began encouraging the consumption of foods from the areas they believe suffer financially from 'harmful rumors' of radionuclide contamination. Various efforts include advertising a 'support [Tohoku] by eating' campaign with television commercials that feature celebrity guests (Food Action Nippon, 2011), and holding promotional sales events throughout the country for food products from north-eastern prefectures (MAFF, 2012a), among others. To prevent confusion about safe levels of radionuclides in food, the government also began asking private food retailers and restaurants to stop implementing more stringent safety standards and contributing to a "Becquerel war" among each other and with the government (Furukawa, 2012). Additionally, in September, 2012 the national government initiated a new 'consumer feeling safe action plan' as a way to deal with 'harmful rumor' damage to food following the FD1-NPP disasters. Under this plan, the government will implement countermeasures to end rumor damage which include educational hand-outs (MAFF, 2012b) and a plan to host 2,000 meetings at kindergartens and nursery schools throughout the country to educated mothers about the health effects of internal radiation exposure (NHK, 2012a).

The government has also been active in promoting a national 'wide-area disposal' project, asking local municipalities throughout Japan to use ordinary municipal waste facilities to incinerate and landfill disaster debris produced in Miyagi and Iwate Prefectures during the March 2011 tsunami. These debris possibly contain persistent toxic pollutants (including asbestos and dioxins) (Bird and Grossman, 2011),

heavy metals (such as mercury, arsenic and lead) (Shibata, Solo-Gabriele and Hata, 2012), and fallout from the FD1-NPP disasters (MOE, 2012c; Shibata, Solo-Gabriele and Hata, 2012). As of September 20, 2012, in addition to Miyagi and Iwate, there are currently ten prefectures processing the debris in Tohoku (Aomori, Akita, Fukushima and Yamagata), Kanto (Ibaraki, Gunma, Saitama and Tokyo), Chubu (Shizuoka), and Kyushu (Fukuoka). Nine additional prefectures are making plans to process debris in Kanto (Tochigi, Kanagawa), Chubu (Niigata, Toyama, Ishikawa, Fukui—in a location about 500 meters from Kyoto City), Kansai (Mie, Osaka), and Shikoku (Ehime) (MOE, 2012b). In Wakayama City, the mayor is also interested in accepting the debris, but has not yet (as of September 28, 2012) been able to formally accept because a final burial site has not been agreed upon. Kyoto City decided not to accept debris because Miyagi Prefecture no longer needed its help (Kyoto Shimbun, 2012). More information on the disaster debris project can be found in Appendix A.

3. Methods

3.1. *Part one: review and questionnaire design*

Questionnaires investigating peoples' risk perceptions often adopt methods from the psychometric paradigm from the field of cognitive psychology. Such questionnaires use Likert scales to investigate how much people associate certain hazard characteristics (such as whether a hazard has catastrophic potential, is voluntary, or controllable) with various risks (Slovic and Weber, 2002), and has been used to study both general risks and those related to food (Sparks and Shepherd, 1994). While the approach is useful in gaining a better understanding of the different ways in which experts and the public view risks, identifying shared traits among hazards, and tracking risk perceptions over time, it does not result in an in depth description of characteristics members of the public associate with particular hazards (Miles and Frewer, 2001).

To discover an effective way to accomplish this, Miles and Frewer (2001) conducted a two part study to investigate in more detail the public's concerns about and characteristics they associated with five specific food hazards ('BSE,' 'genetic modification of food,' 'high-fat diets,' 'pesticides' and 'salmonella'). In the first part of the study, the researchers used semi-structured interviews (n=130) employing a laddering technique (an advertising research method used to uncover underlying values about the food hazards), and created a questionnaire to validate the data against a larger population (n=309). Respondents of the questionnaire were asked to for their agreement or disagreement (on a seven-point Likert scale) on a number of statements based on the concerns and characteristics identified in the interviews, and principle components analysis (PCA) was used to examine relationships among the statements. Results revealed high agreement between the interviews and the questionnaire, as well as an observation that risk is multidimensional, understood in terms of human health, the environment, future generations, animal health and the economy by the sample population.

Using insights from Miles and Frewer (2011), the current study was designed in two parts. In the first part of the study, a review was used to design a questionnaire investigating consumer perceptions (including concerns about and characteristics associated with) and behaviors relating to the single hazard of radionuclide contamination of food. The review took place between January and May 2012 made up of information collected through: personal conversations with consumers and activists in Wakayama City and Kyoto City; attending meetings of activists groups against the burning of disaster debris in Wakayama City, Osaka City and Kyoto City; and reviewing newspaper articles, blogs and activist fliers related to food safety concerns and radionuclide contamination of food.

In question 1 of the questionnaire, characteristics and concerns collected in the review were transformed into statements where respondents were asked their degree of agreement based on a seven-point Likert scale. Additionally, because concerns about contamination in specific prefectures was often mentioned in the review, question 2 inquires about consumer perceptions on which prefectures in Japan produce food that is safe for consumption.

Question 4 uses a five-point Likert scale to inquire about consumers perceptions on which information sources they most trust to provide them with information relating to radionuclide contamination of food. The question was adapted from a similar question in a questionnaire designed by Grande et al. (1999) to assess Norwegian and Scottish consumer perceptions and behaviors toward both radionuclide contaminated food and treated foods (foods from a fallout region where farmers used countermeasures to decrease radionuclide levels) with the goal of being able to better communicate the safety of treated food to the public. Additionally, to explore opportunities for food system stakeholders to become more involved in food safety issues related to radionuclide contamination of food, question 5 was adapted from a question in Smith and Riethmuller's (2000) study on consumer concerns about food safety in Japan and Australia. The adapted question asks which groups consumers would most or least trust (on a five-point Likert scale) to ensure their foods contain safe levels of radionuclides.

The review also revealed that people are not only concerned about radionuclide contamination of food, but some are taking actions to reduce risks they perceive to be associated with the food hazard. Therefore, question 3 was designed to inquire about changes in consumer consumption behaviors. The section adapts another question from Grande et al. (1999), which asks consumers to indicate how much their consumption of specific foods have increased or decreased due to their concerns of radionuclide contamination. Foods chosen were based on those demonstrating high radiation levels in government monitoring results or those mentioned in the review. Lastly, question six was designed to collect demographic information. While the questionnaires were anonymous, some respondents left their contact information if they were interested in obtaining results or answering further questions on the study subject.

Because the questionnaire was administered in Japanese, the original English version was translated into Japanese by one translator and then translated back into English by another in order to catch any inconsistencies before the final Japanese version was administered. A small pilot test (n=4) was conducted in early May 2012 in order to get feedback on the questionnaire's design, comprehensibility, and any language problems.

3.2. *Part two: data collection*

3.2.1. *Respondents and sampling*

The study's total respondent sample (n=111) is made up of four groups with different demographic criteria and sampling types. All questionnaires were self-administered and all findings were anonymous. Table 1 summarizes the main demographic characteristics of each group. The first group, concerned consumers in Wakayama City (WCC), includes twenty participants of a meeting to discuss concerns related to radiation and food safety held at a café in Wakayama City, Wakayama on June 4, 2012. The organizers, of the meeting, identified through chain referral, are involved in activism to protect their children from consuming radionuclide contaminated food and preventing disaster debris from being brought to Wakayama City and the neighboring

Table 1
Demographic profile of respondents by group (in percentages).

Group name		WCC (n =20)	KCC (n =20)	WNA (n =20)	HUS (n =51)
Gender	Female	90	75	90	49
	Male	10	25	10	51
Age	18-29	15	10	10	98
	30-39	45	45	50	
	40-49	20	40	30	
	50-59	20	5	10	
	Missing				2
Children under 20 in home	Yes	85	60	85	22
	No	15	40	15	74
	Missing				4
Current prefecture of residence	Wakayama	85		100	
	Kyoto		100		2
	Osaka	15			20
	Hyogo				70
	Missing				8
Activism[a]	Yes	90	95		98
	No	10	5	100	2
Evacuee	Yes	25	20		
	No	75	80	100	100
Primary profession	Public service	20	20	15	
	Private restaurant or food retail	10	10	5	
	Unpaid homemaker	40	35	50	
	Student				100
	Other	30	35	30	
Usually eat organic when available	Yes	60	85	70	72.5
	No	40	15	30	27.5
Highest education completed	High school	15	15	25	100
	Junior college	15			
	Vocational school	20	25	10	
	University	40	50	55	
	Graduate school	10	5	10	
	Other		5		

[a]Individuals who are in a group or participate in events of groups that are against nuclear power, against the acceptance of disaster debris, want to protect children from radiation exposure, or test food for radionuclide contamination.

Osaka City. Of the twenty questionnaires handed out at the meeting, all were returned and used in the analysis. The group's population is made of mostly women (90%), individuals in their 30s (45%), individuals with children under twenty living in their homes (85%), non-paid homemakers (40%), university or graduate school graduates (50%), and individuals who have been involved in some anti-nuclear or radiation-related activism (90%) . 60% say they usually eat organic food when it is available. Evacuees from Fukushima, Chiba, Tokyo, or Kanagawa Prefectures make up 25% of the group, and, while a majority of participants live in Wakayama Prefecture, 15% came from the neighboring Osaka Prefecture to attend the meeting.

The second group, concerned consumers in Kyoto City (KCC), consists of twenty participants of a meeting held at a café in Kyoto City on May 27, 2012 to discuss questions and concerns related to internal radiation. One of the organizers was identified at a meeting on food safety held in January 2012 by an activist group in Osaka City. Of the 28 questionnaires handed-out at the event, 20 were returned and used in the analysis (a 71% response rate). Similar to the WCC group, the population is made of mostly women (75%), individuals in their 30s (45%) or 40s (40%), individuals with children under twenty living in their homes (60%), university or graduate school graduates (55%), and individuals who have been involved in some anti-nuclear or radiation-related activism (95%). 85% say they usually eat organic food when it is available, and evacuees from Tokyo, Kanagawa and Fukushima Prefectures make up 20% of the population.

The third group, non-activist consumers Wakayama City (WNA), consists of twenty consumers chosen through controlled sampling methods to match as closely as possible the population of the WCC group, but targeting individuals without any involvement in anti-nuclear or radiation-related activism. Questionnaires were collected between June and August, 2012. Respondents were identified through chain referral based mainly on criteria of activism, gender, age, presence of children under 20 in home, and current prefecture of residence. As with the WCC group, the majority of the population is composed of women (90%), individuals in their 30s (50%), individuals with children under twenty living in their homes (85%), non-paid homemakers (50%), and university or graduate school graduates (65%), but with no individuals having been involved in any anti-nuclear or radiation-related activism. 70% say they usually eat organic food when it is available. The entire population is from Wakayama City and includes no evacuees.

The final group, university students in Hyogo Prefecture (HUS), consists of fifty-five first, second, and third year university students attending or assisting with basic (n=37) and advanced (n=14) seminars in environmental economics at Kwansei Gakuin University's School of Policy Studies in Sanda City, Hyogo. All students are involved in a group research project on nuclear energy or general energy issues. Of fifty-two questionnaires collected on June 8, 2012 by a contact met through chain referral, only one was excluded due to incompleteness. The group is almost equal in its male (49%) and female

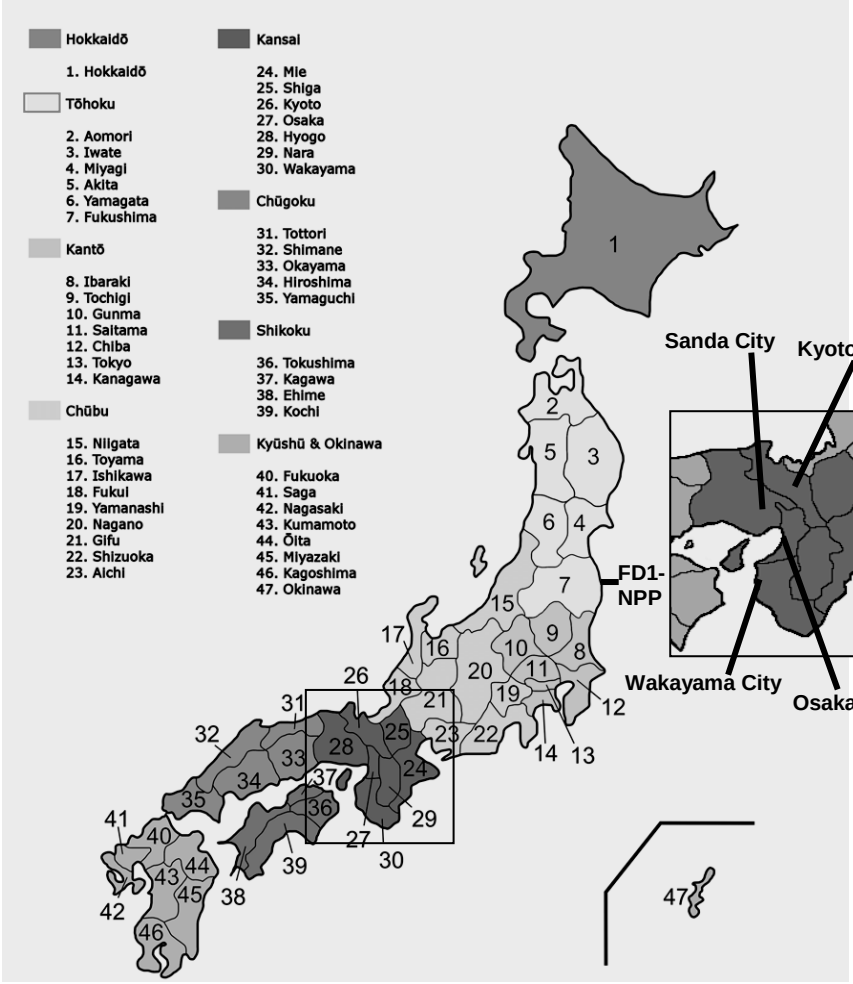

Fig. 1. Map of Japan's prefectures and regions highlighting the FD1-NPP and cities in the Kansai region referred to in the study [original maps from Regions and prefectures of Japan, (s.a.) and Japan Kinki region (s.a.)].

