3. Assessment of the aquaculture potential in St. Kitts and Nevis

3.1 Some key data on natural resources

Overview of the natural resources will be presented in GIS maps, but the general data are that the Federation has 261 km^2 land area of which Saint Kitts is 168 km^2 and Nevis 93 km^2. Since this study for various reasons will concentrate on use of seawater in aquaculture it is relevant to note that the total shoreline is about 140 km of which St. Kitts has about 90km. St Kitts and Nevis both have volcano mountain peaks of more than 1,000m, but the islands are unique among the smaller Caribbean islands because they have a large 75% part of the land with a gentle slope (less than 10%).

Due to the hurricane risk the fish farming will combine farming both on land and in the sea, using the sea only outside the hurricane season. The relative flat near shore land makes it suitable for land based (seawater) farms.

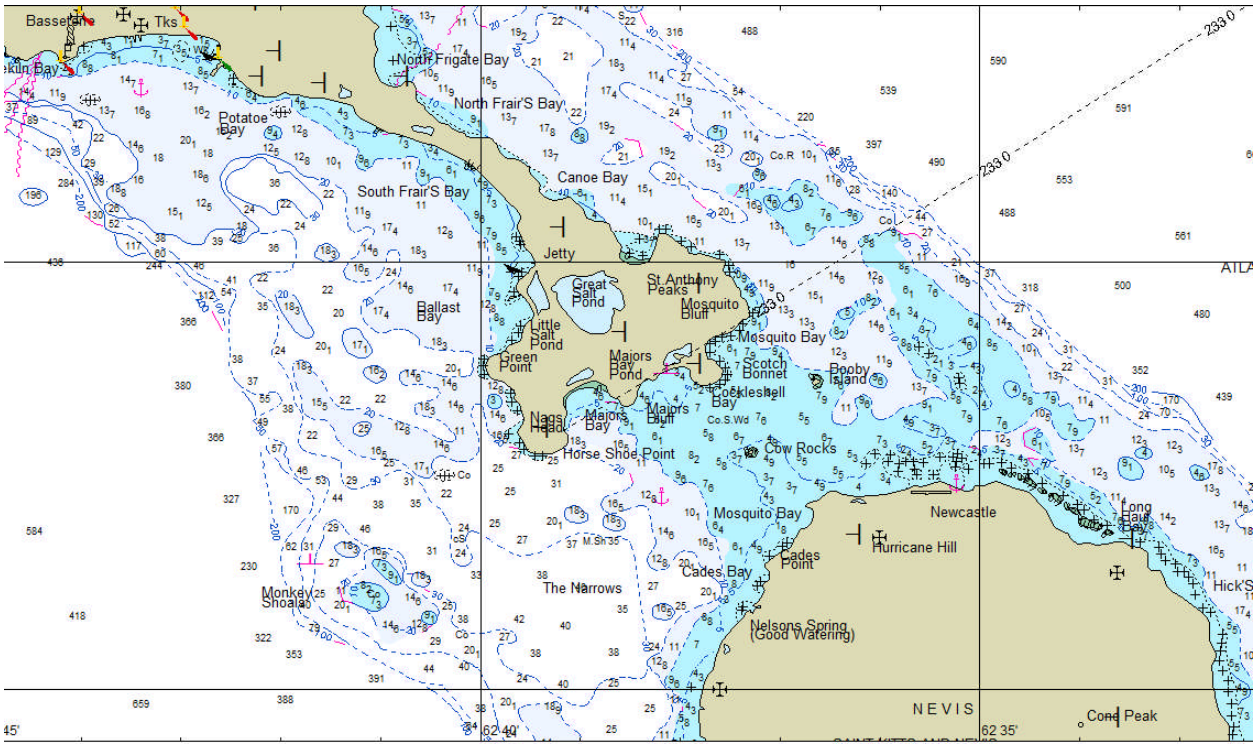


Figure 2: Naval map showing bathymetrics of suitable fish farming areas Southwest of St Kitts and West of Nevis

While for the easiest version of sea based cage farming it is recommended to utilise between 20-30 m depths of which there are ample areas. Southwest of St Kitts and Wests of Nevis are most suitable being protected from the main trade winds coming from Eastern directions (Figure 2).

