

CHAPTER 7 MARINE AND COASTAL COMMERCIAL FISHERIES

7.1 INTRODUCTION

This supplemental information is provided in order to address specific questions raised following publication of the international style Environmental Impact Assessment (EIA) in 2003 and as such forms a component of the EIA addendum (EIA-A). In brief, the focus of the questions or requirement for the provision of further information included the following:

- Lack of information on fisheries and in particular non-fish species of commercial value;
- Information on dredging and disposal and the effects on fish, particularly commercial interests within Aniva Bay;
- Potential adverse effects of noise disturbance during construction on marine organisms (fish and shellfish);
- Clarification of some issues relating to how compensation to fisherman is provided through the fish damage compensation arrangement.

Further information on the above issues is provided in the following sections. Potential effects on fisheries associated with dredging and disposal are covered in EIA Addendum Chapter 12, except with respect to the effects of noise disturbance, which are also covered in this Chapter. The social aspects of the fishing industry and in particular issues relating to subsistence fishing are covered in the Social Impact Assessment (Section 12.3).

7.2 BACKGROUND

The fishing industry is of vital economic importance to the Sakhalin economy. It provides employment and livelihoods for the local population on the island, primarily for those who live in coastal areas. According to data from 2001 (SEIC Social Impact Assessment 2003), the fishing industry represents approximately 26.7% of the industrial production volume in the regional economy, 25.4% of the export volume, and 7.6% of total employment. In addition to its role in the regional economy, fishing is also a recreational activity undertaken by a large number of people in some areas and a main source of food and/or income for some indigenous peoples, where several settlements are built around fishing enterprises.

According to official statistics, in 2003, Sakhalin fishermen exported more than 160,000 tonnes of seafood in 2003, up by 22% from 2002. In 2003, Sakhalin enterprises manufactured 422,000 tonnes of seafood products (including canned food), which is 21% more than in 2002. The major part of exported seafood goes to Japan – 41% (TIA Ostrova Apr. 2004).

In 2003, the total reported catch comprised 464,000 tonnes, which is 26% more than in 2002. The major catch species in 2003 comprised (2002 figures in brackets):

- Pollock – 222,500 (147,100) tonnes;
- Salmon – 117,500 (66,400) tonnes;
- Herring – 23,400 (29,200) tonnes;
- Pacific saury – 16,400 (19,300) tonnes.

Quotas for some stocks were not claimed during the year, notably kelp and anchovy (possibly, in the latter case due to low stock levels), while others were not achieved (saffron cod, flounder, herring and Pacific saury).

Studies undertaken for SEIC suggest that there are approximately 654 commercial fishing vessels registered in the Sakhalin Oblast (GU Regional Centre for Coastal Fishing and Fish Finding 2003). Fishing vessels in Sakhalin predominantly use trawl, seine net, long-lines and fixed net fishing methods. Generally, large and medium-size vessels use trawls and medium and small-sized vessels use fixed gear (*e.g.* fish traps). Detailed information on the type and size of fishing vessels active in the area, main fishing areas, the gear types used and landings are, however, not available due to the commercial sensitivity of the Sakhalin fishing industry and the availability of adequate and reliable statistical information.

The offshore installations that will be constructed as part of the Sakhalin II Phase 2 Project have the potential to interact with the commercial fishing activities. The main geographical areas of interaction are:

- The north-east coast of Sakhalin in the vicinity of the PA-B and LUN-A platforms and the associated pipelines and landfalls;
- Aniva Bay in the vicinity of the proposed LNG jetty, OET subsea pipeline and connected TLU.

These two areas are discussed in more detail below. SEIC has undertaken several assessments of commercial fisheries activities, including a recent study executed by the GU Regional Centre for Coastal Fishing and Fish Finding (2003). This study assessed commercial fishing activities specifically for the areas affected by the project and provides data on fishing activity and catches in Aniva Bay. In addition, during the period 1998-2003, SEIC executed an extensive range of environmental baseline surveys geared at analysing the marine ecological characteristics of north-eastern Sakhalin and Aniva Bay. These surveys are listed in Table 7.1.

Table 7.1 SEIC Marine Ecology and Fisheries Surveys

Survey Organisation	English Title	Year
SakhNIRO: Sakhalin Research Institute of Fisheries and Oceanography	Calculation of fishing damage to fishing industry by exploratory drilling on Piltun-Astokhskoye oil field.	1998
SakhNIRO: Sakhalin Research Institute of Fisheries and Oceanography	Ecological and fisheries characteristics of the shelf zone of PA-A.	1998
SakhNIRO: Sakhalin Research Institute of Fisheries and Oceanography	Expert analysis of damage to the fish stock during the development of the Piltun-Astokhskoye oil and gas field in the North-Eastern Sakhalin shelf. Phase 1: Astokhskoye Feature. Book 2.	1999
SakhNIRO: Sakhalin Research Institute of Fisheries and Oceanography	Fishery characteristics of eastern Sakhalin and Aniva Bay areas (on the basis of trawl-acoustic survey, carried out in September-October 1998).	1999
SakhNIRO: Sakhalin Research Institute of Fisheries and Oceanography	Information report on voyage - about the conducting of trawl-acoustic survey at R/V "Dmitry Peskov" off north-eastern Sakhalin Island.	1999
SakhNIRO: Sakhalin Research Institute of Fisheries and Oceanography	Background condition of bioresources in the Piltun-Astokhskoye oil-gas field.	2000
SakhNIRO: Sakhalin Research Institute of Fisheries and Oceanography	Estimation of damage to marine biological resources caused by Pressure Maintenance Project Implementation (Astokh Feature, Piltun-Astokh Licence Area).	2000
SakhNIRO: Sakhalin Research Institute of Fisheries and Oceanography	Report on conducting a trawl-acoustic survey at R/V "Dmitry Peskov" off north-eastern Sakhalin in September - November 1999.	2000
VNIRO. Russian Federal Research Institute of Fishery and Oceanography	On Salmon Population Size and Biological State Studies in Northeast Sakhalin Coast Areas and in Aniva Bay in the Summer and Autumn of 2001.	2001
SakhNIRO: Sakhalin Research Institute of Fisheries and Oceanography	Assessment of fish stock on the area of Sakhalin eastern coastal zone (by the results of trawl survey in 2000).	2001

Survey Organisation	English Title	Year
SakhNIRO: Sakhalin Research Institute of Fisheries and Oceanography	Environmental and fisheries characterisation of the Aniva Bay and preliminary calculation of possible damage to the marine biological resources from bottom dredging and excavated soil dumping works - Book 1: Environment and Fisheries.	2001
SakhNIRO: Sakhalin Research Institute of Fisheries and Oceanography	Ecological and fisheries conditions of Aniva Bay and preliminary calculation of possible damage to the marine biological resources from bottom dredging and excavated soil dumping works – Book 2: Approximate fish damage calculation from bottom dredging.	2001
SakhNIRO: Sakhalin Research Institute of Fisheries and Oceanography	Ecological fisheries characteristics of bays of north-eastern Sakhalin.	2003
SakhNIRO: Sakhalin Research Institute of Fisheries and Oceanography	LNG and OET facilities, environmental report. Environmental monitoring for fisheries purposes. Book 1 – Description of research results.	2004
SakhNIRO: Sakhalin Research Institute of Fisheries and Oceanography	Expert Opinion. Current condition of the Far Eastern saffron cod (<i>Eleginus gracilis</i>) in the Sakhalin north-east.	2004

An overview of the findings of these studies is presented in the baseline environment sections of the international style EIA (*Volume 2, Chapter 1* for north-eastern Sakhalin and *Volume 5, Chapter 1* for Aniva Bay, respectively).

It is important to highlight the distinction between potential fisheries resources and commercial fisheries activity. This section presents an assessment of commercial fisheries activities in the coastal and marine areas of Sakhalin. It does not attempt to address, in detail, marine ecology or abundance and distribution of commercial fish stocks beyond what is appropriate within the scope of this assessment. An assessment of impacts on fisheries resources was undertaken in the EIA (*Volume 2, Chapter 3* and *Volume 5, Chapter 3*). Where information on the assessment of fisheries resources is relevant to this section a reference to the appropriate EIA section is provided.

7.3 COMMERCIAL FISHING IN THE PILTUN-LUNSKOYE OFFSHORE AREA

7.3.1 Fish and fisheries activity

An investigation of commercial fishing activities, executed by the GU Regional Centre for Coastal Fishing and Fish Finding (2003) concluded that commercial

fishery intensity in both the Piltun and Lunskeye areas is generally low. What fishing activity there is consists of small-scale fisheries for:

- Great (starry) flounder (*Platichthys stellatus*) (July to September) with a maximum permissible annual catch limited to 160t for the north-eastern region as a whole;
- Coastal and lagoon fishing for salmon (August to September);
- Herring (*Clupea pallasii*) (July);
- Navaga (saffron cod - *Eleginus gracilis*) in winter;
- Pacific capelin (*Mallotus villosus*) (July).