(51%) ratio, and the majority of respondents are between 18 and 29 years old (98%), have no children under twenty at home (74%), live in Hyogo (70%) or Osaka Prefectures (20%), and are currently students (100%). 72.5% say they usually eat organic food when it is available, and only one respondent mentioned having been involved in anti-nuclear or radiation-related activism.

3.2.2. *Analysis*

Data was analyzed with SPSS (Version 15.0) using descriptive statistics, and graphs were made using Microsoft Excel 2007. As recommended for ordinal data by Newing (2011), the median and mode were calculated for Likert scale responses (questions 1, 3, 4 and 5) to assess the central tendency and most common answers held by the various groups, and interquartile range was calculated to show the distance between the lower quartile (Q_L) at 25% and the upper quartile (Q_U) at 75% of the data. Median responses were used to compare groups within the paper. Questionnaires with missing data were included in the descriptive statistics analysis on the condition that all questions had less than 10% missing responses. Exceptions were made to include two questions with 15% missing data and one question with

20% missing data because the consistency in answers among group members meant the absence of data had no effect on median calculations. Charts containing complete sets of the above mentioned data can be found in Appendix C.

As in Miles and Frewer's (2001) study, PCA was performed on Likert scale responses in questions 1, 4 and 5 to reduce the data and examine relationships among the statements, and the Varimax rotation method was used on solutions to clarify ambiguous loadings. Missing data was dealt with using mean substitution to maximize the number of data points included. Finally, for question 2, bar charts were created based on the frequency (in percentage) of respondents per group who felt food from all Japanese prefectures were safe or unsafe/safety unknown for consumption.

4. Results

The results section is divided into five sub-sections to describe the results from questions 1 to 5 of the questionnaire.

4.1. *Concerns about and characteristics associated with radionuclide contaminated food*

Using a seven-point Likert scale (from 1 = 'completely disagree' to 7 = 'completely agree,' with 4 = 'neutral/do not disagree or agree'), respondents were asked how much they agreed or disagreed with 37 statements about concerns or characteristics related to radionuclide contaminated food. PCA was performed on the responses, but did not generate factors with explanatory power. Therefore, as done in Greiner et al. (2009), five categories were created through thematic attribution using Cronbach's alpha (score >0.7) to evaluate internal reliabilities. Two statements were not included in the final analysis because they did not fit into the themes. The final themes include: health; further contamination; future implications and coping strategies; personal vulnerability and responsibility; and action.

4.1.1. *Health*

A comparison of group median levels of agreements to seven statements related to health can be found in Figure 2. Results indicate that all groups tend to agree with five of the statements, expressing concern that children and adults can suffer health effects from internal radiation; low-doses of internal radiation can be dangerous for health; government officials do not understand the health effects of radiation exposure; and the government prioritizes the economy over peoples' health. WCC and KCC showed the highest level of concern among groups, also agreeing that internal radiation is more dangerous than external radiation, and that females have a higher health risk from radiation exposure than men.

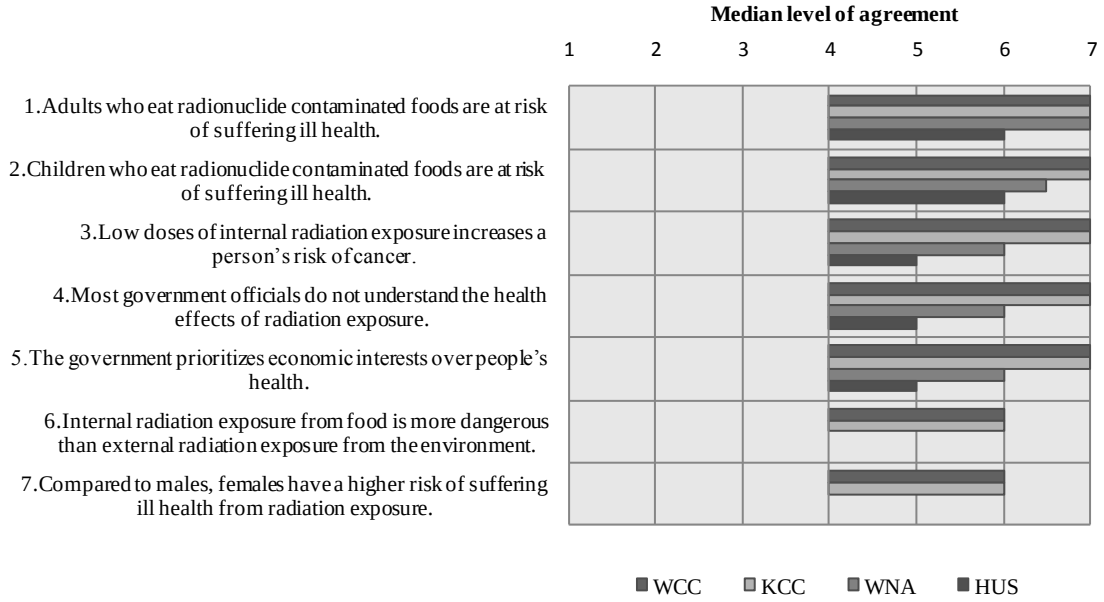

Fig. 2. Level of agreement with statements about radionuclide contamination of food related to health. Items sorted by general median level of agreement. Rating scale from 1 = 'completely disagree' to 7 = 'completely agree,' with 4 = 'neutral/do not agree or disagree.'

4.1.2. *Further contamination*

Statements in the category 'further contamination' characterize five ways in which radionuclides from the FD1-NPP or other pollutants from disaster debris could possibly further contaminate food in Japan. A comparison of median responses in Figure 3 reveals that WCC, KCC and WNA tend to think that radionuclides could further contaminate food sources through various pathways: an accident at FD1-NPP's Unit 4's spent fuel pool (SFP)—see Green Action Japan (2012) for more information; radionuclides from disaster debris, disposed of within respondents' own cities and in nearby cities; and from the FD1-NPP through environmental sources (wind, rain, river, ocean, etc.). They also tend to agree that disaster debris could not only contaminate food with radionuclides, but also with other persistent toxic pollutants such as asbestos and dioxins. HUS median scores were neutral on these issues, but disagreed with the idea that disaster debris incinerated in another city could affect food in their locality.

4.1.3. *Future implications and coping strategies*

The theme 'future implications and coping strategies' include three statements of concerns relating to the potential impact radionuclide contamination can have on the environment, future generations and Kansai's local food economy, as well as two statements about preventative measures that could be taken to cope with the risk. Figure 4 reveals that all groups tend to agree that radionuclide contamination will impact the environment and future generations, and that there is a need for coping strategies such as preventative measures by primary producers in Kansai and radiation testing in school lunches. WCC, KCC, and WNA also agree that that processing disaster debris in Kansai could result in

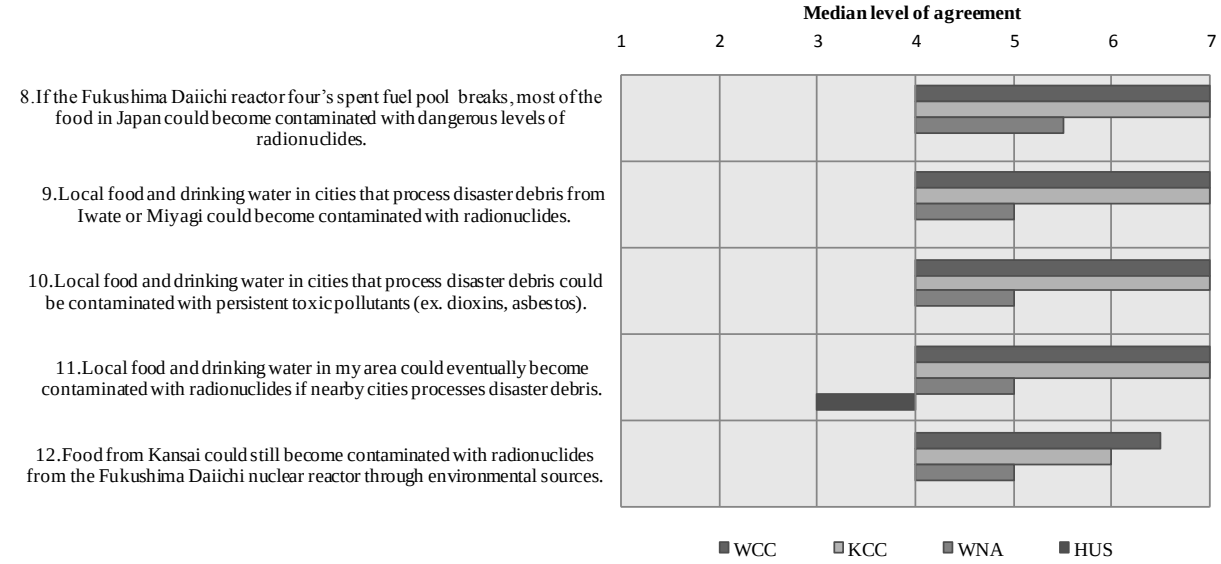

Fig.3. Level of agreement with statements about radionuclide contamination of food related to further contamination. Items sorted by general median level of agreement. Rating scale from 1 = 'completely disagree' to 7 = 'completely agree,' with 4 = 'neutral/do not agree or disagree.'

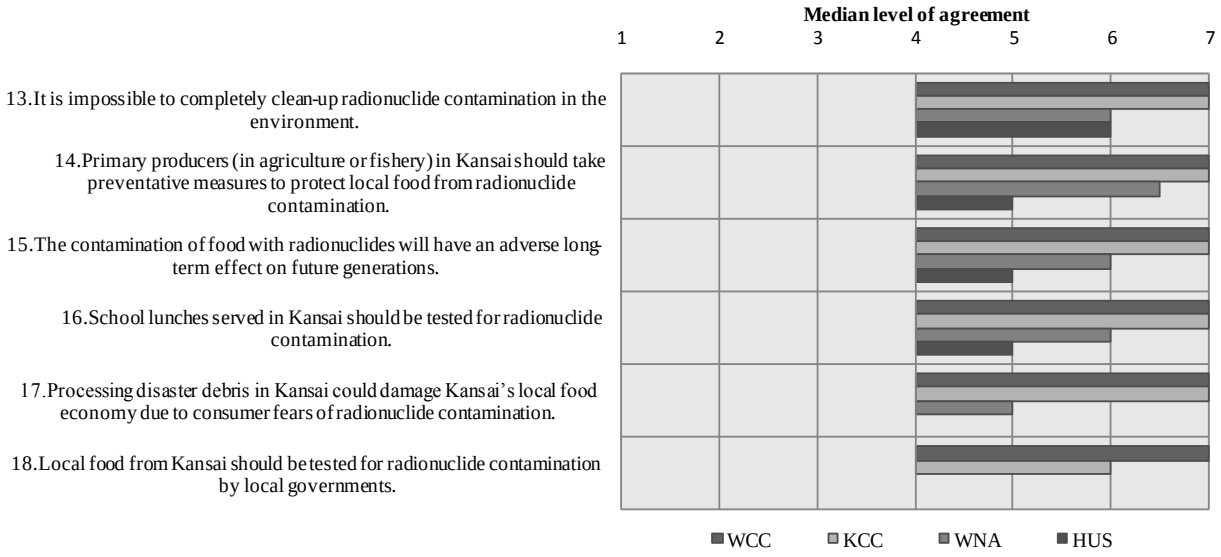

Fig. 4. Level of agreement with statements about radionuclide contamination of food related to future implications and coping strategies. Items sorted by general median level of agreement. Rating scale from 1 = 'completely disagree' to 7 = 'completely agree,' with 4 = 'neutral/do not agree or disagree.'

economic losses in the local food system. Only WCC and KCC seemed to agree that foods in Kansai should be tested for radionuclides by local governments.

4.1.4. *Vulnerability and responsibility*

'Vulnerability and responsibility' is the largest theme, made of twelve statements related to characteristics of different ways that radionuclide contaminated food could pose a risk to consumers, and perceptions on personal responsibility in handling such risks. Figure 5 illustrates that all groups tend to agree that they are personally responsible for protecting themselves and their family members from consuming radionuclide contaminated food, and that avoiding these foods takes a lot of time, money and labor. However, HUS was the only group where respondents tended to feel they were not at risk of consuming radionuclide contaminated food, which is expected to be very influential in determining their behaviors related to the risk.

WCC and KCC again tended to express the most concern of all the groups, showing distrust in the government's ability to prevent radionuclide contaminated food from reaching consumers, and agreeing that food from Tohoku, Kansai, school lunches and even organic foods in Japan could be contaminated with radionuclides. Respondents in the groups, many of which are activists involved in issues related to disaster debris and radiation issues, also tended to agree that people who spoke about radiation were viewed as strange, while WNA and HUS, who are not active in such groups, disagreed. This indicates that, according to WCC and KCC, self image is somehow linked to one's concerns about radionuclide contaminated food, and that there may be some social pressures upon those people who speak up on such risk—which individuals not active in these groups have probably not experienced.