3.2 Climate

3.2.1 Seasons; precipitation and air temperature

The climate of SKN is tropical and has 2 more or less distinct seasons, a dry and a wet season, the latter lasting from July to December. However rainfall does occur all year with a mean annual precipitation of 1,170 mm to 1,905 mm in St Kitts. However the latter varies from 400mm in South east peninsula region to several meters in the central mountain areas. In the different references different values are given, but this is attributed a very large variation in annual rainfall depending on the occurrence of hurricanes in the vicinity or not. This has a strong impact on annual precipitation volume up to a factor of more than 200% and thus some years the rainfall is down at 700mm creating draught like conditions.

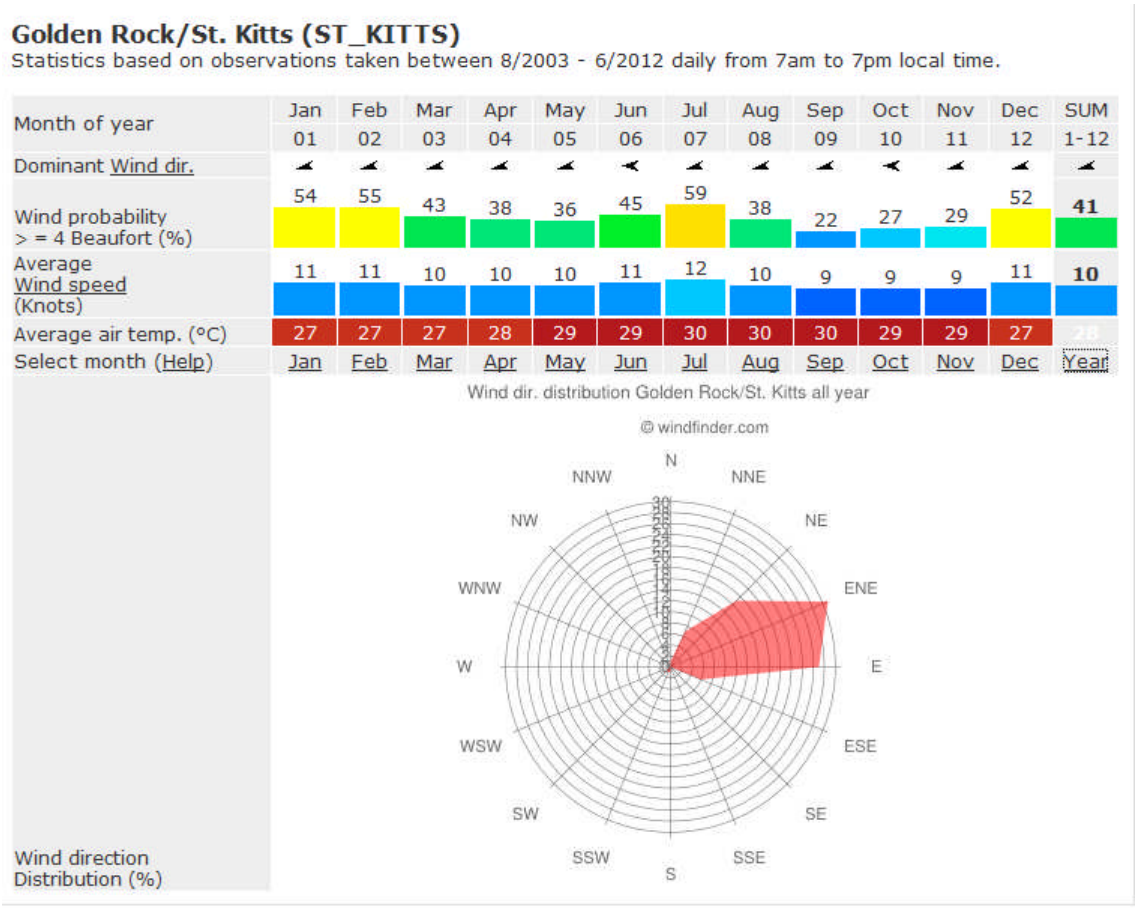
Even if some areas receives plenty of rainfall the fast-draining soil conditions combined with the sloping landscape result in that no natural, permanent freshwater ponds or lakes are formed and there are only few and small perennial streams, while many ephemeral channels/streams.