In addition to commercial fisheries activity it should be noted that the lagoon systems of the north-east and the nearshore coastal waters are of importance for small-scale subsistence fishing by local people. This is discussed in more detail in the Social Impact Assessment (Section 12.3). Of the above species, saffron cod is of most commercial interest in the area. This species spawns in the estuarine waters of the Piltun, Chaivo, Niskiy, Nabil, Lunskey and the Sea of Okhotsk areas. Spawning grounds are located close to the coast, at a depth of two to eight metres. Saffron cod tend to shoal in the coastal zone towards the end of November after the coastal ice appears. The commercial fishing season starts in December and finishes in March with maximum catches registered in January to February. The fish are caught in the spawning grounds using fyke nets and are also caught by local people through the sea ice. Data (SakhNIRO 2004a) indicate that the waters of Piltun Bay support the highest densities of this species, which is reflected by the fact that approximately 70% of the saffron cod catch is harvested from this area.

Figure 7.1 illustrates the catch of saffron cod in north-eastern Sakhalin since 1938. This shows that daily catches increased from around 250 tonnes *per annum* (tpa) in the 1970s to around 400tpa by the end of the 1980s due to the commercialisation of fishing. Catches have also fluctuated as a result of ice conditions, which influence the suitability of spawning grounds at the mouths of the lagoons and also determine the navigability of channels and level of fishing activity.

As can be seen from Figure 7.1, the commercial catch of saffron cod has decreased since 1986, falling from a maximum of 950 tonnes (in 1985) to 40 tonnes in 2004. In analysing the abundance of saffron cod generations from north-eastern Sakhalin, two distinct periods can be distinguished. The first is between 1976-1984, when the mean annual abundance (of all age classes) constituted 11 million individuals (varying between 8.0 – 15.9 million); the second, from 1985 through to the present time, involves a significant decline in abundance to approximately two million individuals.

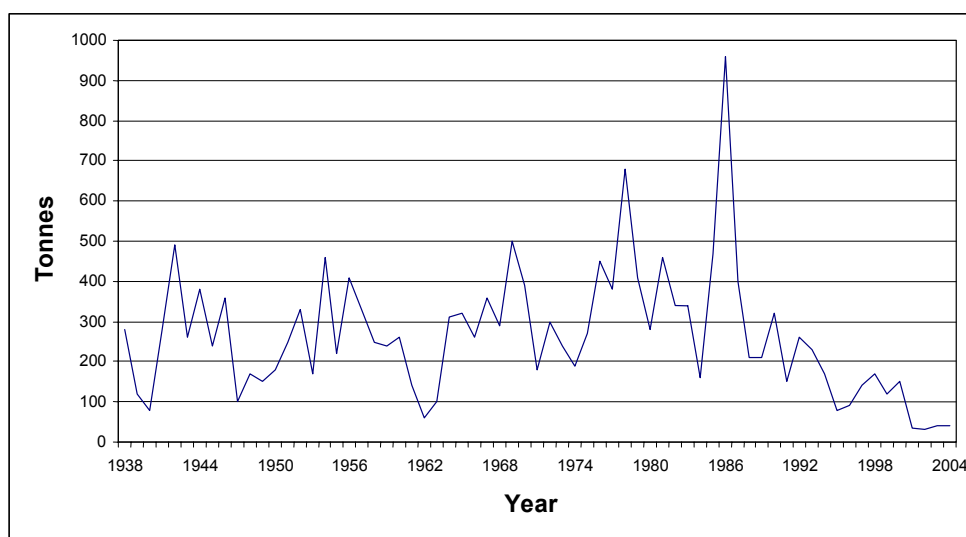


Figure 7.1 Catches of Saffron Cod ('000 tonnes) in the North-eastern Sakhalin Bays from 1938 to 2004

The value of the commercial stock has fluctuated in line with changes in recorded biomass. The maximum commercial stock was in 1985 (1.8 thousand tonnes), while much lower stocks were recorded 1993, 1994, 2000 and 2001 with values ranging from 0.3 to 0.47 thousand tonnes. The significant recorded decrease in commercial catch in this species has been blamed on over fishing during the 1970-1980s. It is also considered that the low levels of reported catch in the 1990s and up to the present day do not reflect the actual tonnage being landed. SakhNIRO (2004a) considers that the present population of saffron cod in the Piltun area is stable, albeit at historically low levels when compared with the population levels of the pre-1990s.

Other commercial fisheries within the vicinity of the proposed pipeline route are limited to the use of Danish seines (snurrevaads) for starry flounder and pollock using small seine-net fishing vessels. The fishery is small-scale and the fishery companies operating in the area include Vostok fish works, Vostok-Nogliki Company Ltd and Ostrov Company Ltd. Landing tonnages are unknown. The planned pipeline route from the offshore platforms to landfall is not thought to intersect with any locations presently used to set fixed nets for salmon.

In summary, the recent survey (GU Regional Centre, 2003) found that commercial fishing activity along the north-east coast is very limited. This is a function of low stock densities for commercial species (e.g. saffron cod) and the absence of any significant infrastructure (i.e. ports and harbours) to support commercial fishing.

7.3.2 Commercial shellfish interests of north-east Sakhalin

As discussed above, commercial exploitation of the fish resources of the coastal and continental slope waters of eastern and north-eastern Sakhalin is relatively limited. This situation also applies to shellfish in the area, the stocks of which are comparatively poorly studied. Some information on the

distribution of key commercial species is available from trawl surveys undertaken by SakhNIRO, the results of which are briefly summarised below (SakhNIRO 2001a).

The extensive trawl sampling programme undertaken by SakhNIRO clearly demonstrates that a number of crab and shrimp species are present in commercial quantities off the north-east coast of Sakhalin, including blue king crab, snow opilio and pink, bear cub and sculptured shrimps. According to SakhNIRO (2001a) several of these species, but notably spiny lebbeid and deep-water pandalopsis (*Pandalopsis ochotensis*), have become of interest to commercial fisherman and stocks are beginning to be exploited. However, no information on the scale of this fishery is presently available. The distribution and characteristics of stocks of a number of species are briefly highlighted below.

Snow crab (*Chionoecetes opilio*) – This species is widely distributed along the north-eastern Sakhalin coast, occupying all substrates between 90-500m water depth. Commercial male specimens were recorded by SakhNIRO from 20% of survey trawl stations at depths of 200-500m. Overall, the catch data indicated a relatively homogeneous distribution but with a few small areas of higher abundance (see Figure 7.2).

Blue king crab (*Paralithoides platypus*) – Occurs in the southern part of the north-east shelf in the Terpeniya Gulf area at depths of 25-300m, mainly on sand and pebble substrates (SakhNIRO 2001a). Only one commercially viable aggregation of this species was observed (see Figure 7.3).

Sculptured shrimp (*Sclerocrangon boreas*) – This species was recorded from 30% of all trawl survey stations by SakhNIRO indicating that it is widely distributed along the north-eastern coast. It favours water depths of between 20-200m and commercially exploitable populations were observed in the northern part of the shelf, to the north of Lunsky Bay (see Figure 7.4).

Bear-cub shrimp (*Sclerocrangon salebrosa*) – This species occupies relatively shallow water (30-100m) generally on sandy substrates along the north-eastern coast. The greatest aggregations were observed to occur off Schmidt Peninsula and further to the south offshore of Nabilsky Lagoon (see Figure 7.4).

Spiny lebbeid (*Lebbeus groenlandicus*) – Occurs at depths from 20-500m mainly on sand and sandy-pebble substrates. During the trawl survey undertaken by SakhNIRO (2001a), maximum catches were recorded at depths of 150m with the main populations being centred in waters off Schmidt Peninsula and much further to the south off Terpeniya Point (see Figure 7.4).

7.4 COMMERCIAL FISHING INTERESTS IN ANIVA BAY

7.4.1 Fish and fisheries activity

Aniva Bay is considered to be one of the most biologically productive areas in the Sakhalin coastal region. A full description of potential fish resources is provided in the international-style EIA (*Volume 5, Chapter 1, 2003*).

This productivity, particularly that of humpback (pink) salmon (*Oncorhynchus gorbuscha*), is reflected by the presence of numerous fishing and processing enterprises in the Korsakov district, relatively close to the proposed Liquid Natural Gas (LNG), Oil Export Terminal (OET) and Tanker Loading Unit (TLU) facilities. As a result, the biological resources of the immediately adjoining coastal area are actively exploited. Large enterprises such as Kirov's Collective farm (Ozersky), Persey (Korsakov) and Tunaycha have, between them, a powerful processing base, which fully exploits the available (allocated) fisheries resources, even if these works have a low profitability.

A recent study on commercial fishing activities undertaken by the Regional Centre for Coastal Fishing and Commercial Exploitation of Fish Resources on Sakhalin (2003) concluded that Aniva Bay contains a number of commercially important species, of which the most important is the humpback salmon. In total, it is estimated that about 25% of the total commercial pink salmon catch comes from fisheries operating in Aniva Bay. The life cycle of this species results in greater populations returning to natal rivers during odd years and smaller populations in even years. Hence catches (as shown in Table 7.2), quotas and the number of fishing companies operating in Aniva Bay vary in line with these population fluctuations. This data also illustrates the significant annual fluctuation and variability in the pink salmon population in Aniva Bay. Attributing cause to this variability is extremely difficult but is likely to be related to a wide range of factors including mortality of young fish at sea (predation, climate, disease), numbers of fry released from fish hatcheries and overall commercial fishing effort.