WNA also showed concern that food from Tohoku may be contaminated with dangerous levels of radionuclides, but expressed, along with KCC and HUS, a sense of guilt from not purchasing these foods, indicating a general concern for societal wellbeing among respondents of these groups. WNA seemed to have a positive outlook that foods from Kansai are free from radionuclides, but tended to feel it is impossible to avoid the consumption of radionuclide contaminated food. A combination of these beliefs may be important influences on the group's behaviors relating to radionuclide contaminated food. Both WNA and HUS felt that imports were not safer than foods grown in Japan.

4.1.5. *Action*

The final theme refers to five statements listed in Figure 6 regarding actions respondents have taken, or think could be taken, to reduce risks associated with radionuclide contamination of food. Of the statements, all groups tended to agree that citizens must talk to their local governments about policies related to radiation and food safety. Again, WCC and KCC responses indicated the highest level of concern among the groups, changing their eating habits and how they celebrate cultural activities, and asking about the origin of food products in stores and restaurants due to their concerns about radionuclide

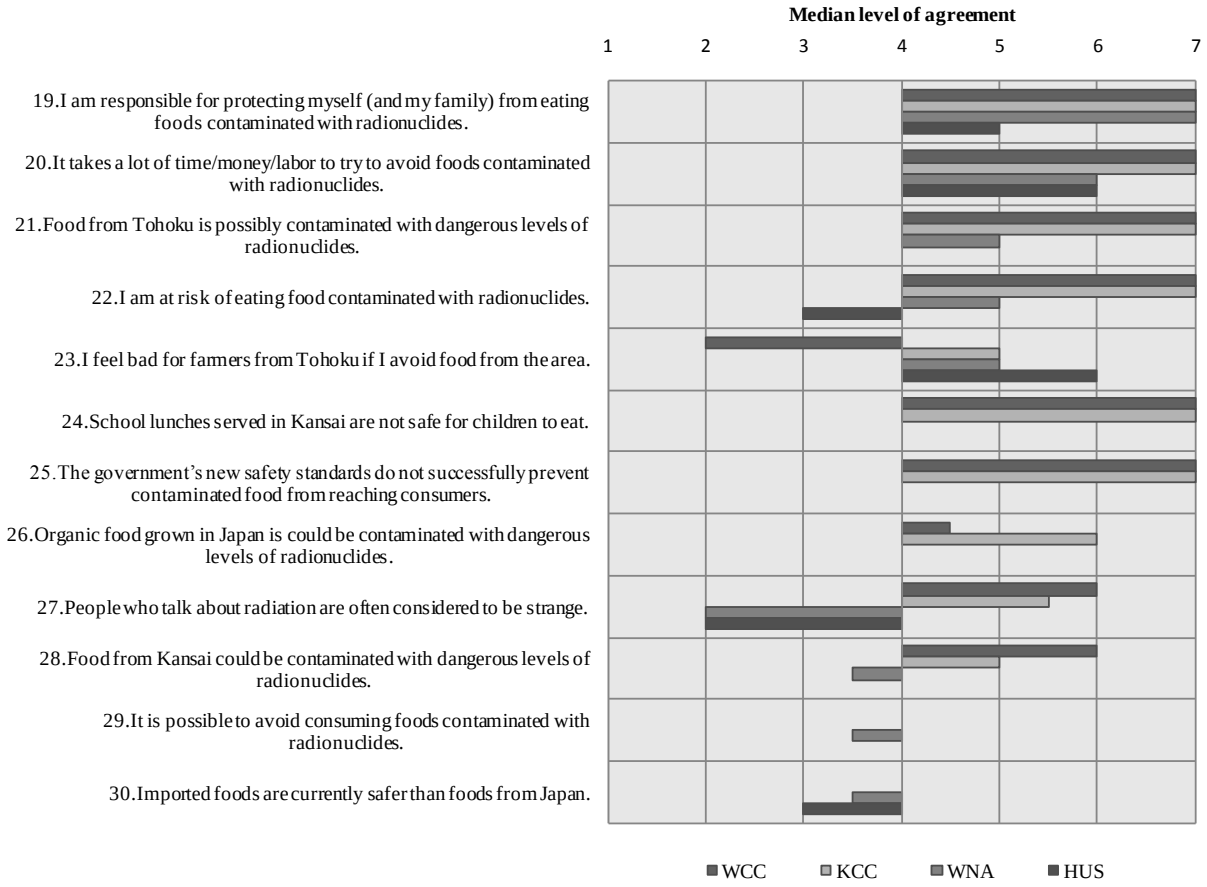

Fig. 5. Level of agreement with statements about radionuclide contamination of food related to vulnerability and responsibility. Items sorted by general median level of agreement. Rating scale from 1 = 'completely disagree' to 7 = 'completely agree,' with 4 = 'neutral/do not agree or disagree.'

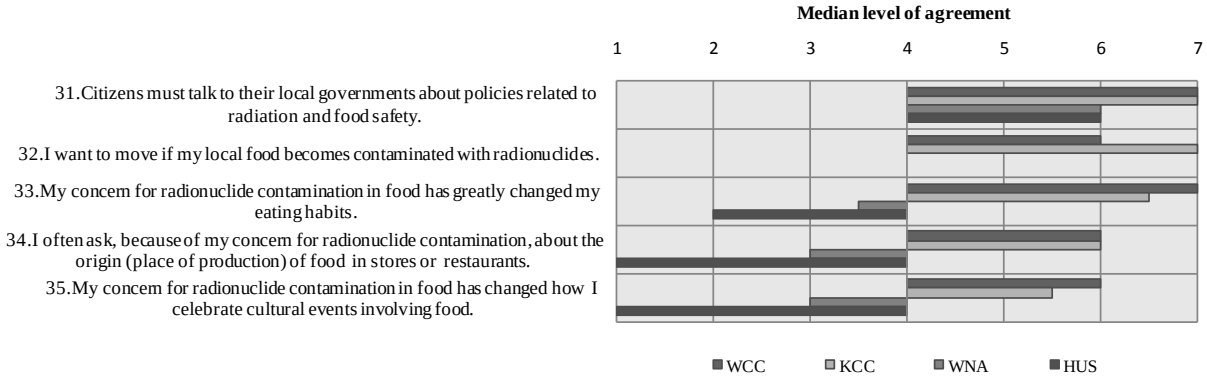

Fig. 6. Level of agreement with statements about radionuclide contamination of food related to action. Items sorted by median level of agreement. Rating scale from 1 = 'completely disagree' to 7 = 'completely agree,' with 4 = 'neutral/do not agree or disagree.'

contamination of food. They also tend to agree that they want to move if their local food becomes contaminated with radionuclides—and as 25% of WCC and 20% of KCC are evacuees from north-eastern Japan, some of them already have. Another example of an individual response, mentioned by WCC and KCC respondents and other activists, is a trend in which parents have begun removing their children from school lunch programs due to concerns about radionuclide contamination of food (personal communication, April 10, 2012; May 27, 2012; June 4, 2012; and July, 5 2012). Most parents who did this mention a social pressure against such actions, as principals asked them and their children to tell others that they are eating home lunch due to allergies so not to cause panic. Responses from WNA and HUS, on the other hand, show an opposite trend, indicating group members have not made changes in their consumption or purchasing habits due to concerns about radionuclide contamination of food.

4.2. *Prefectures that produce foods 'safe' for consumption*

Question 2 asked respondents to specify which prefectures in Japan they *believe* produce foods that are generally safe for consumption. Results in Figure 7 indicate a general belief that foods produced in south-western Japan are safer than those from north-eastern and central Japan. All groups had generally low safety ratings for Tohoku and Kanto, which increased a little in Chubu (though not much for WCC) and then reached a safety rating above 50% somewhere in Kansai. The only prefecture in north-eastern Japan receiving more than 50% safety rating (from both WNA and HUS) was Hokkaido. No respondents from WCC, KCC or WNA, and few from HUS felt foods from Iwate, Miyagi, Fukushima or Ibaraki were safe for consumption, and WNA was the only group with a safety rating of 100%, given to the respondents' prefecture of residence, Wakayama. It is interesting to point out that there are some cases in which bordering prefectures (such as Fukui Prefecture in the case of KCC) were not considered to be safe, even though foods within the prefecture of residence were. In addition, some members of WCC and KCC checked no prefectures on the questionnaire, leaving a comment that they felt there was no safe food in Japan. Within the WCC group, safety ratings seemed to drop in some south-western prefectures in the Shikoku and Kyushu regions, while most other groups had strong safety ratings in these areas. The only exception was a fall in safety ratings for Fukuoka seen in both WCC and KCC responses which some members of WCC attributed to the prefecture's decision to test burn disaster debris in late May, 2012, just around the time that the questionnaires were administered (personal communication, June 4, 2012).

4.1. *Changes in consumption due to concerns about radionuclide contamination*

Question 3 asks respondents to specify on a five-point Likert scale (from 1 = 'strongly reduced consumption' to 5 = 'strongly increased consumption,' with 3 = 'no change in consumption/do not consume') how much their consumption of certain food products have changed due to concerns about

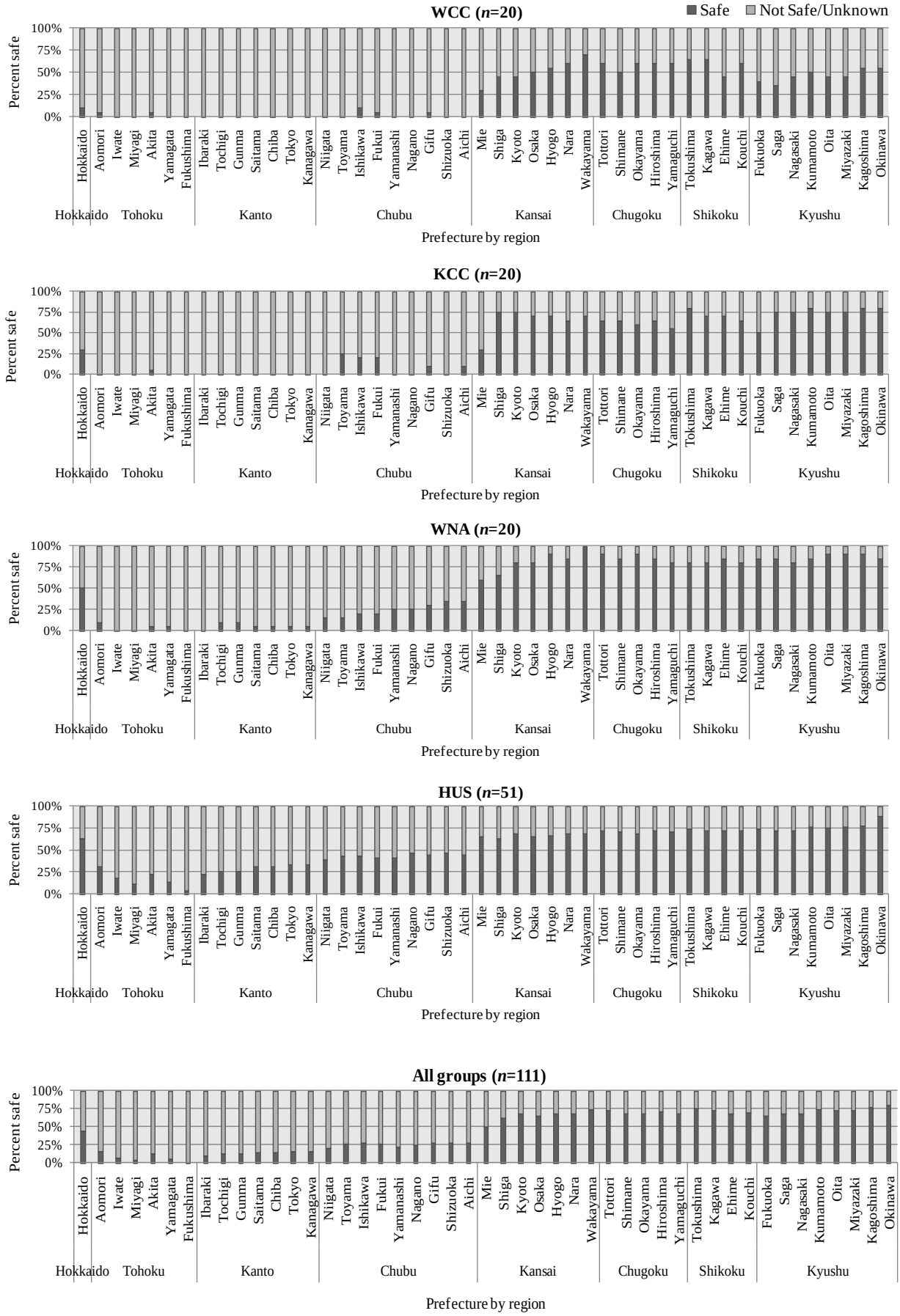

Fig. 7. Comparison of group perceptions on the safety of food from Japanese prefectures (in percentages).

radionuclide contamination. A median comparison in Figure 8 indicates that WCC and KCC made many changes to their diets and eating habits due to concerns about radionuclide contaminated food (decreasing their consumption of foods they feel are unsafe—Japanese mushrooms, seafood, fresh water fish, green tea, beef, and dairy products; foods from Hokkaido, Tohoku, Kanto and Chubu; foods prepared outside of the home; and processed foods—and increasing their consumption of foods they feel are safe—imported foods; and foods from Kansai, Shikoku, Chugoku and Kyushu). Respondents in these groups commented on how difficult it is to change their eating habits and that it has affected their social lives (for example, not eating out), and forced them to give up foods that are culturally important and that they really enjoy eating (many complained that they really miss fish and sushi) (personal communication, June 4, 2012 and May 27, 2012).