Table 7.2 Commercial catch data (tonnes) for humpback (pink) salmon in Aniva Bay 1983-2003 (data from SakhNIRO 2004b)

Years	Abundance	Catch		Commercial capture
	Million Nos,	Million Nos,	Thousand t,	%
1983	4,49	2,78	3,19	61,92
1984	1,33	0,16	0,18	12,03
1985	10,36	5,67	5,93	54,73
1986	1,42	0,01	0,02	0,70
1987	11,71	7,16	8,91	61,14
1988	1,83	0,02	0,02	1,09
1989	14,35	7,08	8,50	49,34
1990	2,00	0,53	0,64	26,50
1991	32,92	24,76	29,72	75,21
1992	6,64	3,28	4,80	49,40
1993	2,70	2,06	3,17	76,30

Years	Abundance	Catch		Commercial capture
	Million Nos,	Million Nos,	Thousand t,	%
1994	18,21	9,34	10,46	51,29
1995	24,82	18,25	23,73	73,52
1996	9,37	3,50	4,00	37,35
1997	16,98	12,83	16,68	75,56
1998	6,20	3,93	4,76	66,12
1999	17,35	13,52	16,63	77,92
2000	2,93	1,26	1,74	43,0
2001	33,41	29,16	39,37	87,3
2002	3,87	0,73	1,05	26,7
2003	20,84	23,68	18,35	88,05
Even (av.)	5,38	2,28	2,77	31,42
Odd (av.)	17,27	13,36	15,83	71
Total average	11,61	8,08	9,61	52,15

Catches over the 1983-2003 period, taking into account the variation between odd and even years, averaged 9,61tpa. It is estimated that commercial fisheries have accounted for approximately 50% of the humpback population and therefore total resources of this species in Aniva Bay over the past few years are estimated at approximately 20,000t (again averaged between odd and even years). The local pink salmon population in Aniva Bay is maintained at this level mainly through artificial reproduction at breeding farms situated at several rivers (Lyutoga, Taranay and Ostrovka) flowing into the bay. Chum and cherry salmon (*Oncorhynchus keta* and *O. masou masou*, respectively) are also fished on a smaller scale with average annual yields of 10t to 15t for the latter species caught in Aniva Bay.

The most sensitive period for salmon in coastal waters is linked to their migration, which occurs during spring and summer periods. Peak sensitivity for salmon in Aniva Bay is between May and September.

Other commercially harvested species are shown in Table 7.3.

Table 7.3 Main Commercial Species Harvested in the Aniva Bay Area with recommended catches in 2004)

Species (Common Name)	Latin Name	Allowable Catch (tonnes/year)
Japanese smelt	<i>Hypomesus japonicus</i> and <i>Hypomesus nipponensis</i>	641
Redfin	<i>Tribolodon hakonensis</i> and <i>T. brandty</i>	1,011
East Siberian Char	<i>Salvelinus leucomaenis leucomaenis</i>	826
Capelin	<i>Mallotus villosus</i>	172

Other species that are also harvested but are of less commercial importance include: rainbow smelt *Osmerus mordax dentex*, salmon trout *Salmo trutta trutta*, saffron cod (navaga), Gilbert's Irish lord *Hemilepidotus gilberti*,

shorthorn sculpin *Myoxocephalus scorpius* and capelin *Mallotus villosus*. It is thought that fish are predominantly caught by Danish seines and by fixed-gear from small seine boats.

Stocks of other species caught commercially or on a subsistence basis by local people around Sakhalin Island, such as herring, Pacific saury and Pollack are highly unlikely to be impacted by the proposed works in Aniva Bay as their habitat and life cycle do not coincide with the footprint or activities of the project.

7.4.2 Shellfish and non-fish resources

Information on shellfish resources, stocks and catch levels is available from a number of specific studies as outlined in Table 7.1. The majority of this data concentrates on the bioresources of Aniva Bay rather than specifics of commercial activity. The study by the Regional Centre for Coastal Fishing and Commercial Exploitation of Fish Resources on Sakhalin (2003) mentions several shellfish and algal species that are commercially harvested in the Bay (see Table 7.4). Two of these species, common scallop and laminaria, are also collected from the shore and in the shallow waters on a regular basis by local people, although data on the annual take of these species is not available.

Table 7.4 Main Commercial Shellfish and Non-fish Species Harvested in the Aniva Bay Area

Species (Common Name)	Latin Name	Allowable Catch (tonnes/year)
Japanese common scallop	<i>Mizuhopecten yessoensis</i>	400
Japanese laminaria	<i>Laminaria japonica</i>	2,770
Short spined sea urchin	<i>Strongylocentrotus intermedius</i>	59

Trawl surveys in the nearshore and offshore areas of Aniva Bay (e.g. SakhNIRO 2001a and 2004b) have also provided information on the presence of commercial stocks of other shellfish species, notably crustaceans. The information indicates that there are stocks of snow crab (*Opilio*) and red king crab (*Paralithoides camtschatica*) present within the Bay although the level of exploitation of these resources is unknown. Snow crab appears to be widely distributed in Aniva Bay although it occurs mainly in the south-eastern part of the region. In trawls undertaken by SakhNIRO (2001) juvenile (non-commercially viable) snow crab males and females occurred in approximately 40% of the trawls undertaken, forming the main bulk of shellfish catch by number and frequency.

Red king crabs were observed in trawl surveys around the Aniva Peninsula area and within the central part of the Bay, as shown in Figure 7.5 (SakhNIRO 2001a). This species also occurs regularly and in commercial quantities in the nearshore coastal zone (SakhNIRO 2004b).

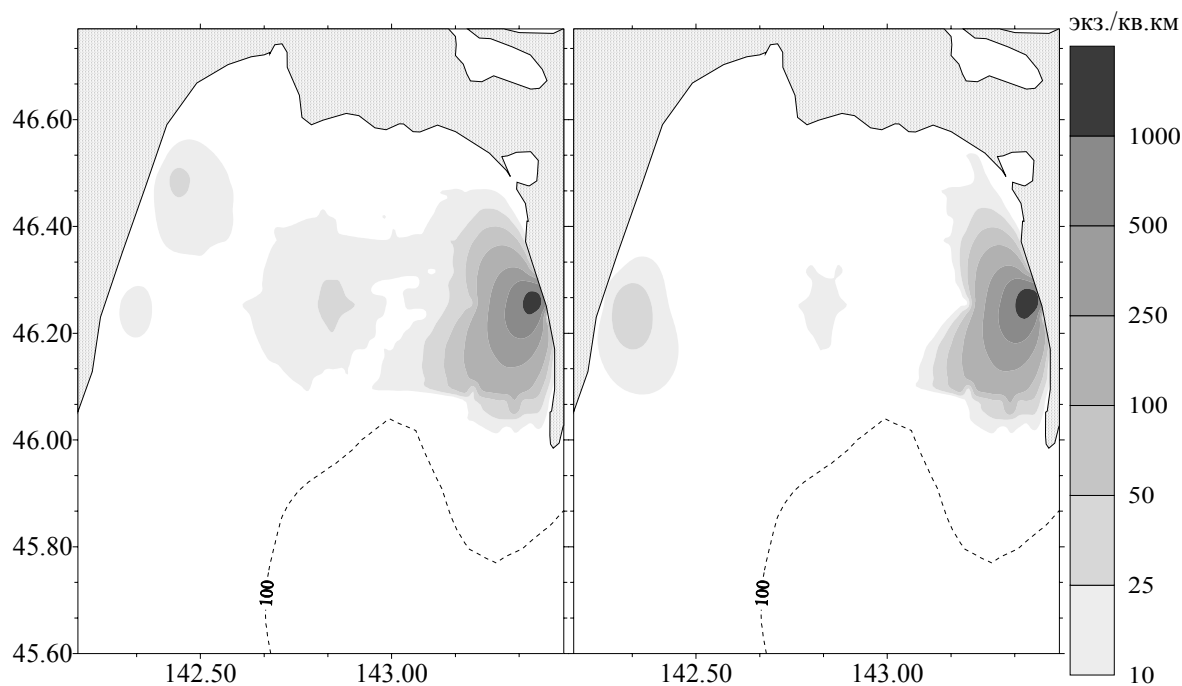


Figure 7.5 Distribution of Male (A) and Female (B) Red King Crabs in Aniva Bay in 2000

A number of commercially exploitable stocks of shrimp species, notably bear-cub shrimp, visored shrimp (*Argis larlar*) and ridged crangon (*Crangon dalli*) also occur within the Bay (SakhNIRO 2001b).

7.5 POTENTIAL IMPACTS

7.5.1 PA-B and LUN-A Platforms

The potential fisheries resources for the north-east coastal area of Sakhalin have been examined during the field studies referenced in Table 7.1. The level of fishing effort in the north-east coast of Sakhalin in the vicinity of the SEIC offshore installations is limited and largely confined to three main zones (see below). A small amount of commercial fishing occurs within Nabilsky lagoon and in the adjacent nearshore zone (for shrimps), otherwise fishing in the lagoons and rivers entering the lagoons is undertaken mainly for local consumption by people from coastal communities. Native people have a personal quota of 100kg of salmon, which they fish for from specific fishing grounds:

- A nearshore and shallow water (lagoons) zone with some potential for limited salmon fishing activities but with no port infrastructure to develop the fishery;
- Mid-water depth (30-100m) zone with a dynamic sediment regime that does not support large fish stocks;
- A deepwater (>100m) zone supporting a potentially valuable shellfish community (e.g. crab and whelk).

The potential impacts to commercial fishing activities in the vicinity of the platforms and the associated pipelines during the construction phase include:

- Direct interference with fishing activity *e.g.*, presence of increased number of vessels associated with construction;
- Imposition of exclusion zones around the platforms;
- Loss of fishing equipment (*e.g.* nets, lines, fixed gear);
- Disturbance or damage to marine habitats and commercial species.

Due to the relatively low level of fishing activity in coastal waters in north-east Sakhalin, potential impacts on fishing activity through direct interference or loss of equipment and implementation of exclusion zones are likely to be minor. For local people the vast majority of fishing activity occurs within the lagoons and river mouths. Within these areas there would be no project-related vessel traffic or imposition of exclusion zones and therefore the potential for impact on local subsistence fisheries during construction would be negligible. Similarly, the potential impacts on marine habitats and commercial fish species *e.g.*, through physical disturbance to habitats or deterioration in water quality, have been assessed in the international style EIA (*Volume 2, Chapter 3*) and are considered to be minor.

The potential impact on commercial fisheries during the operation of the platforms and pipelines is considered to be lower than during the construction phase due to reduced levels of marine activity and seabed disturbance. Impacts will therefore be minor to negligible.

7.5.2 Aniva Bay

In recognition of the potential importance of Aniva Bay for commercial fisheries and the absence of comprehensive and reliable data on fishing activities, SEIC recently commissioned an additional study in Aniva Bay. This study, executed by the Regional Centre for Coastal Fishing and Commercial Exploitation of Fish Resources of Sakhalin (2003), determined the main commercial species (*i.e.* fish, shellfish and algae) present in the Bay and estimated potential losses to commercial catches that could result from implementation of the Project.

Exclusion Zones

The physical presence of exclusion zones associated with the construction of the TLU, OET pipeline, LNG Jetty and Material Offloading Facility (MOF) in Aniva Bay, which are in place to manage safety and navigational risks, will result in a restriction of access by fishing (and other) vessels within the vicinity of these offshore facilities. During construction, the exclusion zones will be as follows:

- 1,000m radius around the TLU (April 2005 to December 2005);
- 750m on both sides of the OET-TLU pipeline (June 2004 to September 2004);
- 200m around the LNG Jetty (1 April 2005 to 31 December 2005);
- 200m around the MOF (April 2003 to 2009).

Furthermore, a "warning area" will also be established around the whole development area, which will be marked on marine charts and within which fishing will be limited. This area will occupy approximately 64km² of coastal waters. Information about the warning area zone and exclusion zones will also be communicated to fishermen, either directly by SEIC or through representatives of fishing organisations. During the operational phase, the exclusion zones will be as follows:

- 900m radius around the TLU;
- 300m turning circle around the LNG Jetty (restricted access to LNG carriers only);
- 500m on both sides of the Oil Export Pipeline.

These exclusion zones will remain in place during the operational phase, hence there will be a permanent reduction in the size of the available fishing grounds by about 8.5km². Moreover, the warning area of 64km² will remain in place and be shown on marine charts throughout the operational phase.

The implications of the exclusion zones during both construction and operation for commercial fisheries interests in the Aniva Bay area have been assessed and calculated using data collected from trawl and sampling surveys, as set out in Table 7.1 (Regional Centre for Coastal Fishing and Commercial Exploitation of Fish Resources of Sakhalin 2003). The calculations were based on the recorded biomass of the key commercial species within the area of the proposed exclusion zones, distribution data and % of stock exploited (invertebrates only) within the zones and resource loss as a function of the area covered by the exclusion zones in relation to the rest of Aniva Bay.

Using this data, potential catch losses for commercial species that could result from implementation of the exclusion zones were calculated. Table 7.5 provides a summary of the calculated losses for commercial invertebrate species and Table 7.6 losses for fish species (excluding salmon). The area of affected resource is estimated according to the known distribution of resources that occur within the proposed exclusion zones. For invertebrate species and algae, this is based on mapped data (*ibid.* 2003) and for fish on the basis that the entire exclusion zone(s) could potentially provide a fishing resource.

Table 7.5 Estimated Loss of Catch for Commercial Species (Shellfish and Algae) Resulting from Implementation of Exclusion Zones during Construction and Operation of LNG and OET Facilities in Aniva Bay

Species	Resource Area Excluded ('000 m ²)*	Specific Biomass, kg/m ²	% of Stock Viable	Annual Quota, Aniva Bay**	Estimated Catch, Prigorodnoye (tonnes)	% Overall Catch in Aniva Bay
Far East Scallop	3,800	0.06	15	400	34	8.5
	4,000				36	9.0
Short spined sea urchin	0	1.07	10	59	0	0
	15				1.6	2.7
Japanese Laminaria	0	6.4	40	2,770	0	0
	60				154	2.17

* Top figure represents excluded resource during operation, lower figure excluded area during construction.

** Recommended quota for 2004 fishery (Regional Centre for Coastal Fishing and Commercial Exploitation 2003)

Table 7.6 Estimated Loss of Catch for Commercial Fish Species (excluding salmon) Resulting from Implementation of Exclusion Zones during Construction and Operation of LNG and OET Facilities in Aniva Bay (Op. – Operation; Con. – Construction)

Species	Biomass, kg/m ²	Stock, tonnes		Potential Catch, tonnes		Total Quota (tonnes)	% of Total Quota	
		Op.	Con	Op.	Con		Op.	Con.
Japanese smelt	0.0091	3	36.4	1.18	14.6	641	0.18	2.3
Rainbow smelt	0.0076	2.47	30.4	0.6	7.6	120	0.5	6.3
Redfin	0.0033	1.1	13.2	0.43	5.3	1,011	0.04	0.52
East Siberian Char	0.0075	2.4	30	0.6	7.5	826	0.07	0.92
Capelin	0.35	590		10.5	28	172	5.8	16.3

For commercial shellfish interests in Aniva Bay, the above figures (in Table 7.5) provide an indication of the likely loss of an available resource. The calculated values suggest that, apart for the far eastern scallop, the effect of the exclusion zones will be limited to the construction period and even then the annual loss of sea-urchin and *Laminaria* harvest would be relatively small when compared with quotas for the entire Aniva Bay area. Potentially, during

the construction period it is likely that harvest effort would be directed elsewhere in the Bay in order to compensate for the loss of available resource due to exclusion. This may place some additional pressure on resources of these species in the immediate area. However, given the relatively low volume of catch involved it is considered that this additional pressure would not constitute an adverse effect on existing resources within the rest of the Bay.

The situation with respect to the far eastern scallop is somewhat different. During both construction and operation, an estimated 8.5-9% of the annual quota (based on 2004 figures) could be lost. This is largely due to the exclusion area covering much of the observed scallop ground at Prigorodnoye (Regional Centre for Coastal Fishing and Commercial Exploitation of Fish Resources of Sakhalin 2003). The significance of this loss is difficult to determine with any certainty, particularly as there is no readily available data indicating whether the stock here is commercially harvested. Potentially, this long-term resource loss could be met by additional exploitation of colonies elsewhere in the Bay, some of which are, according to population structure data, not being exploited at the present time (SakhNIRO 2001b). Some of these colonies are located towards the southern end of the Bay, at a significant distance from the main fisheries base at Korsakov, and may therefore not be commercially viable. However, given the presence of colonies of this species throughout the Bay, it is considered that the quota for this shellfish would still be met, despite the effective loss of much of the colony at Prigorodnoye.

Potentially, the exclusion of fishing from the pipeline corridor (i.e. an effective no-take zone) may lead to the establishment of a healthy "broodstock" population of far eastern scallop in the area local to Korsakov. This population could then act as a source of new planktonic larvae that could either establish new colonies elsewhere in suitable locations within the Bay or enhance the population structure of existing colonies that are exploited by the shellfish industry. As stated previously, the salmon fishery in Aniva Bay is of key commercial importance. The effect of the exclusion zones on this fishery is therefore of potential significance. Data from the study (Regional Centre for Coastal Fishing and Commercial Exploitation of Fish Resources of Sakhalin 2003) shows that the salmon fishery in Aniva Bay supports a relatively high number of fishing companies (32 in 2002 and 54 in 2001) and established quotas are regularly exceeded (e.g. in 2001 the quota was 23,440t and 33,963t were produced). The proposed exclusion zones would impact directly on one fixed salmon net along the planned offshore pipeline route at Prigorodnoye (fixed net № 345A, owned by the Lenbok Company).