Comparatively, WNA made one change (a decrease in consumption of foods from north-eastern Japan) and HUS made none. No median change in consumption were found for tobacco, vitamins and supplements, brown rice, filtered water or bottled water. No changes in filtered or bottled water could be attributed to the fact that all respondents tend to perceive that the food from their prefecture of residence is safe and, therefore, may perceive the same about their water sources.

4.2. *Trust in information sources reporting on radionuclide contamination of food*

Question 4 asks respondents to rank how much they trust specific information sources about their information on radionuclide contamination of food and drinking water (referred to as food in the paper).

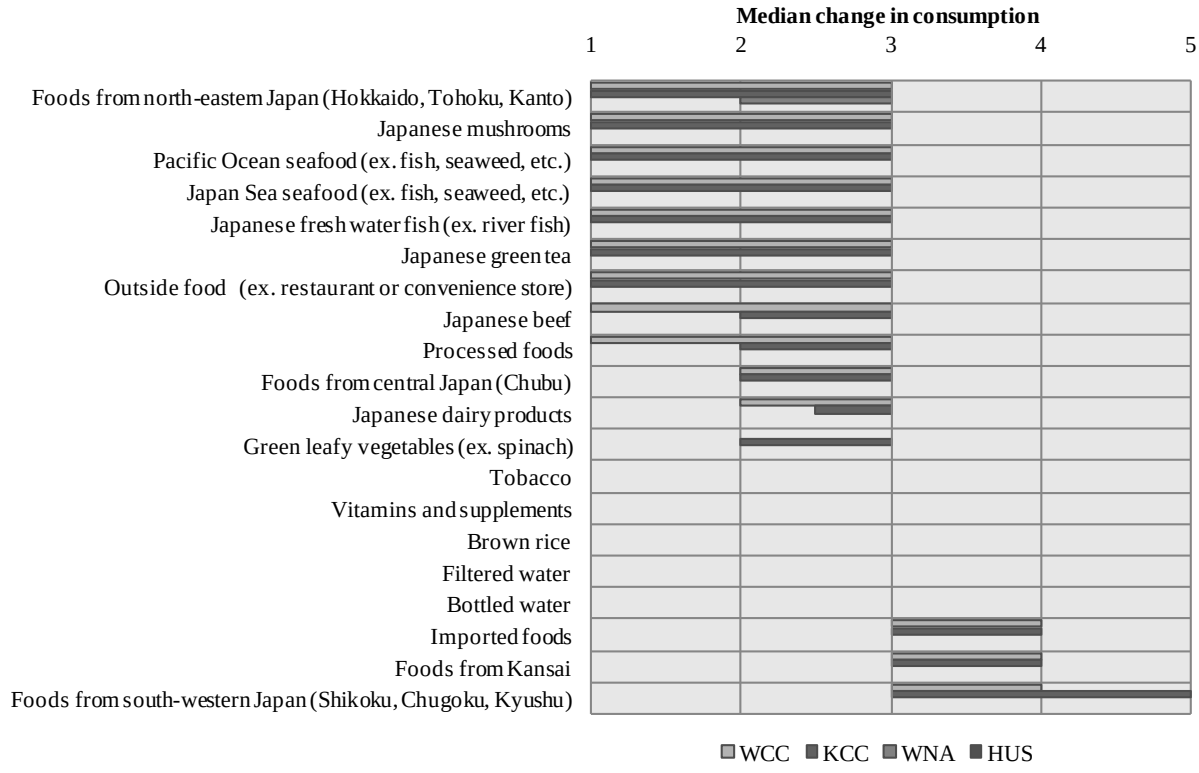

Fig. 8. Changes in consumption of various foods due to concerns about radionuclide contamination. Items sorted by median level of agreement. Rating scale from 1 = 'greatly reduced' to 5 = 'greatly increased,' with 3 = 'no change/do not consume.'

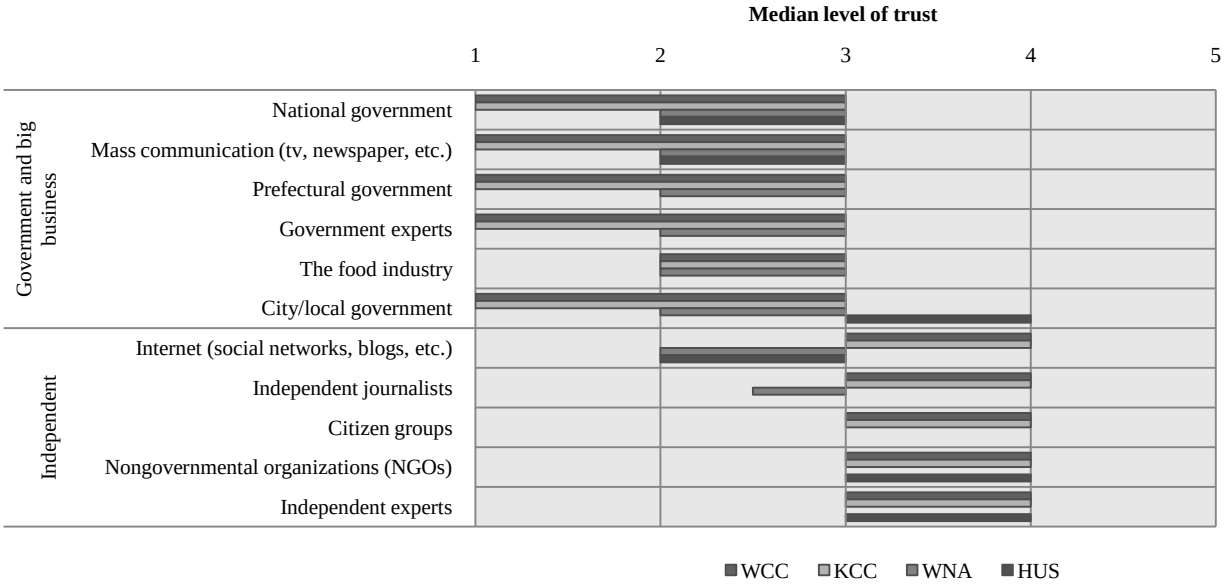

Fig. 9. Trust in information sources reporting on radiation contamination of food. Items sorted by median level of trust (lowest to highest) for each information group. Rating scale from 1 = 'no trust' to 5= 'high trust,' with 3 = 'indifferent.'

PCA was performed on results, and two information source groups were produced. Median amount of trust for sources within these groups are compared in Figure 9. Results show that all respondent groups tend to lack trust in the national government and mass communication, and there is a general lack of trust in government and big business contrasted with a general trust in independent sources. WCC and KCC follow this trend in all cases. WNA follows it concerning government and big business, but tends to be less sure about the trustworthiness of independent sources, indicating a lack of trust in the internet and independent journalists. HUS tends to trust information from the city/local government, NGOs and independent experts, but also shows a lack of trust the internet as an information source.

4.3. *Trust in groups who could ensure food contains safe levels of radionuclides*

In question 5, respondents were asked how much they trust selected groups to ensure their food contains safe levels of radionuclides. As in question 4, PCA was performed, producing three groups of actors. The median level of trust held by respondents is compared within these groups in Figure 10. Median levels indicate that all groups distrust the national government to ensure their food contains safe levels of radionuclides. WCC and KCC have similar views, distrusting all government and food business actors, and trusting only citizens groups and themselves to ensure their food contains safe levels of radionuclides. However, according to discussions with some KCC and WCC respondents, their actual level of trust depends on the group (i.e. they do not trust all sales points, but do trust some), mentioning some food cooperatives that test for radionuclides and local farmer groups which they do trust (personal communication, May 27, 2012 and June 4, 2012). Both groups also mentioned their weariness in purchasing foods form shops or companies they do not fully trust, since there have been incidents of

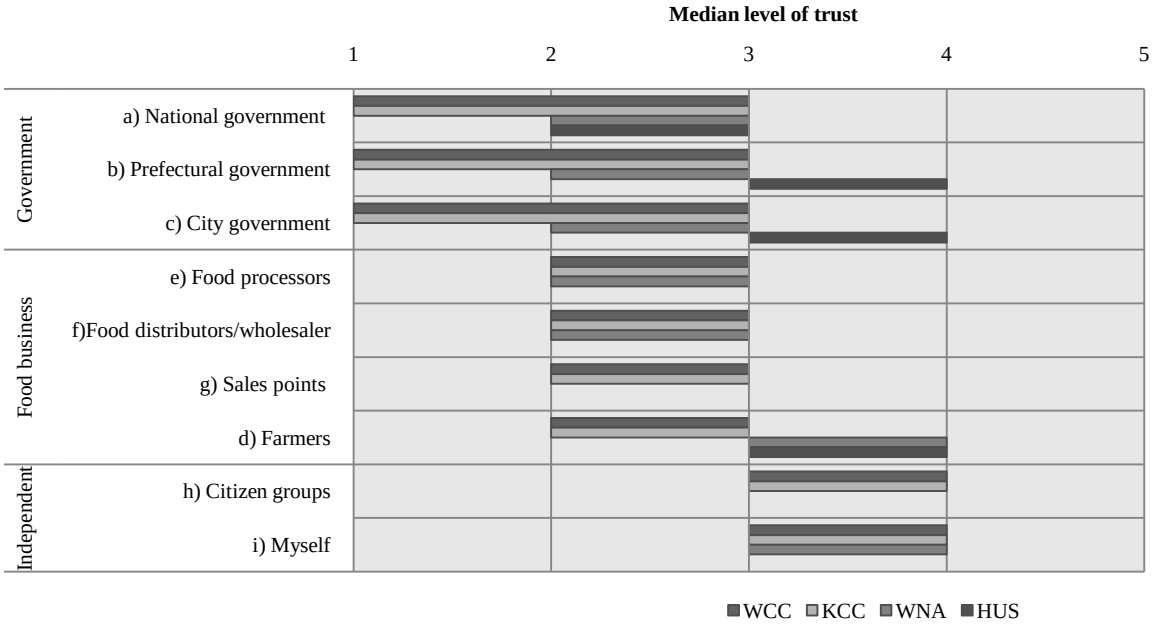

Fig. 10. Trust in groups who could ensure food contains safe levels of radionuclides. Items sorted by median level of trust (lowest to highest) for each actor group. Rating scale from 1 = 'no trust' to 5= 'high trust,' with 3 = indifferent.'

intentional mislabeling. For example, cucumbers produced in Fukushima were labeled by a distribution company as produced in Hokkaido (MSN, 2012); beef sold in Osaka was allegedly labeled by the butcher shop as coming from Hokkaido or Kagoshima (Kyodo, 2012); and rice from Fukushima was sold by a wholesaler as rice from Nagano (NHK, 2012b). WNA respondents also show a lack of trust in government and some food business actors, but specify trust in farmers and themselves to ensure there are safe levels of radionuclides in their foods. HUS is the only group that shows trust in the government (prefectural and city). They also tend to trust farmers, but are neutral toward all other actors.

5. Discussion

5.1. *Consumer profiles and comparisons*

The results of this study indicate three consumer profiles present in the Kansai area following the FD1-NPP disasters: the 'active concerned consumer,' the 'passive concerned consumer,' and the 'young consumer.' The active concerned consumer is characterized by both the WCC and KCC groups. These consumers are mostly women with children living in their homes whose concerns about radionuclide contaminated food relate to health and human illness, the environment, future generations, the economy, societal wellbeing and self image. They tend to be university educated and to choose organic foods when they are available. They are also concerned about the threats posed to the food system from further dispersion (accidental and intentional) of radionuclides into the environment, and believe that measures and should be taken to prevent and counter this. This group feels vulnerable to consuming radionuclide

contaminated food and responsible for protecting themselves and their family from this risk, even though they feel society may think they are strange in the process. They are active in changing their eating habits, changing how they celebrate cultural events, learning more about where their food comes from, and taking political action due to their concerns. These consumers tend to trust only in independent sources to provide them with information on radionuclide contamination of food and to ensure that their food contains safe levels of radionuclides.

The passive concerned consumer, characterized by the WNA group, is also made of mostly women with children in their homes whom tend to be university educated and to consume organic products when available. They share many of the concerns and feelings of vulnerability and responsibility of the active concerned group concerning the risk of radionuclide contamination of food; however, they do not take much action to reduce perceived risks aside from making an effort to avoid some foods produced in north-eastern Japan. They have a sense that food from their prefecture and region are safe and uncontaminated with dangerous levels of radionuclides. These consumers tend not to trust in information from the government and big business, but do not seem to be sure about which sources of information can be trusted. They would trust themselves and farmers to ensure that foods contain safe levels of radionuclides.

The young consumer group is made of young male and female university students, most without children living in their homes, who tend to consume organic foods when available. This group is also concerned about radionuclide contaminated food and the potential negative impacts radionuclides they can have health and human illness, the environment and future generations, and see a need for some preventative measures and countermeasures in the Kansai area. While they feel responsible for protecting themselves from risks associated with consuming radionuclide contaminated food, they tend not to feel personally vulnerable to these risks and to take no actions to avert consequences associated with them. This group tends to trust both government (city and local level) and independent (NGOs and independent experts) information sources, and government (prefectural and city), food business (farmers) and independent (themselves) actors to ensure that food contains safe levels of radionuclides.