With respect to non-salmonid fish resources, calculations suggest that the overall implications of the exclusion zones would be of limited significance for a number of reasons as briefly highlighted below:

- The commercial fish assemblage recorded for the proposed exclusion area is found throughout much of the Bay;
- Stocks are mobile and therefore there is effectively no loss of resource, but a reduction in available fishing area;

- The figures presented are calculated as a % of quota rather than actual stock;
- During operation (i.e. long-term) estimated losses relative to quotas (assuming no displacement fishing effort occurs) for all of the commercial species, would be less than 0.5%;
- Even assuming that fishing effort may increase in other areas due to activity displacement, it is considered that quota levels could still be achieved without a detrimental impact to resources within the Bay;
- Existing fishing effort within the proposed exclusion zones is unknown and may presently occur at a level at which potential catch would never be achieved (i.e. the calculated figures are worst case);
- The exclusion zone would effectively act as no-take zone and in this respect could actually provide some benefit in the long-term to local fisheries in the area.

The estimated loss figures for capelin (16% during construction and 6% during operation) are rather misleading, since they relate to a relatively low quota limited compared with the estimated stock level.

Data for the Prigorodnoye–Ozersky section of coastal waters indicate a stock level of around 590t (Regional Centre for Coastal Fishing and Commercial Exploitation of Fish Resources of Sakhalin 2003) which suggests that the overall loss due to exclusion would be in the region of 1.8% of potential stock during operation. Again, however, this figure needs to be viewed in the context of the points raised above.

Taking into account the factors highlighted above it is considered that the imposition of the exclusion zone during construction and operation would have a negligible effect upon the existing fish resources of Aniva Bay. Although commercial fishing activity would be prevented within the exclusion zone, the viability of commercial exploitation to achieve quotas would be unlikely to be compromised. With respect to this, it should be noted that redfin, east Siberian char and smelt effectively fill in the seasonal gap when salmon fishing and processing is not taking place. Quotas, as a rule, are therefore fully met, except for capelin, the price of which during periods of abundance (e.g. in 2002) falls to unprofitable production levels.

Relocation of facilities

Installation of the project facilities and operation of the exclusion zones has directly affected one of the three nearshore fishing companies, Lenbok. Lenbok lost land previously used for a fisherman's camp when the LNG/OET plant was being constructed, and was compensated in 2003. Compensation was spent finding and obtaining alternative fishing areas and further business development.

SEIC is presently discussing potential and perceived impacts alleged by the other two neighbouring fishing companies, Calypso and Contract. Calypso and Contract are both small commercial fishing entities employing around 20 permanent staff and 100 to 150 temporary staff engaged in both fishing and fish processing. These two companies potentially face some impacts due to an overlap of 3% and 28% respectively of the Project impacted area with the agreed fishing water area. The agreed fishing water area was allocated by Sakhryvod (the local fisheries authority). The Company is committed to pursue an amicable settlement with these companies. In pursuing such settlement SEIC will operate in accordance with applicable Russian legislation, relevant international treaties such as World Bank Operational Directive 4.30, and its Resettlement Action Plan.

7.6 POTENTIAL EFFECTS OF PROJECT NOISE DISTURBANCE

7.6.1 Background

A concern has been raised that man-made noise levels above certain threshold limits may have an adverse effect upon commercial fish populations and invertebrates in proximity to project activities, notably during construction of the LNG jetty in Aniva Bay. This issue is of particular importance with respect to the potential for the proposed works to influence migratory behaviour of salmon.

The effects of anthropogenic noise on fish species in the wild have not been well-studied. However, migratory species such as salmon continue to migrate in coastal waters and into rivers that are significantly affected by dredging, port development and marine traffic (*e.g.* The Solent in the UK), suggesting that inbuilt behavioural responses are strong enough to overcome relatively high levels of anthropogenic disturbance. It is apparent, though, from a number of studies, that high impact underwater noise can have adverse physiological effects on fish and in some instances lead to mortality.

The acoustic impedance of fish nearly matches that of water, so much of the sound energy will enter their bodies if they are in the vicinity of the source. Studies show that fish suffer damage to their auditory system as well as other parts of their bodies and may even die when exposed to sufficient sound pressure levels underwater for relatively short periods of time. High levels of mortality have been found in fish exposed to 177dB of sound and the threshold for internal injuries to fish is around 160dB. On the basis of available data and the variable response of fish to noise sources, typically a sound pressure level of 150dB is adopted as a maximum threshold for bony fish, below which direct harm is unlikely to occur (Hastings 1991). A recent major causeway project in California used 150 dB re 1 μ Pa (relative to 1 micro pascal) as a safe upper limit to avoid harm to fish.

Salmon are only sensitive to low frequency sound (Hawkins and Johnston 1978) and do not appear to react to frequencies above 380Hz. This is at the lower end of sensitivity for birds and mammals and indicates that salmon are able to sense low frequency vibrations but do not hear in the human sense. They detect particle motion rather than pressure change. The lowest response threshold and, therefore, presumably the frequency of greatest

sensitivity is between 100 and 150Hz. Above 150Hz sensitivity rapidly declines.

Experiments using a range of frequencies from 100 to 500Hz concluded that sound levels need to be in the range 108-138 dB/1 μ Pa to produce an alarm or avoidance response in fish. The threshold response of salmon is also reduced by background noise. Some species such as flatfish are even less sensitive than salmon while others such as cod are more sensitive to low frequencies than salmon. For cod, the threshold for response at frequencies of 300 to 500Hz is around 100 to 120 dB/1 μ Pa.

7.6.2 Noise generated during piling

Potentially, the noisiest activity that would take place would be sheet piling works for a temporary platform during construction of the LNG jetty in Aniva Bay and pile driving works for the Tanker Loading Unit (TLU). The sheet-piling work would be undertaken by crane from the shore using a vibro-hammer (vibropiling). The piles for the TLU would be emplaced using a vibro-hammer following drilling of slots in the seabed from a jack-up rig. In total, it is estimated that the piling and drilling works for the TLU would take approximately two days.

Nedwell and Howell (2004) provide data from several studies of noise levels generated during piling operations and the documented effects on marine life. The reported results are interesting in that they indicate that piling noise has diverse consequences for marine animals such as, little or no effect, avoidance and mortality. It is most likely that the significant factors which affect the noise level include the piling technique, pile diameter, local geology and bathymetry.

Nedwell *et al.* (2003) reports on monitoring measurements of the waterborne noise resulting from impact piling and vibropiling at Town Quay, Southampton, UK, during construction of a ferry terminal. Underwater noise levels were monitored during the vibropiling operation at a location 417m from the actual site of piling. The recorded levels showed that there was no discernible increase in the background noise signal at this point during the vibropiling operation (with recorded background levels periodically reaching 150dB, but typically in the region of 110-120dB). However, it should be noted that background noise levels in Southampton Water, as a result of the high level of shipping traffic and other water-based activities, are likely to be significantly greater than those for Aniva Bay. Caged brown trout (*Salmo trutta*) placed at 25m from vibropiling locations reportedly showed no discernible behavioural reaction to the works (Nedwell *et al.* 2003).

Nedwell and Edwards (2002) report on underwater noise measurements obtained during vibropiling operations for a wharf extension at Littlehampton in the UK. The recorded noise levels from a number of points showed a considerable degree of scatter indicating that the level of sound generated by the source varied. They attributed this variation to differing propagation conditions caused by variations in soil density near to the piles. The average (root mean square RMS) noise level for each measurement location varied between 132-152 dB/1 μ Pa at distances of 20-80m from the piling works. Noise spectra obtained for the piling shows that there was a strong signal in

the region of 27Hz but with most of the signal being concentrated in the mid-frequencies (200Hz – 2KHz).

Nedwell *et. al.* (2003), measured underwater noise levels associated with seabed drilling operations (from a jack-up rig) into sandstone for the installation of piles for offshore wind turbines. Although a source noise level for the drilling could not be obtained, all of the measurements from 100m to 9km from the drilling location were below a level at which a significant behavioural effect (marine mammals and fish) might be expected to occur (Nedwell *et. al.* 2003).

Much higher noise levels are generated during pile-driving operations using the impact piling technique (this would not be used for the LNG jetty work or construction of the TLU). An assessment of the effect of impact pile driving noise on fish species predominant near Rødsand, Denmark has been made by Engell-Sørensen (2000). This work assessed the potential behavioural and physical effects of the noise levels of pile driving associated with construction of offshore wind turbines. Sound Exposure Levels for four measurement positions between 30 to 720m from the activity gave levels ranging from 166 dB to 188 dB re 1 mPa, with a calculated Source Level of 210 dB re 1 μ Pa @ 1m. Engell-Sørensen (2000) concluded that: avoidance reactions would be likely to occur up to 30m from the source, especially for species with swim bladders; the measured noise levels could harm the hearing ability of clupeids such as herring (*Clupea harengus*) and sprat (*Sprattus sprattus*), but this may regenerate over time; and, other than those already mentioned, the noise from pile driving is unlikely to cause any other physical effect.

The data from this and other studies demonstrates that the noise generated by impact piling works in the marine environment has the potential to cause acute damage and even mortality to fish. For pelagic fish, the most likely behavioural response during piling would be avoidance of the area in which the noise signals reach a threshold at which discomfort or annoyance is reached. Site measurements indicates that the noise levels associated with vibropiling, such as would be used in Aniva Bay, are significantly lower than those created during impact piling and consequently the potential for disturbance or harm to fish is also much reduced. Nedwell and Edwards (2000), processed recorded noise levels from vibropiling works into levels that are indicative of how much a species would be affected by sound (dB_{ht} species levels, where ht = hearing threshold). These figures indicated that the noise levels generated by vibropiling were considered to be unlikely to induce any significant behavioural response in fish species such as salmon or flatfish.

Available evidence therefore indicates that the noise levels likely to be generated during vibropiling works in Aniva Bay would be unlikely to have an adverse impact upon commercial fish populations that may be in the vicinity during the works. Recorded source noise levels for vibropiling are below levels at which mortality and acute harm to fish would be likely to occur and data also suggests that significant behavioural responses in species such as salmon would also be unlikely. Even so, if disturbance threshold levels were exceeded there would be extensive acoustically undisturbed areas available for fish to move into without detriment to their survival.

Specific mitigation measures to deal with noise generation during vibropiling are not considered necessary (e.g. ramp up). However, to minimise the potential for disturbance to commercially valuable salmon populations the vibropiling works would be undertaken prior to the start of the main migration/spawning period (i.e. before May). If the works are completed before migration then it is considered that the piling works would have a negligible impact upon commercial salmon populations in Aniva Bay. For the reasons discussed above, the noise generated during the works would have a negligible impact on other commercial species (e.g. capelin, saury).

7.6.3 Noise generated during dredging

As set out in EIAA Chapter 12 on Dredging in Aniva Bay, only grab dredgers were used in the dredging campaign up until Sept 2005. For the dredging work post September 2005, a grab dredger was used for the LNG jetty work (approximately 26,000m³ remaining) and for the dredging of the turning circle (approximately 1,100,000m³ of material) a large cutter suction dredger and bottom dumping hopper barge (capacity of 25,000m³) were used between the end of September and end of October 2005. The decision to use a large cutter suction dredger was to expedite the dredging programme and to complete all dredging in 2005, rather than carry it over into 2006 (see Chapter 12 for further information). This decision conveys some avoidance of environmental impact through significantly reducing the period of disturbance, and enabling an earlier start to the natural recovery of affected areas.

Reported source levels for general marine dredging operations range from 160 to 180 dB re 1µPa @ 1m for 1/3 octave bands with peak intensity between 50 and 500Hz (Greene and Moore 1995). One of the most comprehensive studies of underwater noise emissions from dredging was carried out by the United States Army Corps of Engineers in Cook Inlet, Alaska (Dickerson *et. al.* 2001). The research provides detailed records of the underwater noise generated by a bucket (grab) dredging operation (the type of equipment that it is proposed to use during construction of the LNG jetty in Aniva Bay). Measurements of the dredging in Cook Inlet, showed that the bucket striking coarse gravels on the seabed generated the most noise with a recorded peak of 124 dB re 1 µPa-m at 150m from the dredge site which attenuated by 30 dB re 1 µPa-m over a distance of 5km. The digging operation was characterised by a grinding noise with a recorded peak of 113.2 dB re 1 µPa-m at 150m from the dredging site to 94.97 dB re 1 µPa-m, 5km away. These measurements were recorded for the dredging of gravels, and similar noise levels would be expected for dredging of similar sediments in Aniva Bay.

Recorded noise levels for large cutter suction dredgers are higher than those associated with grab dredgers. Recorded broadband noise data for the large cutter suction dredger *JFJ de Nul* are given as 183 dB/1 Pa at 1m (Sakhalin Energy, 2004). Measurements of two suction dredgers, the *Aquarius* and *Beaver Mackenzie*, are reported in Nedwell and Howell (2004). Their octave band spectra peak between 80 and 200 Hz, with the *Aquarius* having the higher of the two spectra peaking at approximately 177 dB re 1 mPa. In the 20-1000 Hz band, the *Beaver Mackenzie* and the *Aquarius* were measured to

have a 133 dB re 1 mPa level at 0.19km and a 140 dB re 1 mPa level at 0.2km respectively.

Information from a number of studies indicates that acute damage to fish caused by sound does not occur below about 160 dB/1 Pa. During grab dredging activities, this noise level is unlikely to be generated, even when dredging through partially consolidated rock. However, noise levels as high or higher than 160 dB/1 Pa could have been generated in close proximity to the cutter suction dredger. Available data indicates that in shallow coastal waters, underwater noise transmission loss is typically of the spherical spreading type (Nedwell and Howell 2004). This means that for each tenfold increase in distance from the source the sound level will reduce by 20 dB. For the source measurements for the cutter suction dredgers provided above, this means that a noise level of approximately 160 dB/1 Pa would occur at a distance of 10m from the cutter head and 140 dB/1 Pa at 100m. This calculation, although broad brush, demonstrates that potential acute damage to fish would only be likely to occur up to 100m of the cutter head and probably at a distance significantly less than this.

Thus, at distances greater than a 100m, acute damage would not have been likely to occur. Fish would have avoided moving close to the working dredger head as the sound would have caused an avoidance response, and therefore acute damage would only occur if fish were present in the vicinity when dredging operations started. This in itself would be highly unlikely given the physical disturbance that this activity would have caused.

It has also been calculated that the majority of fish (including salmon) would not be able to detect the noise made by dredging activity at a distance greater than 1km from the activity. Henderson (2003), assuming spherical spreading of sound, calculated that the predicted sound level from a suction cutter dredger would be 100 dB/1 μ Pa at 1km. On this basis it is considered that the noise generated during dredging would not lead to fish mortality and at worst would lead to temporary avoidance of nearshore waters immediately adjacent to the dredging activity.

Dredging noise varies through time and periodically dredging ceases whilst the dredged material is taken away for disposal. This creates periods of calm and quiet, during which fish can move through the area undisturbed.

7.6.4 Effects of shipping generated noise

In the longer term, there would be an increase in vessel-generated noise associated with use of the LNG and TLU facilities in Aniva Bay and potentially ship-generated noise could have an impact upon marine life within the Bay.

At low frequencies (5 to 500Hz), commercial shipping is the major contributor to noise in the world's oceans. Distant ships contribute to the background noise over large geographic areas. The sounds of individual vessels are often spatially and temporally indistinguishable in distant vessel traffic noise. Ships generate noise primarily by propeller action, propulsion machinery and hydraulic flow over the hull. Overall, vessel noise covers a wide range of frequencies from 10Hz to 10kHz. A recent study of noise levels from small powerboats suggests peak spectral density levels in the 350-1,200Hz band of 145-150 dB re 1 μ Pa²/Hz @ 1m (Bartlett and Wilson 2002). Richardson *et. al.*

(1995) report noise levels of 162dB at 630Hz (@ 1m) for a tug/barge travelling at 18km/hr, through to a large tanker with source level around 177dB (@ 1m) in the 100Hz third octave band.

Larger vessels have more powerful engines and slower-turning engines and propellers. Larger hull areas more effectively couple machinery sound from within to surrounding water. Therefore, as a rule-of-thumb, the bigger the ship, the higher the source level produced and the lower the dominant frequency range of the noise. In addition, for a given ship size and design, sound power level increases with speed.

Overwhelming evidence has been presented that fish show an avoidance reaction to vessels when the radiated noise levels exceed their threshold of hearing by 30 dB or more. Environmental and physiological factors play a part in determining the noise levels that will trigger an avoidance reaction in fish. For many vessels fish avoidance reaction distances are 100 - 200m but for the noisiest 400m is more likely.

Based on available data (Richardson *et. al.* 1995) the highest expected vessel generated noise level would be in the region of 170-180 dB/1 μ Pa of broadband noise close to ships in the vicinity of the TLU and LNG jetty. The sound levels in the low frequency range of 50 to 150Hz (to which fish such as salmon are most sensitive) will be of lower power and unlikely to cause physical injuries which may occur at levels above 150 dB/1 μ Pa. However, during shipping movements the noise levels will be sufficient to cause alarm reactions in fish within at least 200m of any large ship (> 55m in length).

Flatfish such as flounder are relatively insensitive to sound and are unlikely to be deterred by vessel-generated noise. Fish such as salmon, may be alarmed and may avoid areas of high ship movement in the vicinity of the TLU. These fish would, however, still migrate to and from natal rivers, as sound levels 1km away from facilities can be anticipated to be below the 108-138 dB/1 μ Pa level required to produce an alarm or avoidance response for salmon.

7.7 MITIGATION AND MONITORING

A full list of mitigation measures proposed to avoid or minimise impacts on fish species and marine ecology in north-eastern Sakhalin and Aniva Bay are included within the EIA (Volumes 2 and 5, Chapter 3, respectively).