A table comparing these consumer profiles can be found in Appendix D. An interesting comparison is that all groups show a tendency to consume organic foods when possible, which could indicate they share a general interest in food quality and safety that goes beyond radionuclide contaminated food. Among the groups, active and passive concerned consumers share the most similarities, most likely influenced by the presence of children in their homes. Mothers in the active concerned consumer profile constantly mention their children as the main reason they are so concerned about food safety (personal communication, May 27, 2012 and June 4, 2012). The names of anti-disaster debris groups encountered during the study—*kodomonomirai to hibakushya wo kangaerukai* (‘Think about the Future of Children and Radiation Exposure’) and *kodomo to mirai wo mamoru* (‘Protect Children and the Future’)—also reflect this sentiment. Holm and Kildevang’s (1996) qualitative interview

study on consumer views of food quality had similar findings in which parents admitted uneasy feelings about the possible long term effects some foods could have on children's health.

On the other hand, the major difference among groups is the amount of action they take to reduce their risk in consuming radionuclide contaminated food. There are bound to be many reasons why both the passive concerned consumers and young consumers do not to take action. Results reveal it may stem from perceptions that avoiding radionuclide contaminated food takes a lot of time, money and labor; these foods are not possible to avoid (passive concerned consumers); or that respondents are not at risk of consuming these foods (young consumers). In addition, 100% of the passive concerned consumer group indicated a belief that food within their prefecture of residence is safe for consumption, and tended to agree that food from Kansai is free from radionuclide contamination. In discussions with active concerned consumers, some admitted that they "want to believe food here is safe," a sentiment which may be shared by respondents in the other two groups (personal communication, June 4, 2012). All of this may point to a type of 'optimistic bias' (Miles and Scaife, 2003) among some consumers in which the they may not feel they need to take much action to avert the risk of consuming radionuclide contaminated food because they perceive themselves to be less at risk, or even immune, to the hazard.

Whatever the reason preventing consumers from taking action, it is important to realize that this lack of inaction does not necessarily indicate a lack of concern. When concerned citizens speak up about their apprehensions related to disaster debris and radionuclide contaminated food, the government often refers to an opposing 'silent majority' that is in favor of the government's views and policies (Mainichi Japan, 2012). However, the results from this study may indicate the opposite: just because people do not act out politically on the issue of radionuclide contamination of food, it does not necessarily indicate they are not concerned.

5.2. *Individual and collective responses to 'system oriented' distrust*

A major finding in the study is that all groups express distrust in the national government as an information source and actor to ensure foods contain safe levels of radionuclides. Frewer et al. (1996 p. 484) describes trust as being linked with "perceptions of accuracy, knowledge and concern" and distrust with "perceptions of deliberate distortion of the information by the source, and a history of providing erroneous information." This definition fits well with the current study as all groups share concerns that consuming radionuclides is a risk to health, but feel the government lacks understanding of these health effects and prioritizes economic interests over the health of citizens, possibly leading to perceptions of inaccuracies or biases in their opinions. The study's results also suggest that the distrust experienced by respondents is food 'system oriented' (Kjaernes and Dulsrud, 1998 cited in Hansen et al., 2003) which can explain why many of the concerned consumers were driven toward individual and collective responses to cope with the food safety risks they perceive.

Individual responses by active concerned consumers include changing diets and eating habits (including altering how cultural events involving food are celebrated) and avoiding certain food products from areas they do not view as safe (prefectures in north-eastern and central Japan), while increasing consumption of foods they feel are safe (prefectures in south-western Japan). Figure 11 illustrates that the prefectures in which more than 50% or the total population felt produced food safe for consumption (Section 4.2) do not include any which were estimated to have elevated levels of Cs-134 and Cs-137 in soil or air, or prefectures where food testing is currently taking place. In addition, they include only one prefecture where disaster debris is currently being processed (Fukuoka, which began its full scale processing in September, 2012, after the questionnaires were administered). Active concerned consumers seem to be generally aware of this information; however, these results indicate that it is possible that consumers from all groups use such information to formulate their perceptions about food safety. Taking action to avoid foods, however, presents its problems and frustrations for the active concerned group. Some revealed their frustrations with their own perceptions and behaviors, expressing that they know some prefectures only have a little bit of fallout, but feel the need to avoid all foodstuffs from the prefecture because there is no way to know specifically where products come from (personal communication, April 10, 2012 and May 27, 2012).

The active concerned consumers' behaviors in reducing their consumption of certain foods (for example, Japanese mushrooms, seafood, fresh water fish, green tea, processed food, beef, dairy products and green leafy vegetables) also align in many ways with food monitoring results for radionuclides found in Appendix A. As all consumer groups in the study tend to feel it is their responsibility to protect themselves and their family members from consuming radionuclide contaminated food, individual actions seem to be able to give consumers a sense of control over their own food safety, and even though these actions are thought to take a lot of time, money and labor, allows them to create diets and eating habits that align with their values and give them a sense of *anzen*. In Wakayama City, securing radiation testing for school lunches—which all consumer groups in the study tended to agree was important—has not developed into collective action as it has in other parts of Japan, potentially due to social pressure and the fact that it is possible to remedy the situation individually by preparing home lunches for children using foods parents perceive to be safe. Therefore, in the context of this study, the ability of consumers to feel a sense of *anzen* through individual action seems to be dependent on their perceptions that safe food alternatives exist.

In this regard, results reveal that collective action seems to be driven by a perception that these 'safe' food alternatives are at risk of contamination. Within the study, the project of 'wide-area disposal' of disaster debris stands out as a major driving force for such collective action within the active consumer group. Both active and passive concerned consumers in the study tend to make a direct link between the processing of disaster debris and food safety, agreeing that foods within and near the processing-city

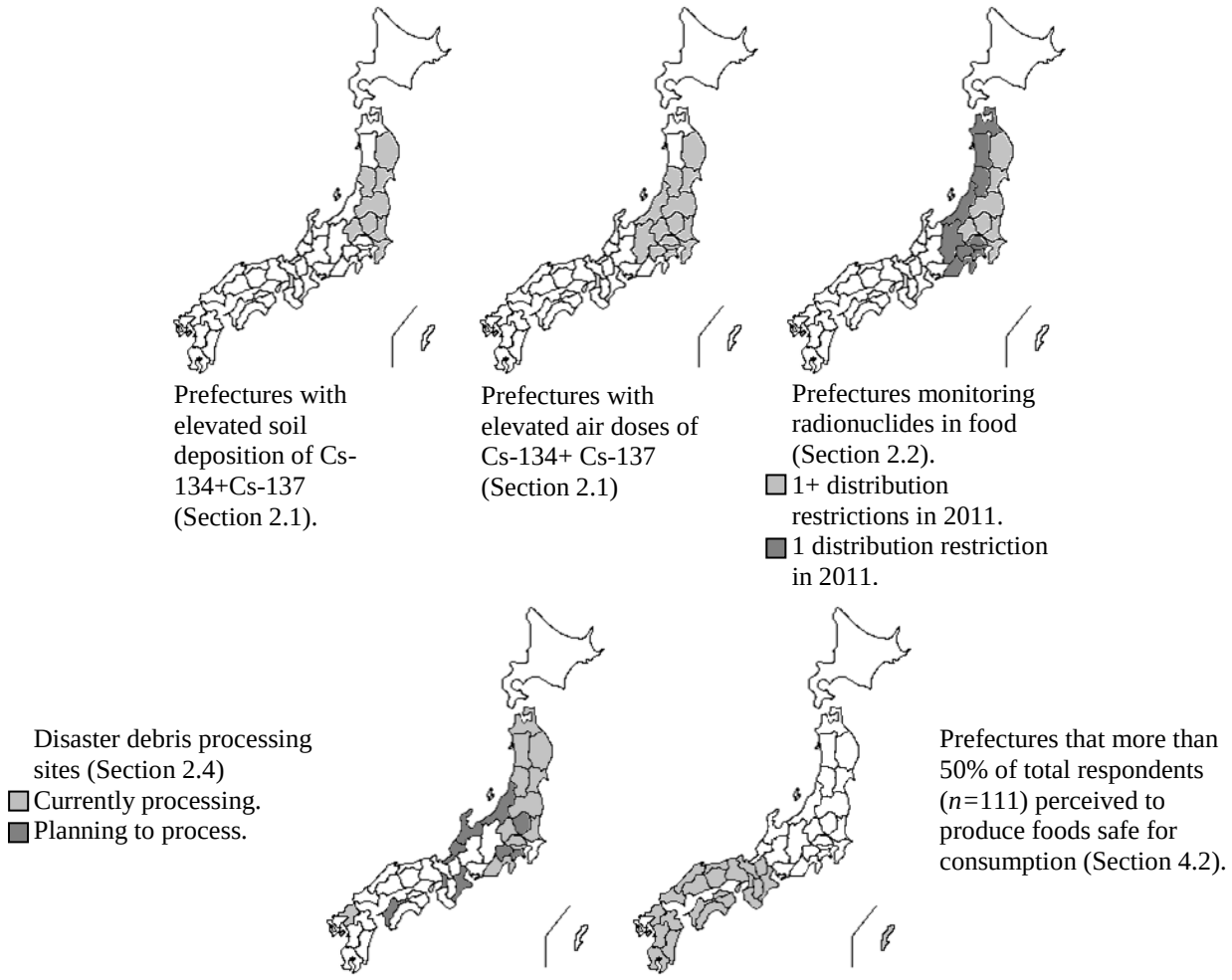

Fig. 11. A comparison of consumer perceptions on the location of safe food in Japan (by prefecture) with soil and air contamination estimates, food monitoring locations, and disaster debris processing sites [original map from Wakayama (prefecture) (s.a.)].

could possibly become polluted with radionuclides or other persistent toxic pollutants. Research on opposition to the storage of radioactive soil helps to explain some of the logic behind the collective response to the disaster debris project in Kansai: it is an imported and technologically-natured hazard; the government can be held responsible; it involves an involuntary risk; the risk is represented visibly (the piles of debris, the incinerator, the landfill); and the risk can be completely eliminated if processing is prevented (Sandman et al., 1987 cited in Slovic, 2012 p.70). Some of the active concerned consumers that are members of anti-disaster debris groups mention these frustrations, explaining that they see it as a preventable risk being forced upon them by a government that is not perceptive to their concerns (personal communication, May 27, 2012 and June 4, 2012). The disaster debris processing sites in Figure 11 illustrate how this perceived risk is moving into prefectures believed to produce safe foods such as Osaka, Mie and Ehime prefectures. Results and personal conversations reveal that active concerned consumers are worried about the permanent contamination of foods they currently view as safe and that they will no longer be able to choose foods in a way that give them a sense of *anzen* (personal communication, May 27, 2012 and June 4, 2012). These findings are consistent with results from studies

involving technological food hazards such as genetically modified (GM) foods in which consumers feared the "inevitable and irreversible permeation of food markets with GM products" would lead to a loss of consumer choice (Grove-White et al., 1997 cited in Hansen et al., 2003 p.118). The risk of losing their right to choose 'safe' food seems to be a prevalent concern among active concerned consumers, and therefore, the fight against disaster debris is likely to remain an active collective issue until consumers' underlying concerns are addressed by the government or other actors in the food system.

5.3. *Opportunities for food system stakeholders*

In the context of the current study, consumer concerns associated with radionuclide contaminated food relate to health and human illness, the environment, future generations, the economy, societal wellbeing and self image. These results are consistent with finding by Miles and Frewer (2011) which indicate that consumer concerns about food hazards are complex and multidimensional, relating to concerns beyond health, and as such, need to be understood and included in risk communication on the topic. In Japan, it seems that the national government is overlooking some of these underlying concerns, trying to pacify consumer anxieties about the risk of radionuclide contamination of food by combating against them, using scientific explanation and guilt as ammunition. For example, in its projects to end 'harmful rumors,' the government implies that consumer concerns about the risks posed from consuming radionuclide contaminated food are inaccurate or misinformation, and that they are hurting their fellow citizens by feeling this way. Such guilt touches upon consumer concerns for societal wellbeing, which was expressed by members from all consumer profiles. To deal with consumers' 'inaccurate' risk perceptions, the national government hopes to educate citizens on the logic of their food safety regulations, targeting the mothers of young children in their project. Results from the current study help to explain the logic of the government's choice, as women with children living in their homes is the demographic that showed the most concern toward the risk of radionuclide contaminated food. Such an approach is reminiscent to the knowledge deficit model (Hansen et al., 2003; Hilgartner, S., 1990) in which the government of Japan feels the need to educate the 'ignorant' public about 'facts' relating to the risk of radionuclide contaminated food, without addressing the underlying concerns they hold.

Contrary to the view that consumers are ignorant on topics related to radiation, observations reveal that many of the active concerned consumers in the study put a lot of effort into studying on their own and attending study sessions and workshops with scientists, professors and other professionals to educate themselves on the technical aspects of the topic. In fact, it appears that consumers within the study may see the government as suffering from a 'knowledge deficit,' as all consumer groups tend to believe that the government itself lacks knowledge on the health effects of radiation exposure. In the case of active concerned consumers, this result may arise from the fact that many of them believe in a different scientific model on the health effects of radiation exposure from that which the government bases its calculations on—those of the International Commission on Radiological Protection (ICRP) (personal

communication, May 27, 2012 and June 4, 2012). In fact, many of these consumers question the ICRP's calculations on internal exposure, believing more in arguments made by the European Committee on Radiation Risk (ECRR) which considers internal exposure to pose a higher risk to health (ECRR, 2010).