There are a number of standard procedures that will be adopted by SEIC to reduce potential direct impacts on commercial fishing vessels or equipment as follows:

- Continued consultation will be carried with interested parties and prior notification will be given to them providing details of platform towing routes and schedules, and the location and scheduling of construction and pipe laying activities;
- Notices to Mariners will be issued giving the location of the temporary and permanent exclusion zones around the construction and platform sites;

- Community liaison officers (CLOs) appointed by SEIC will be responsible for maintaining dialogue with fishermen and ensuring that fisheries issues are communicated during all phases of the project;
- Should fixed fishing gear be located along the pipeline routes, the fishing representative will organise its removal and return. As a last resort, a support vessel may be required to remove the fishing gear;
- Records shall be kept of all communications with fishermen and legitimate and verifiable damage to fishing gear and all compensation claims shall be handled according to agreed protocols between the contractor and the local fisheries representatives.

Where there is a need for relocation of fishing enterprises, as is the case in Aniva Bay, SEIC will ensure sufficient compensation and assistance to help ensure that such enterprises are in an equal or better position after relocation. In such cases, SEIC will ensure:

- The removal and relocation of equipment;
- Compensation for lost income, based on value of catch;
- Assistance in and compensation for purchase of a new fishing licence.
- Consultations between SEIC and Sakhalin Fisheries Association to discuss potential impacts on the fishing industry will be continued;
- Compensation for potential damage to the salmon fishery is being paid based on Fish Damage Calculations that estimate the net loss of salmon biomass in accordance with Russian Federation regulations. Compensation is directed towards salmon hatcheries to replace the estimated loss of fish biomass. The principles which the Company adheres to in any future compensation claims are set out in the Resettlement Action Plan (RAP), on the Company's website. Any grievances that fall outside of the RAP will be addressed through the SEIC Grievance Procedure (information on how to inform the Company of a grievance is provided in the Public Consultation and Disclosure Plan (PCDP));
- Where appropriate, further investigations will be carried out by SEIC on existing commercial fishing activities and general vessel operations within the area potentially affected by construction activities and project operations to further define appropriate mitigation measures;
- SEIC's dredging and disposal policy is fully in line with the regulatory regime of the Russian Federation. Proposed dredging works and the determination of disposal locations is also undertaken in consultation with the main environmental regulatory body (SakhNIRO).

Specific mitigation measures that will be applied in Aniva Bay to minimise potential impacts on the commercially important fisheries will include:

- Any discharges of wastewater will be in accordance with Maximum Permitted Concentration (MPC) values;

- Rainwater runoff from construction sites will be collected in a drainage system and treated in settling ponds prior to discharge, in accordance with the MPC values for suspended solids;
- Undertaking piling works in accordance with specific measures to avoid excessive noise generation and potential harm to fish in the vicinity of the LNG/MOF works (see Section 7.6.2);
- The dredge spoil disposal site will be located offshore (approximately 25km from the coast) in order to avoid impacts to fisheries in the coastal areas of Aniva Bay where the majority of fishing activity takes place. The selection of spoil disposal locations (see EIAA Chapter 12 for information on the project's dredging and disposal activities in Aniva Bay) included consideration of relative impacts on marine fisheries and found that fishing activities in the location of the spoil disposal site were very limited;
- As part of a hydrobiological survey during 2003 (SakhNIRO 2004b), benthic samples were taken in the dredging, disposal areas and pipeline route. Ecological monitoring of commercial fish species will be conducted for these areas twice per year (May/August) during the construction phase. Information from this monitoring/survey work will feed back into the impact verification process to ensure that mitigation measures are focused and address identified issues;
- Existing surface water (Mereya River and Goluboy River) and seawater monitoring will be continued during and after the construction phase to identify any change in key ecological parameters that might be associated with construction activity. Monitoring criteria will include plankton, invertebrates, fishes, fish spawning activities, the chemical quality of seabed sediments, and seawater; and
- The development of a dedicated monitoring programme to determine the level of small-scale fishing activity in the vicinity of the LNG plant and potential effects of the construction works on the recreational fishing use of the beach. The need for monitoring post-construction will be determined on the basis of the data collected and discussion with the relevant authorities. Monitoring of the activity will be undertaken by a Community Liaison Officer on an *ad hoc* basis throughout the fishing season (generally May to September and outside of the dredging period). The type of information will include the numbers of people fishing, fishing effort and estimated catch, and the number of fish licences issued by fish inspectors. Data collected from the site through an initial survey and questionnaire carried out during the summer 2005 indicates that approximately 150-250 people use the area daily, 95% of whom purchase a licence to fish. The majority (65%) of fishing activity is recreational and for subsistence purposes. The monitoring data collected will be used in determining the nature of any potential effects on small-scale fishing activity and, if required, developing appropriate management/mitigation measures.

7.7 RESIDUAL IMPACTS

7.7.1 PA-B and LUN-A Platforms and offshore pipelines

Available information indicates that commercial fishing activity in the coastal and offshore area of north-eastern Sakhalin is relatively small-scale, although the area supports commercially exploitable stocks of a number of fish and shellfish species and the lagoon system is an important fishery for local people (SakhNIRO 2001a). The exclusion zones and physical presence of platforms, pipelines and associated vessels will therefore be unlikely to have a significant impact upon either commercial or native fisheries interests. Taking into account the successful implementation of the proposed mitigation measures, as listed above, it is considered that the impact of the project, during both construction and operation, would be of minor significance.

7.7.2 Aniva Bay

In comparison to the north-east of the Island, Aniva Bay is an important commercial fishing area and there will be some direct impacts on fishing activity as a result of construction works, the physical presence of the project and the associated exclusion zones. The direct impacts of the works on commercial operations and fish stocks, notably the imposition of exclusion zones around the OET pipeline and LNG jetty and impact on licensed fishing areas, have been resolved through assistance with relocation and financial compensation. As such, the outstanding elements of the construction and operation of the facilities in Aniva Bay relate to specific aspects such as dredging and disposal and wastewater discharge during operation. A number of mitigation measures, as listed above in Section 7.6, will need to be introduced to ensure that these identified effects do not impact upon commercial fish and shellfish populations and that commercial interests are maintained. With the implementation of these measures, in combination with a dedicated monitoring programme, it is considered that impacts on commercial fisheries in Aniva Bay can either be avoided or reduced to a negligible level.

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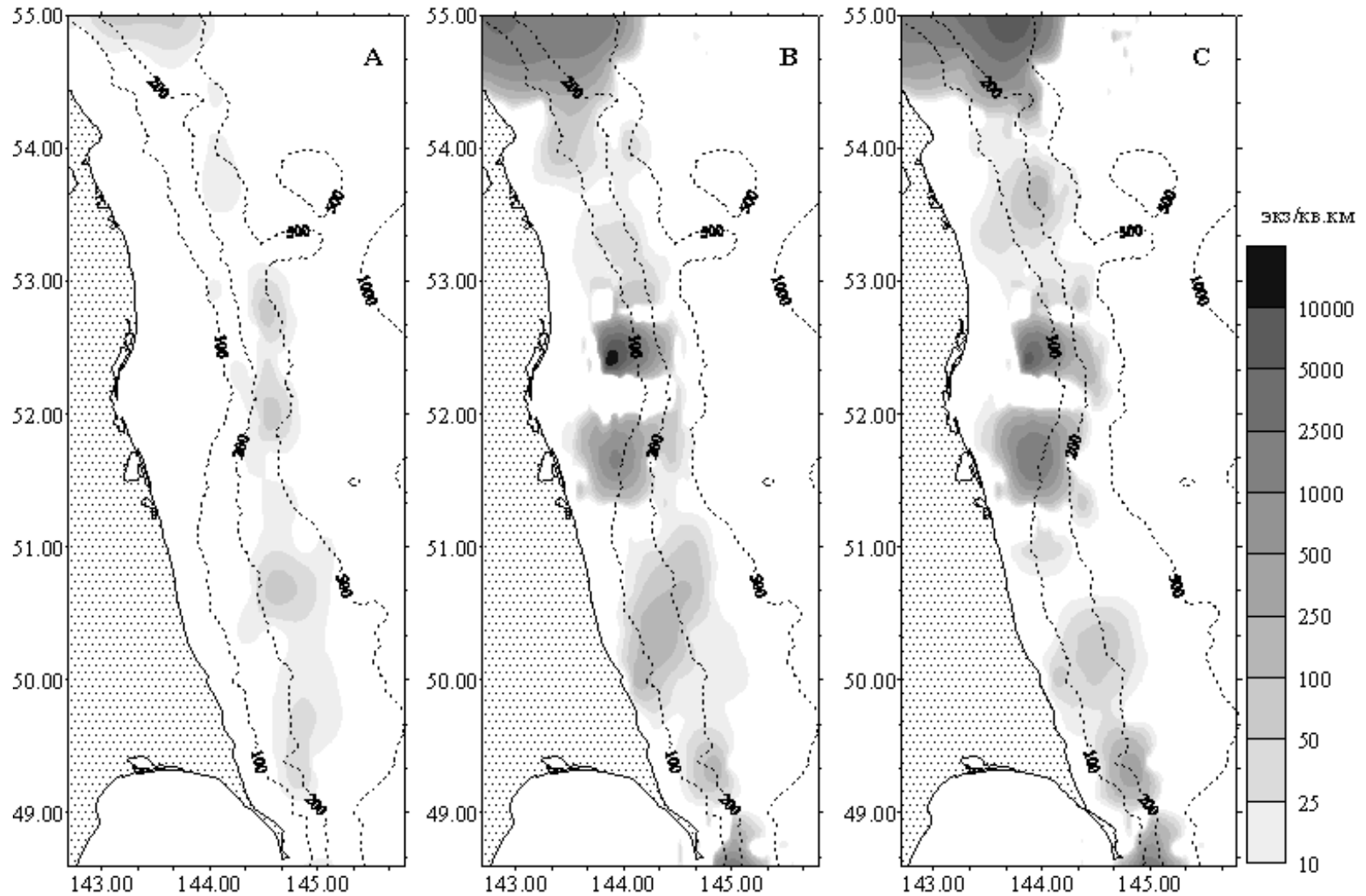