Distrust in the food system accompanied with strong discrepancies in fundamental beliefs and values between the government and consumers in the study indicates an opportunity for new stakeholders to step in to provide information and services that can help to restore consumer trust in the food system and help them to regain a sense of *anzen* in their food choices. Results show that all consumers are looking for information sources and food system actors that care about their health and wellbeing over economic benefit. As for trust in actors ensuring foods contain safe levels of radionuclides, most trust tends to be put into food system stakeholders that are closest in proximity to consumers (city or prefectural governments; citizens groups; consumers themselves), or closest in proximity to food sources (farmers). This could reveal consumer desires for 'relational trust' based on direct interactions with food systems actors (Kjaernes and Dulsrud, 1998 cited in Hansen et al., 2003 p. 119), mentioned by some respondents in the active concerned consumer group as one of the only things that makes them feel a sense of *anzen* in their food choices (personal communication, May 27, 2012). Results from this study indicate that there may be many opportunities for stakeholders in Kansai to step into these roles as there is a general concern among consumers, and a great need for trustworthy representatives within the current food system.

6. Conclusion

This paper presents the results of an exploratory study using data from a survey of consumers in the Kansai region of Japan. The study resulted in the identification of three consumer profiles present in the region in the aftermath of the FD1-NPP disasters: the active concerned consumer, the passive concerned consumer, and the young consumer. Consumer concerns associated with the risk of radionuclide contaminated food were found to be complex and related to health and human illness, the environment, future generations, the economy, societal wellbeing and self image. While all groups showed concern related to radionuclide contamination of food, the most concerned groups were composed mostly of women with children living in their homes. Results reveal that all groups tend to lack trust in the national government as an information source and actor to ensure food contains safe levels of radionuclides, which is expected to open opportunities for independent sources and other food system actors, whom understand consumer concerns, to step into these positions. Of all the groups, the active concerned consumers were the most proactive in changing eating habits in order to consume foods they perceive to be safe. Additionally, the issue of nation-wide disaster debris disposal stands out as a major threat to food safety in the minds of the active and passive concerned citizens, provoking a collective political response from many of the active concerned consumers who feel it will remove their ability to choose 'safe' foods.

Ultimately, the study reveals some of the implications the FD1-NPP disasters have had on the perceptions and behaviors of consumers living more than 600km from the disaster site. “The agricultural system is an open system, interacting with nature and with society,” and sustainable agroecosystems are created and maintained when humans are able to see themselves as an integral part of the system (Francis et al., 2003 p. 6). The transboundary nature of nuclear fallout transport means that radionuclides can impact ecosystems and agroecosystems far from the source of the disaster, threatening the health of food systems, the livelihoods of food system stakeholders, and consumer perceptions and behaviors at local, national and even global scales for hundreds or thousands of years. Therefore, while it is important for stakeholders in Kansai and greater Japan to take action in mending the breaks in the current food system, it is also recommended that they try to recognize and work toward addressing the underlying causes of such problems (in this case, the safety of nuclear power plants and other radiation sources, and their potential effects on agriculture and food systems) if they hope to prevent similar or worse damage from occurring in the future.

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Appendix A: Background and context

Table A1
Information on radionuclides often referred to in food safety.

Radionuclide	Approximate physical half life	Approximate physical hazardous life	Main type of emission	Element mimicked	Human organ most affected	Source
Cs-134	2 years	20-40 years	Beta (β), Gamma (γ)	K	Whole body	ATSDR, 2010; CDC, 2004
Cs-137	30 years	300-600 years	β, γ	K	Whole body	ATSDR, 2010; CDC, 2004
I-131	8 days	80-160 days	β, γ	I	Thyroid	ATSDR, 2010
Sr-90	28 years	280-560 years	β	Ca	Bone	ATSDR, 2010
Pu-239	24,400 years	244,000-488,000 years	Alpha (α)	Fe	Lung, bone, liver, spleen	CDC, 2005; Kosman, 2011

Table A2
Japanese provisional and new safety levels for radioiodines and radiocesiums in food following the FD1-NPP disasters (measured in Bq/kg or Bq/l).

	Provisional food safety levels[a] (from March 17, 2011)		New food safety levels[b] (as of April 1, 2012)
Food category	I-131	Cs-134 + Cs-137[c]	Cs-134 + Cs-137[d]
Drinking water	300 (100 for infants)	200	10
Milk, dairy products	300 (100 for infants)	200	50
Vegetables	2,000 (excluding root vegetables and tubers)	200	100 (reffered to as 'general foods')
Grains	n/a	500	
Meat, eggs, seafood and other foodstuffs	n/a	500	
Seafood	2,000 (from April 5, 2011)	500	

[a] FSCJ, 2011

[b] MHLW, 2012a

[c] These values take into account radioactive strontium.

[d] These values take into account radioactive strontium and plutonium.

Table A3
Example of radiation monitoring results for selected Japanese food and agriculture products.

Sample date	Category	Food item	Region	Prefecture	Isotope	Activity	Source
2011.7.11	Beef	Beef	Tohoku	Fukushima	Cs-134+137	3240 Bq/kg	MHLW, 2012d
2011.7.27	Beef	Beef[a]	Chubu	Shizuoka	Cs-134+137	329 Bq/kg	MHLW, 2012c
2011.8.19	Beef	Beef	Tohoku	Akita	Cs-134+137	226 Bq/kg	MHLW, 2012d
2011.9.15	Beef	Beef[a]	Tohoku	Miyagi	Cs-134+137	1349 Bq/kg	MHLW, 2012c
2012.8.20	Beef	Beef	Kanto	Tochigi	Cs-134+137	130 Bq/kg	MHLW, 2012f
2011.3.18	Green vegetable	Spinach	Kanto	Ibaraki	I-131	54100 Bq/kg	MHLW, 2012d
					Cs-134+137	1931 Bq/kg	MHLW, 2012d
2011.3.21	Green vegetable	Kukitachina (Brassica leafy vegetable)	Tohoku	Fukushima	I-131	15000 Bq/kg	MHLW, 2012d
					Cs-134+137	82000 Bq/kg	MHLW, 2012d
2011.3.19	Milk/dairy	Cattle milk	Tohoku	Fukushima	I-131	5200 Bq/l	MHLW, 2012d
					Cs-134+137	420 Bq/l	MHLW, 2012d
2012.5.30	Mushroom	Dried shiitake (log-grown) *(Lentinula edodes)*	Tohoku	Iwate	Cs-134+137	1200 Bq/kg	MHLW, 2012e
2012.8.3	Mushroom	Tawny milk cap mushroom *(Pholiota lubrica)*	Kanto	Tochigi	Cs-134+137	31000 Bq/kg	Tochigi Prefecture, 2012
2011.11.15	Rice	Brown rice	Tohoku	Fukushima	Cs-134+137	630 Bq/kg	MHLW, 2012d
2011.11.15	Rice	Milled (white) rice	Tohoku	Fukushima	Cs-134+137	300 Bq/kg	MHLW, 2012d
2011.5.26	River fish	Ayu Sweetfish (*Plecoglossus altivelis*)	Tohoku	Fukushima	Cs-134+137	2900 Bq/kg	MHLW, 2012d
2011.4.1	Seafood	Japanese sandlance *(Ammodytes personatus)*	Kanto	Ibaraki	I-131	4080 Bq/kg	MHLW, 2012d
					Cs-134+137	447 Bq/kg	MHLW, 2012d
2011.5.21	Seafood	Hijiki seaweed *(Sargassum fusiformis)*	Tohoku	Fukushima	I-131	1500 Bq/kg	MHLW, 2012d
					Cs-134+137	1100 Bq/kg	MHLW, 2012d
2012.5.21	Seafood	Japanese Seabass *(Lateolabrax japonicus)*	Tohoku	Miyagi	Cs-134+137	340 Bq/kg	MHLW, 2012e
2012.8.1	Seafood	Greenling (species unknown)	Tohoku	Fukushima	Cs-134+137	25800 Bq/kg	TEPCO, 2012
2011.11.17	Soybean	Soybean	Tohoku	Miyagi	Cs-134+137	240 Bq/kg	MHLW, 2012d
2011.11.7	Soybean	Soybean	Kanto	Gunma	Cs-134+137	111Bq/kg	MHLW, 2012d
2011.5.11	Tea	Raw tea leaf	Kanto	Kanagawa	Cs-134+137	780 Bq/kg	MHLW, 2012d
2011.5.12	Tea	Dried tea leaf	Kanto	Kanagawa	Cs-134+137	3000 Bq/kg	MHLW, 2012d
2011.6.9	Tea	Processed tea	Chubu	Shizuoka	Cs-134+137	679 Bq/kg	MHLW, 2012d
2011.6.15	Tea	Raw tea leaf	Kanto	Tokyo	Cs-134+137	1700 Bq/kg	MHLW, 2012d
2012.5.18	Tea	Tea (drink)	Kanto	Ibaraki	Cs-134+137	13 Bq/l	MHLW, 2012e
2011.9.6	Tobacco	Yellow tobacco leaf (dried)	Kanto	Tochigi	Cs-134+137	217 Bq/kg	JT, 2011
2011.6.29	Wheat	Wheat	Kanto	Saitama	Cs-134+137	51 Bq/kg	MHLW, 2012d
2012.2.3	Wheat	Processed wheat noodles (Okinawa soba)[b]	Kyushu	Okinawa	Cs-134+137	258 Bq/kg	MHLW, 2012d

[a] Cattle possibly fed radionuclide contaminated rice straw from Fukushima Prefecture.

[b] Processed using firewood from Fukushima Prefecture.

A.1. Japan's disaster debris project

Following the March 11, 2011 tsunami, an estimated total of 18.8 million tons of debris (as of June 2012) were generated in Iwate, Miyagi and Fukushima Prefectures (MOE, 2012a). With the goal of quick clean-up and disposal, in August 2011, the Japanese Ministry of the Environment (MOE) designed guidelines to promote the disposal (incineration and landfilling) of disaster debris from Iwate and Miyagi in other prefectures throughout Japan. The project is a form of political *kizuna*, or 'bond,' intended to allow outside prefectures to contribute to the rehabilitation of disaster-stricken areas. Local municipalities that accept debris will use municipal waste facilities equipped with a bag filter, designed to capture dioxins and heavy metals, which the government ensures will capture at least 99.9% of radioactive cesium released through incineration (MOE, 2012a). However, it is difficult to find any scientific evidence supporting these claims. Additionally, expenses incurred throughout and following the disposal (including transportation, radiation tests, and future financial aid if changes to the disposal facilities are needed, among others.) will be paid or subsidized by the national government (Ito, 2012). Ashes with under 8,000 Bq/kg of cesium are allowed to be buried in a landfill and, according to the Japanese government's calculations, waste below 480 Bq/kg will produce ashes under this limit (MOE, 2012d).

Appendix B: Questionnaire

In this survey, ***radionuclide*** refers to all artificial (human-made) radioactive isotopes created from nuclear fission. These include cesium 134, cesium 137 and iodine 131, among others.

1. Please rate on a scale of one to seven if you disagree or agree with the following 37 statements.
(*Please circle one number per line*: 1= completely disagree; **2**=disagree; **3**=somewhat disagree; **4**=neutral/don't disagree or agree; **5**= somewhat agree; **6**=agree; **7**=completely agree)

	Completely Disagree						Completely Agree
1) I am at risk of eating food contaminated with radionuclides.	1	2	3	4	5	6	7
2) Children who eat radionuclide contaminated foods are at risk of suffering ill health.	1	2	3	4	5	6	7
3) Adults who eat radionuclide contaminated foods are not at risk of suffering ill health.	1	2	3	4	5	6	7
4) External radiation exposure[1] in the environment is more dangerous to health than internal radiation exposure[2] from food.	1	2	3	4	5	6	7
5) Compared to males, females have a higher risk of suffering ill health from radiation exposure.	1	2	3	4	5	6	7
6) Low doses of internal radiation exposure do not increase a person's risk of cancer.	1	2	3	4	5	6	7
7) Food from Tohoku[3] is possibly contaminated with dangerous levels of radionuclides.	1	2	3	4	5	6	7
8) I feel bad for farmers from Tohoku if I avoid food from the area.	1	2	3	4	5	6	7
9) Food from Kansai is not contaminated with dangerous levels of radionuclides.	1	2	3	4	5	6	7
10) Food from Kansai could still become contaminated with radionuclides from the Fukushima Daiichi nuclear reactor through environmental sources (wind, rain, river, ocean, etc.).	1	2	3	4	5	6	7
11) If the Fukushima Daiichi reactor four's spent fuel pool[4] breaks, most of the food in Japan could become contaminated with dangerous levels of radionuclides.	1	2	3	4	5	6	7
12) Local food and drinking water in cities that process (transport, burn and store ashes of) disaster debris from Iwate or Miyagi could become contaminated with radionuclides.	1	2	3	4	5	6	7
13) Local food and drinking water in cities that process disaster debris could be contaminated with persistent toxic pollutants (ex. dioxins, asbestos).	1	2	3	4	5	6	7
14) Local food and drinking water in my area could eventually become contaminated with radionuclides if nearby cities processes disaster debris.	1	2	3	4	5	6	7
15) Processing disaster debris in Kansai could damage Kansai's local food economy due to consumer fears of radionuclide contamination.	1	2	3	4	5	6	7
16) My local government might decide to process disaster debris from Iwate and Miyagi.	1	2	3	4	5	6	7
17) I want my local area to process disaster debris from Iwate and Miyagi.	1	2	3	4	5	6	7
18) Most government officials understand the health effects of radiation exposure.	1	2	3	4	5	6	7
19) Primary producers (in agriculture or fishery) in Kansai should take preventative measures to protect local food from radionuclide contamination.	1	2	3	4	5	6	7
20) It is impossible to completely clean-up radionuclide contamination in the environment.	1	2	3	4	5	6	7
21) The contamination of food with radionuclides will have an adverse long-term effect on future generations.	1	2	3	4	5	6	7

[1] ***External exposure*** refers to radionuclides with gamma rays in the external environment that pass through your body, but do not remain inside your body.

[2] ***Internal exposure*** refers to alpha and beta particles that enter your body through air, food, water and cuts in the skin.

[3] **Tohoku** includes the north-eastern prefectures of Aomori, Iwate, Miyagi, Akita, Yamagata and Fukushima.

[4] The **spent fuel pool** is the storage place used to cool spent (used) fuel that once powered a nuclear reactor.

22) It is possible to avoid consuming foods contaminated with radionuclides.	1 2 3 4 5 6 7
23) It takes a lot of time/money/labor to try to avoid foods contaminated with radionuclides.	1 2 3 4 5 6 7
24) I often ask, because of my concern for radionuclide contamination, about the origin (place of production) of food in stores or restaurants.	1 2 3 4 5 6 7
25) Organic food grown in Japan is generally not contaminated with dangerous levels of radionuclides.	1 2 3 4 5 6 7
26) Imported foods are currently safer than foods from Japan.	1 2 3 4 5 6 7
27) I am responsible for protecting myself (and my family) from eating foods contaminated with radionuclides.	1 2 3 4 5 6 7
28) The government's new safety standards and testing procedures for radionuclide contamination in food and water (which began on April 1, 2012) successfully prevent contaminated food from reaching consumers.	1 2 3 4 5 6 7
29) The government prioritizes economic interests over people's health.	1 2 3 4 5 6 7
30) School lunches served in Kansai are safe for children to eat.	1 2 3 4 5 6 7
31) School lunches served in Kansai should be tested for radionuclide contamination.	1 2 3 4 5 6 7
32) Local food from Kansai should be tested for radionuclide contamination by local governments.	1 2 3 4 5 6 7
33) My concern for radionuclide contamination in food has greatly changed my eating habits.	1 2 3 4 5 6 7
34) My concern for radionuclide contamination in food has changed how I celebrate cultural events involving food.	1 2 3 4 5 6 7
35) I want to move if my local food becomes contaminated with radionuclides.	1 2 3 4 5 6 7
36) People who talk about radiation are often considered to be strange.	1 2 3 4 5 6 7
37) Citizens must talk to their local governments about policies related to radiation and food safety.	1 2 3 4 5 6 7

2. In your opinion, which prefectures produce food that is generally <u>safe</u> for consumption?
(Please put an X in all appropriate boxes☐. The prefectures are organized into the eight regions found on the Japanese Ministry of Foreign Affairs website)

	Safe		Safe		Safe		Safe		Safe
<u>1. Hokkaido</u>		Tochigi	☐	Yamanashi	☐	Nara	☐	Ehime	☐
Hokkaido	☐	Gunma	☐	Nagano	☐	Wakayama	☐	Kouchi	☐
<u>2. Tohoku</u>		Saitama	☐	Gifu	☐	**<u>6. Chugoku</u>**		**<u>8. Kyushu</u>**	
Aomori	☐	Chiba	☐	Sizuoka	☐	Tottori	☐	Fukuoka	☐
Iwate	☐	Tokyo	☐	Aichi	☐	Shimane	☐	Saga	☐
Miyagi	☐	Kanagawa	☐	**<u>5. Kansai/ Kinki</u>**		Okayama	☐	Nagasaki	☐
Akita	☐	**<u>4. Chubu</u>**		Mie	☐	Hiroshima	☐	Kumamoto	☐
Yamagata	☐	Niigata	☐	Shiga	☐	Yamaguchi	☐	Oita	☐
Fukushima	☐	Toyama	☐	Kyoto	☐	**<u>7. Shikoku</u>**		Miyazaki	☐
<u>3. Kanto</u>		Ishikawa	☐	Osaka	☐	Tokushima	☐	Kagoshima	☐
Ibaragi	☐	Fukui	☐	Hyogo	☐	Kagawa	☐	Okinawa	☐

3. Please indicate if there have been any changes in your consumption of the following food products <u>due to your concern about radionuclide contamination</u>. *(Please put an X in only one box ☐ per line. If you do not consume the following foods, please choose "no change in consumption.")*

	Strongly reduced consumption	Reduced consumption	No change in consumption	Increased consumption	Strongly increased consumption
a) Japanese dairy products	☐	☐	☐	☐	☐
b) Japanese beef	☐	☐	☐	☐	☐
c) Japanese mushrooms	☐	☐	☐	☐	☐
d) Pacific Ocean seafood (ex. fish, seaweed, etc.)	☐	☐	☐	☐	☐
e) Japan Sea seafood (ex. fish, seaweed, etc.)	☐	☐	☐	☐	☐
f) Japanese fresh water fish (ex. river fish)	☐	☐	☐	☐	☐
g) Imported foods	☐	☐	☐	☐	☐
h) Foods from north-eastern Japan (Hokkaido, Tohoku, Kanto)	☐	☐	☐	☐	☐
i) Foods from central Japan (Chubu)	☐	☐	☐	☐	☐
j) Foods from Kansai	☐	☐	☐	☐	☐
k) Foods from south-western Japan (Shikoku, Chugoku, Kyushu)	☐	☐	☐	☐	☐
l) Japanese green tea	☐	☐	☐	☐	☐
m) Green leafy vegetables (ex. spinach)	☐	☐	☐	☐	☐
n) Tobacco	☐	☐	☐	☐	☐
o) Vitamins and supplements	☐	☐	☐	☐	☐
p) Brown rice	☐	☐	☐	☐	☐
q) Processed foods	☐	☐	☐	☐	☐
r) Filtered water	☐	☐	☐	☐	☐
s) Bottled water	☐	☐	☐	☐	☐
t) Outside food (ex. restaurant or convenience store)	☐	☐	☐	☐	☐
u) Other:_____	☐	☐	☐	☐	☐

4. Please rank how much you trust the following information sources about their information on radiation contamination of food and drinking water? *(Please put an X in only one box ☐ per line).*

	No trust	Some distrust	Indifferent	Some trust	High trust
a) National government	☐	☐	☐	☐	☐
b) Prefectural government (prefecture)	☐	☐	☐	☐	☐
c) City/local government	☐	☐	☐	☐	☐
d) Government experts	☐	☐	☐	☐	☐
e) Independent experts	☐	☐	☐	☐	☐
f) Nongovernmental organizations (NGOs)	☐	☐	☐	☐	☐
g) The food industry	☐	☐	☐	☐	☐
h) Mass communication (tv, newspapers, etc.)	☐	☐	☐	☐	☐
i) Independent journalists	☐	☐	☐	☐	☐
j) Internet (social networks, blogs etc.)	☐	☐	☐	☐	☐
k) Citizen groups	☐	☐	☐	☐	☐
l) Other:_____	☐	☐	☐	☐	☐

5. Please rank which groups would you trust to ensure your food contains safe levels of radionuclides. ***(Please put an X in only one box ☐ per line.)***

	No trust	Some distrust	Indifferent	Some trust	High trust
a) National government	☐	☐	☐	☐	☐
b) Prefectural government	☐	☐	☐	☐	☐
c) City government	☐	☐	☐	☐	☐
d) Farmers	☐	☐	☐	☐	☐
e) Food processors	☐	☐	☐	☐	☐
f) Food distributors/wholesaler	☐	☐	☐	☐	☐
g) Sales points (ex. shops , supermarkets, restaurants, school cafeterias, cooperatives)	☐	☐	☐	☐	☐
h) Citizen groups	☐	☐	☐	☐	☐
i) Myself	☐	☐	☐	☐	☐
j) Other:_____	☐	☐	☐	☐	☐

6. Personal details (Please fill in the blanks and put an X in the appropriate boxes ☐).

1) Do you usually eat organic food when it is available?..... Yes ☐….No ☐

2) Are you a member of a co-op or consumer group?.....Yes ☐….No ☐
   a. If yes, does the group test foods for radionuclides?..... Yes ☐….No ☐
   b. Group name(s)?_____

3) Do you shop at stores that test foods for radionuclides? .....Yes ☐….No ☐

4) Are you the member of a group trying to protect children from radiation exposure?..... Yes ☐….No ☐
   a. If yes, group name(s)?_____

5) Are you a member of a group that tests food for radionuclide contamination?..... Yes ☐….No ☐
   a. If yes, group name(s)?_____

6) Are you a member of an antinuclear activist group?.....Yes ☐….No ☐
   a. If yes, group name(s)?_____
   b. If no, have you participated in any antinuclear events?.....Yes ☐….No ☐

7) Are you a member of a group against the acceptance of disaster debris?.....Yes ☐….No ☐
   a. If yes, group name(s)?_____
   b. If no, have you participated in any events focused on the tsunami debris?..... Yes ☐….No ☐

8) Gender…… Male ☐…… Female ☐

9) Current city of residence in Japan: city name_____ postal code_____—_____
   a. How long have you lived here? _____months _____years

10) Did you evacuate after the Fukushima accident? Yes ☐….No ☐
   a. If yes, from which prefecture? _____

11) Nationality? Japanese ☐….. Other ☐
   a. If other, what is your home country?_____
   b. How long have you lived in Japan? _____months _____years

12) Age: 18 -20 ☐ 20 – 29 ☐ 30 – 39 ☐ 40 – 49 ☐ 50 – 59 ☐ 60 – 69 ☐ 70 – 79 ☐ 80 + ☐

13) Are the any children 20 years or younger living in your household? ... No ☐….Yes ☐
   a. If yes, how many children 0-6 years old? _____
   b. How many children 7-20 years old? _____

14) What is your highest level of education?
High school ☐…… Vocational school ☐…… University ☐…… Graduate school ☐…… Other ☐ (Please specify)

15) What is your primary profession? (please put an X in only one box ☐)

- Primary production (agriculture ☐; fishery ☐; other ☐)
- Public service (government ☐; teaching ☐; healthcare ☐; non-profit organization (NPO) or non-governmental organization (NGO) ☐; other ☐)
- Manufacturing or industry (food processing ☐; other ☐)
- Private service (restaurant/cafe ☐; food retail ☐; other ☐)
- No paid employment (homemaker ☐; student ☐; other ☐)
- Other:_____ ☐

Thank you for your time!

Please leave your email or mailing address below if you are interested in receiving the results of the survey or in learning more about One World No Nukes. Also, if you want more information or are able to answer any further questions about the survey, please leave your email address below or send an email to tabemonokansai@gmail.com.

Please check all that apply:

- I want to receive the results of the survey ☐
- It is okay to contact me with any further questions about the survey topic ☐

E-mail _____

Postal address_____

Appendix C: Results

Table C1. Descriptive statistics of Question 1's seven-point Likert scale responses[a] agreeing or disagreeing with statements on concerns and characteristics related to the risk of radionuclide contaminated food.