Figure 7.2 Distribution of Commercial (A), Non-commercial (B) Males and Females (C) Snow Crab (*Opilio*) along the North-eastern Sakhalin Coast in 2000 (ind/km²) [From SakhNIRO 2001a]

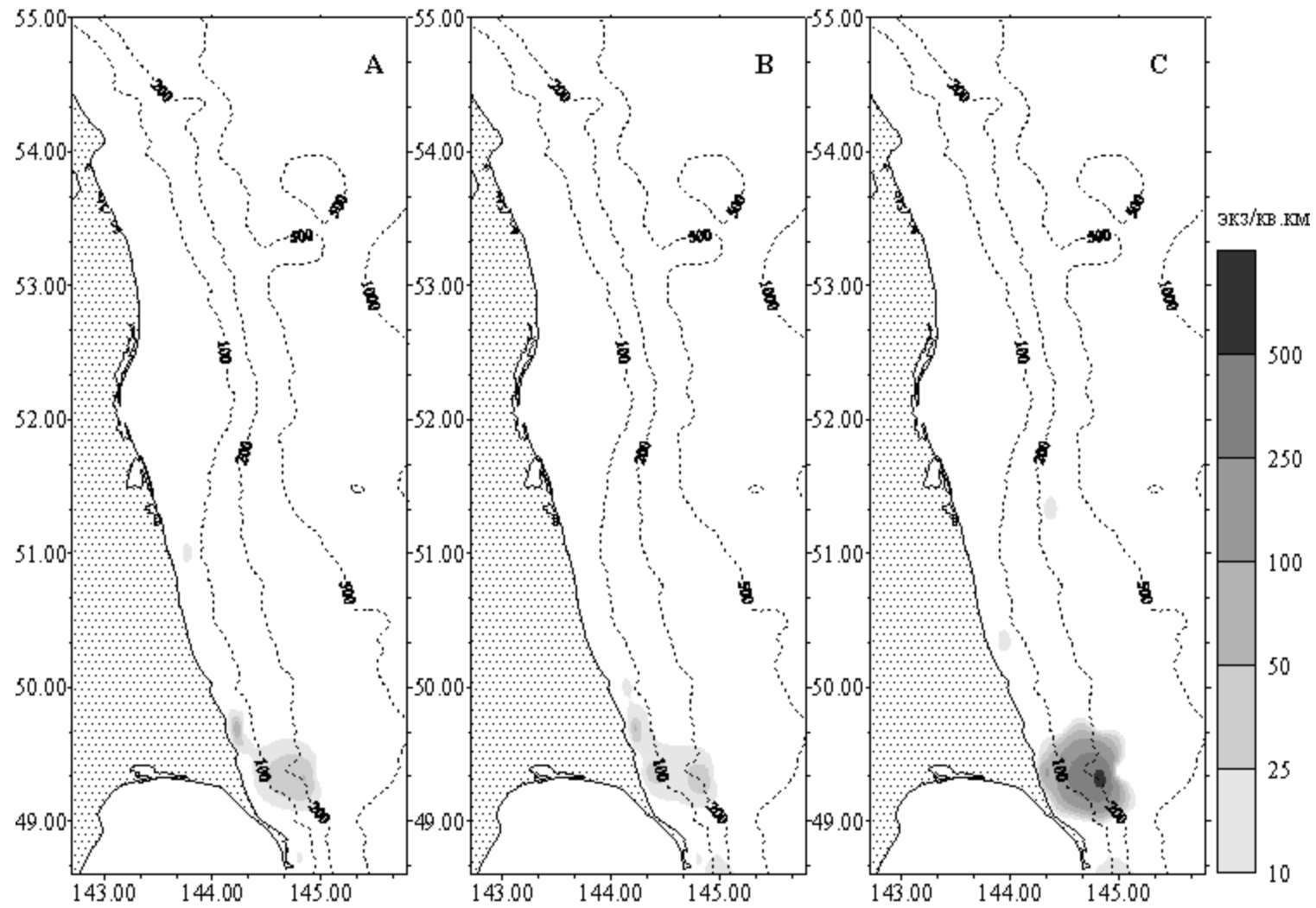


Figure 7.3 Distribution of Commercial (A), Non-commercial (B) Males and Females (C) Blue King Crab along the North eastern Sakhalin Coast in 2000 (ind./km²) (From SakhNIRO 2001a)

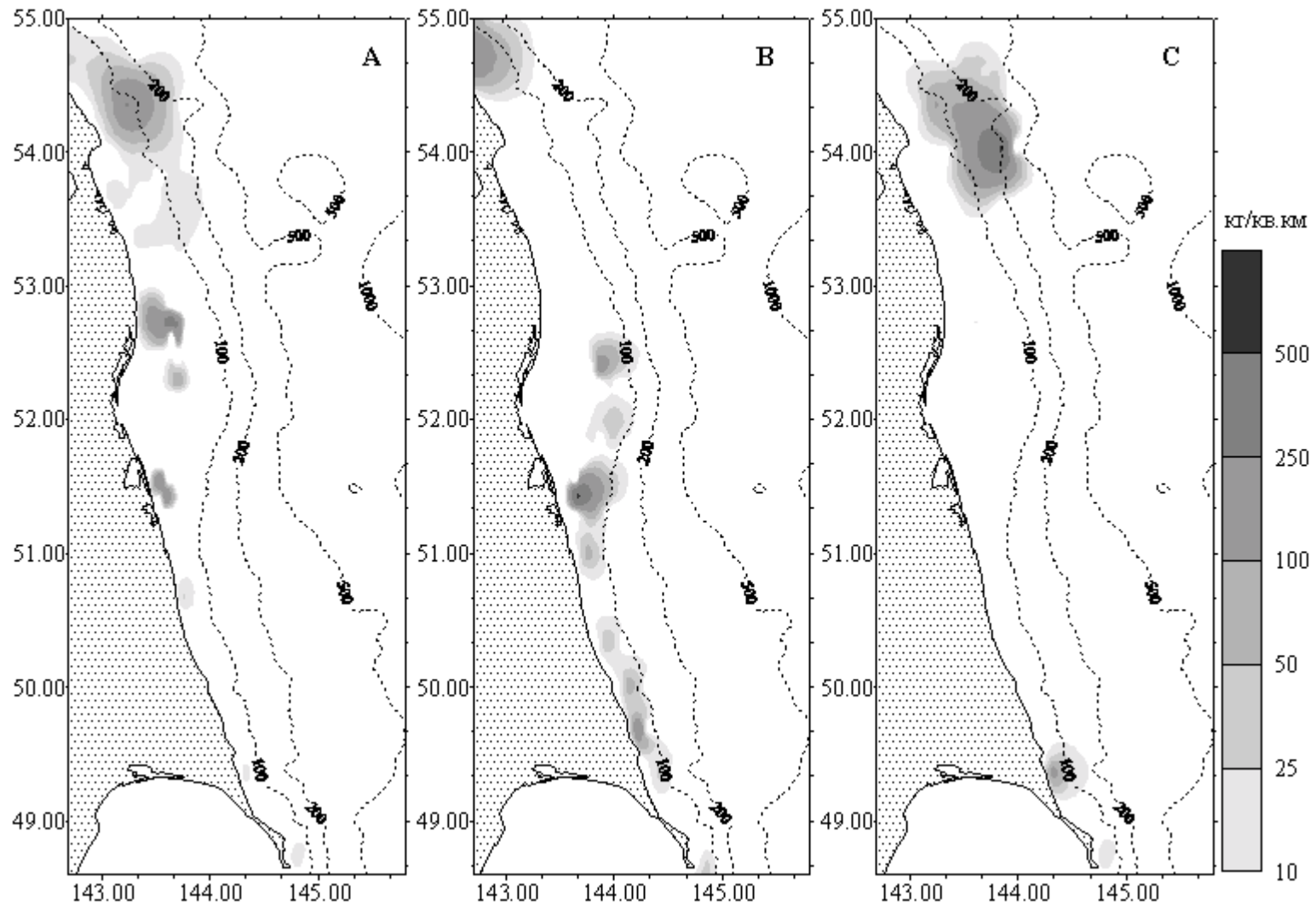


Figure 7.4 Distribution of Total Catches of *S. boreas* (A), *S. salebrosa* (B), and *L. groenlandicus* (C) along the North-eastern Sakhalin Coast in 2000 (kg/km²)