	WCC (total *n* =20)					KCC (total *n* =20)					WNA (total *n* =20)					HUS (total *n* =51)				
	n	Mdn	Mode	Q_L	Q_U	*n*	Mdn	Mode	Q_L	Q_U	*n*	Mdn	Mode	Q_L	Q_U	*n*	Mdn	Mode	Q_L	Q_U
Health																				
Adults who eat radionuclide contaminated foods are at risk of suffering ill health[b].	20	7	7	7	7	19	7	7	7	7	20	7	7	6	7	49	6	6[c]	5	7
Children who eat radionuclide contaminated foods are at risk of suffering ill health.	20	7	7	7	7	19	7	7	7	7	20	6.5	7	5	7	51	6	7	5	7
Low doses of internal radiation exposure increases a person's risk of cancer[b].	20	7	7	7	7	20	7	7	7	7	19	6	6	4	6	49	5	6	4	6
Most government officials do not understand the health effects of radiation exposure[b].	20	7	7	7	7	20	7	7	6	7	20	6	7	4	7	50	5	5	4	6
The government prioritizes economic interests over people's health.	20	7	7	7	7	20	7	7	7	7	20	6	7	5	7	51	5	6	4	6
Internal radiation exposure from food is more dangerous than external radiation exposure from the environment[b].	20	6	7	4	7	20	6	7	5	7	20	4	4	4	5	50	4	4	3	5
Compared to males, females have a higher risk of suffering ill health from radiation exposure.	20	6	7	4	7	20	6	7	4	7	20	4	4	4	5	50	4	4	2	5
Cronbach's Alpha: .711																				
Further contamination																				
If the Fukushima Daiichi reactor four's spent fuel pool breaks, most of the food in Japan could become contaminated with dangerous levels of radionuclides.	20	7	7	7	7	20	7	7	6	7	20	5.5	6	4	6	51	4	4	4	5
Local food and drinking water in cities that process (transport, burn and store ashes of) disaster debris from Iwate or Miyagi could become contaminated with radionuclides.	20	7	7	6	7	20	7	7	7	7	20	5	4[c]	4	7	51	4	5	3	5
Local food and drinking water in cities that process disaster debris could be contaminated with persistent toxic pollutants (ex. dioxins, asbestos).	19	7	7	7	7	20	7	7	7	7	20	5	5	4	7	50	4	5	3	5
.Local food and drinking water in my area could eventually become contaminated with radionuclides if nearby cities processes disaster debris.	20	7	7	7	7	20	7	7	7	7	20	5	5	5	7	51	3	3	3	5
Food from Kansai could still become contaminated with radionuclides from the Fukushima Daiichi nuclear reactor through environmental sources.	20	6.5	7	5	7	20	6	6	5	6	20	5	5	4	6	51	4	5	3	5
Cronbach's Alpha: .907																				
Future implications and coping strategies																				
It is impossible to completely clean-up radionuclide contamination in the environment.	20	7	7	6	7	20	7	7	6	7	20	6	5[c]	5	7	51	6	6	5	6
Primary producers (in agriculture or fishery) in Kansai should take preventative measures to protect local food from radionuclide contamination.	20	7	7	7	7	20	7	7	7	7	20	6.5	7	6	7	50	5	5	4	6
The contamination of food with radionuclides will have an adverse long-term effect on future generations.	20	7	7	7	7	20	7	7	7	7	20	6	6[c]	6	7	51	5	5	5	6
School lunches served in Kansai should be tested for radionuclide contamination.	20	7	7	7	7	20	7	7	7	7	19	6	6[c]	5	7	50	5	5	4	6
Processing disaster debris in Kansai could damage Kansai's local food economy due to consumer fears of radionuclide contamination.	20	7	7	7	7	20	7	7	6	7	20	5	5[c]	4	7	51	4	5	3	5
Local food from Kansai should be tested for radionuclide contamination by local governments.	20	7	7	5	7	20	6	7	5	7	20	4	4	4	6	51	4	4	3	5
Cronbach's Alpha: .814																				
Vulnerability and responsibility																				
It takes a lot of time/money/labor to try to avoid foods contaminated with radionuclides.	19	7	7	7	7	20	7	7	6	7	19	6	6	5	6	49	6	5[c]	5	7
I am responsible for protecting myself (and my family) from eating foods contaminated with radionuclides.	20	7	7	7	7	20	7	7	7	7	19	7	7	6	7	50	5	5	4	6
Food from Tohoku is possibly contaminated with dangerous levels of radionuclides.	20	7	7	7	7	20	7	7	6	7	20	5	5	5	6	50	4	5	3	5
I am at risk of eating food contaminated with radionuclides.	20	7	7	5	7	20	7	7	5	7	20	5	5	4	6	51	3	3	2	5
School lunches served in Kansai are not safe for children to eat.[b]	20	7	7	6	7	20	7	7	5	7	20	4	4	3	4	51	4	4	3	4
The government's new safety standards and testing procedures for radionuclide contamination in food and water do not successfully prevent contaminated food from reaching consumers[b].	20	7	7	6	7	20	7	7	6	7	20	4	3[c]	3	6	51	4	4	3	5
Organic food grown in Japan is could be contaminated with dangerous levels of radionuclides[b].	20	4.5	4	4	7	20	6	7	4	7	20	4	4	4	6	51	4	4	3	5
People who talk about radiation are often considered to be strange.	20	6	7	5	7	20	5.5	7	4	7	20	2	2	1	4	51	2	1	1	3
I feel bad for farmers from Tohoku if I avoid food from the area.	20	2	1	1	4	19	5	5	2	5	20	5	2[c]	2	6	51	6	6	4	7
Food from Kansai could be contaminated with dangerous levels of radionuclides[b].	20	6	6	4	7	20	5	5	4	5	20	3.5	3	2	5	51	4	5	2	5
It is possible to avoid consuming foods contaminated with radionuclides.	20	4	1[c]	2	6	20	4	4	3	5	20	3.5	4	2	4	51	4	5	2	5
Imported foods are currently safer than foods from Japan.	20	4	4	4	4	20	4	4	4	6	20	3.5	4	3	4	51	3	3	2	4
Cronbach's Alpha: .716																				
Action																				
Citizens must talk to their local governments about policies related to radiation and food safety.	20	7	7	7	7	20	7	7	7	7	20	6	6	5	6	51	6	6	5	7
I want to move if my local food becomes contaminated with radionuclides.	20	6	7	5	7	20	7	7	6	7	20	4	4	3	5	51	4	4	2	5
My concern for radionuclide contamination in food has changed how I celebrate cultural events involving food.	20	6	6[c]	6	7	20	5.5	6	6	7	18	3	3	2	5	48	1	1	1	3
I often ask, because of my concern for radionuclide contamination, about the origin (place of production) of food in stores or restaurants.	20	6	6	6	7	20	6	7	5	7	20	3	1	1	5	51	1	1	1	3
My concern for radionuclide contamination in food has greatly changed my eating habits.	20	7	7	5	7	20	6.5	7	4	6	20	3.5	5	1	3	51	2	1	1	2
Cronbach's Alpha: .886																				

[a]A seven point likert scale was used: 1= completely disagree; 2=disagree; 3=somewhat disagree; 4=neutral/don't disagree or agree; 5= somewhat agree; 6=agree; 7=completely agree.
[b]Items that were reverse coded from their original form in the questionnaire for analysis.
[c]Multiple modes exist and the smallest value is shown.

Table C2. Descriptive statistics of Question 3's five-point Likert scale responses[a] indicating changes in consumption due to concerns about radionuclide contamination

	WCC (total *n* =20)					KCC (total *n* =20)					WNA (total *n* =20)					HUS (total *n* =51)				
	n	Mdn	Mode	Q_L	Q_U	*n*	Mdn	Mode	Q_L	Q_U	*n*	Mdn	Mode	Q_L	Q_U	*n*	Mdn	Mode	Q_L	Q_U
Foods from north-eastern Japan (Hokkaido, Tohoku, Kanto)	18	1	1	1	1	19	1	1	1	1	20	2	2	1	2	51	3	3	2	3
Japanese mushrooms	19	1	1	1	1	19	1	1	1	1	20	3	3	2	3	51	3	3	3	3
Pacific Ocean seafood (ex. fish, seaweed, etc.)	19	1	1	1	1	18	1	1	1	1	20	3	3	2	3	51	3	3	3	3
Japan Sea seafood (ex. fish, seaweed, etc.)	19	1	1	1	2	18	1	1	1	2	20	3	3	3	3	51	3	3	3	3
Japanese fresh water fish (ex. river fish)	19	1	1	1	3	19	1	1	1	3	20	3	3	3	3	51	3	3	3	3
Japanese green tea	19	1	1	1	2	19	1	1	1	2	20	3	3	3	3	51	3	3	3	3
Outside food (ex. restaurant or convenience store)	19	1	1	1	2	19	1	1	1	3	20	3	3	3	3	51	3	3	3	3
Japanese beef	19	1	1	1	2	19	2	1	1	3	20	3	3	3	3	51	3	3	3	3
Processed foods	19	1	1	1	3	19	2	1[b]	1	3	20	3	3	3	3	51	3	3	3	3
Foods from central Japan (Chubu)	19	2	1	1	3	19	2	1[b]	1	3	20	3	3	2	3	51	3	3	3	3
Japanese dairy products	18	2	2	2	3	18	2.5	3	2	3	20	3	3	3	3	51	3	3	3	4
Green leafy vegetables (ex. spinach)	19	3	3	2	3	19	2	3	2	3	20	3	3	3	3	51	3	3	3	3
Tobacco	19	3	3	1	3	19	3	3	2	3	20	3	3	3	3	51	3	3	3	3
Vitamins and supplements	19	3	3	3	4	19	3	3	3	3	20	3	3	3	3	51	3	3	3	3
Brown rice	19	3	3	2	3	19	3	3	2	3	20	3	3	3	3	51	3	3	3	3
Filtered water	18	3	3	3	3	19	3	3	3	4	20	3	3	3	3	51	3	3	3	3
Bottled water	19	3	3	2	4	19	3	3	2	4	20	3	3	3	3	51	3	3	3	3
Imported foods	19	4	3	3	5	18	4	3[b]	3	4	20	3	3	3	3	50	3	3	3	3
Foods from Kansai	19	4	3[b]	3	5	19	4	3[b]	3	5	20	3	3	3	3	51	3	3	3	3
Foods from south-western Japan (Shikoku, Chugoku, Kyushu)	19	4	5	4	5	19	5	5	4	5	20	3	3	3	4	50	3	3	3	3

[a]A five-point likert scale was used: 1= strongly reduced consumption; 2= reduced consumption; 3= no change in consumption; 4= increased consumption; 5= strongly increased consumption.

[b]Multiple modes exist and the smallest value is shown.

Table C3. Descriptive statistics of Question 4's five-point Likert scale responses[a] indicating trust in information sources reporting on radionuclide contaminated food.

	WCC (total *n* =20)					KCC (total *n* =20)					WNA (total *n* =20)					HUS (total *n* =51)				
	n	Mdn	Mode	Q_L	Q_U	*n*	Mdn	Mode	Q_L	Q_U	*n*	Mdn	Mode	Q_L	Q_U	*n*	Mdn	Mode	Q_L	Q_U
Government and big business																				
National government	19	1	1	1	1	19	1	1	1	1	20	2	2	1	1	51	2	2	2	4
Mass communication (tv, newspaper, etc.)	18	1	1	1	2	19	1	1	1	2	20	2	2	1	3	51	2	2	2	3
Prefectural government	19	1	1	1	1	18	1	1	1	2	20	2	2	2	2	51	3	4	2	4
Government experts	19	1	1	1	1	19	1	1	1	1	20	2	2	2	2	51	3	4	2	4
The food industry	18	2	2	1	2	19	2	2	2	2	20	2	2	2	3	50	3	4	2	4
City/local government	19	1	1	1	1	19	1	1	1	2	20	2	2	2	3	51	4	4	2	4
Independent																				
Internet (social networks, blogs, etc.)	19	4	4	4	4	19	4	4	4	4	20	2	2	2	3	51	2	2	2	3
Independent journalists	17	4	4	4	4	19	4	4	4	4	20	2.5	2	2	4	50	3	2[b]	2	4
Citizen groups	18	4	4	4	4	19	4	4	4	4	20	3	2	2	4	51	3	3	3	4
Nongovernmental organizations (NGOs)	16	4	4	3	4	19	4	4	4	4	20	3	4	3	4	51	4	4	3	4
Independent experts	17	4	4	3	4	19	4	4	4	4	20	3	4	2	4	51	4	4	3	4

[a]A five-point likert scale was used: 1= strongly reduced consumption; 2= reduced consumption; 3= no change in consumption; 4= increased consumption; 5= strongly increased consumption.

[b]Multiple modes exist and the smallest value is shown.

Table C4. Descriptive statistics of Question 5's five-point Likert scale responses[a] indicating trust in actors to ensure food does not contain harmful levels of radionuclides.

	WCC (total *n* =20)					KCC (total *n* =20)					WNA (total *n* =20)					HUS (total *n* =51)				
	n	Mdn	Mode	Q_L	Q_U	*n*	Mdn	Mode	Q_L	Q_U	*n*	Mdn	Mode	Q_L	Q_U	*n*	Mdn	Mode	Q_L	Q_U
Government																				
National government	20	1	1	1	1	20	1	1	1	1	20	2	2	1	2	51	2	2	2	4
Prefectural government	20	1	1	1	2	20	1	1	1	1	20	2	2	2	3	51	4	4	2	4
City government	19	1	1	1	2	20	1	1	1	2	20	2	2	2	3	51	4	4	2	4
Food business																				
Food processors	19	2	2	1	2	20	2	2	1	2	20	2	2	2	3	49	3	2	2	4
Food distributors/wholesaler	20	2	2	1	2	19	2	2	2	2	20	2	2	2	3	51	3	2	2	4
Sales points (ex. shops , supermarkets, restaurants, school cafeterias, cooperatives)	20	2	2	1	2	18	2	2	2	4	20	3	2	2	4	50	3	2[b]	2	4
Farmers	18	2	4	2	4	18	2	2	2	4	20	4	4	2	4	51	4	4	3	4
Independent																				
Citizen groups	19	4	4	3	4	20	4	4	4	4	20	3	2[b]	2	4	51	3	4	2	4
Myself	19	4	4	4	4	18	4	4	4	4	20	4	4	2	4	51	3	3	2	4

[a]A five-point likert scale was used: 1= strongly reduced consumption; 2= reduced consumption; 3= no change in consumption; 4= increased consumption; 5= strongly increased consumption.

[b]Multiple modes exist and the smallest value is shown.

Appendix D: Discussion

Table D1. A comparison of consumer profiles identified in the study.

	Active concerned consumer	Passive concerned consumer	Young consumer
Groups included	WCC, KCC	WNA	HUS
Demographics			
Consume organic when possible (over 60%)	*	*	*
Completed or attending university/graduate school (over 60%)	*	*	*
Female majority (over 75%)	*	*	
Children in home (over 60%)	*	*	
Concerns related to radionuclide contaminated foods			
Health and human illness	*	*	*
Environment	*	*	*
Future generations	*	*	*
Societal wellbeing	*	*	*
The economy	*	*	
Self image	*		
Characteristics related to radionuclide contaminated foods			
Government puts economy before human health	*	*	*
Government lacks knowledge on health effects	*	*	*
I am personally responsible for avoiding	*	*	*
Citizens responsible for discussing concerns with government	*	*	*
It takes a lot of time/money/effort to avoid	*	*	*
Need for preventative measures and countermeasures in Kansai	*	*	*
Food from south-western Japan is generally safer than food from central or north-eastern Japan	*	*	*
Further contamination threatens local food safety	*	*	
I am vulnerable	*	*	
Food from Kansai is not contaminated with dangerous levels of radionuclides		*	
Trust in information sources			
Lack trust in national government and mass media	*	*	*
Trust NGOs and independent experts	*	*	*
Trust only independent sources	*	*	
Trust city/local government			*
Trust in actors to ensure safe levels of radionuclides in food			
Lack trust in national government	*	*	*
Trust myself	*	*	
Trust farmers		*	*
Trust citizen groups	*		
Trust prefectural and city governments			*
Action due to concerns of radionuclide contaminated foods			
Reduce consumption of foods from north-eastern Japan	*	*	
Change in eating habits and consumption of specific food products	*		
Change in celebration of cultural events involving food	*		
Political activism	*		