Like many islands in the Lesser Antilles St Kitts and Nevis have restricted availability of freshwater (576 m^3/person/year). Until 1970's all water resources used were springs and streams but to secure better and consistent resources now the main domestic freshwater supply on St Kitts originates from wells, while Nevis use mountain spring resources combined with wells. There are some, but few, of the ephemeral channels or springs on the hill sides, which have been dammed to create water catchment ponds mainly used for irrigation purposes such as 3 on Nevis used at Prison Camp for irrigation and 4 at St Kitts. On Nevis there are plans for further 6 reservoirs for potable water and 2 wells for irrigation, while St Kitts have plans for another 5 (Agriculture Department). The spring at Frenchman cave Nevis was used for irrigation and is estimated to give 14 gallons/minute when operational. Several wells may be available for aquaculture as they have showed up to yield brackish water, but often they are located inside village areas and hence not directly available for aquaculture, but one was located at Fort Briston, New Guinea, SK, which is a site of interests for a pilot farm yield 150 gallons per minute and of 5ppt.

As true tropical islands the average air temperatures shows very little variation during the year from 27 to 30 °C with a small increase during the wet season.

3.2.2 Wind speed and directions; hurricanes

Figure 3: Average wind speeds and directions, St. KittsFigure 3 and Figure 4 show that the wind patterns of St. Kitts and Nevis are the typical trade winds expected of the "Leeward Islands" i.e. fairly constant velocity (direction and speed).



Golden Rock/St. Kitts (ST_KITTS)

Statistics based on observations taken between 8/2003 - 6/2012 daily from 7am to 7pm local time.

Month of year	Jan 01	Feb 02	Mar 03	Apr 04	May 05	Jun 06	Jul 07	Aug 08	Sep 09	Oct 10	Nov 11	Dec 12	SUM 1-12
Dominant Wind dir.													
Wind probability > = 4 Beaufort (%)	54	55	43	38	36	45	59	38	22	27	29	52	**41**
Average Wind speed (Knots)	11	11	10	10	10	11	12	10	9	9	9	11	**10**
Average air temp. (°C)	27	27	27	28	29	29	30	30	30	29	29	27	28
Select month (Help)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year

Wind dir. distribution Golden Rock/St. Kitts all year

Wind direction Distribution (%)

Figure 3: Average wind speeds and directions, St. Kitts

The average wind speeds are very steady between 9 – 14 knots (4.59 – 7.20m/s), which is similar to a moderate breeze[2]. The winds tends to be a little stronger at Nevis, but this may also be attributed that the weather station is right at the sea, while that of St Kitts is 2km inland. Also with due respect to the locations of the two weather stations the wind directions of St Kitts are mainly from Northeast to East (87%) while on Nevis it is from East to Southeast (94%).

[2] One of the better and easy accessible overviews of climate related information from coastal areas can be found on http://www.windfinder.com/windstats/windstatistic_map_world.htm a website for windsurfers etc. Statistical climatic data from reliable sources such as airports, weather stations or lighthouses are presented in a uniform format, which makes it easy to compare different areas.

Newcastle/Nevis (NEVIS)

Statistics based on observations taken between 3/2008 - 6/2012 daily from 7am to 7pm local time.

Month of year	Jan 01	Feb 02	Mar 03	Apr 04	May 05	Jun 06	Jul 07	Aug 08	Sep 09	Oct 10	Nov 11	Dec 12	SUM 1-12
Dominant Wind dir.													
Wind probability > = 4 Beaufort (%)	72	58	61	68	62	71	82	59	43	50	43	55	**60**
Average Wind speed (Knots)	13	12	12	13	12	13	14	12	10	11	10	11	**11**
Average air temp. (°C)	27	27	28	28	29	30	30	30	30	29	29	27	28
Select month (Help)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year

Wind direction Distribution (%)

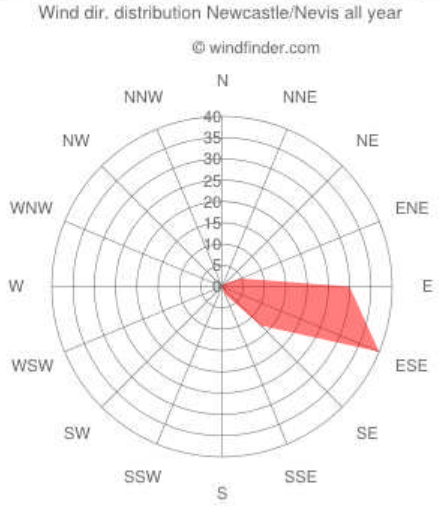


Figure 4: Average wind speeds and directions, Nevis

One of the most important climate factors to be considered in development of at least sea based aquaculture is that St. Kitts and Nevis are located in the hurricane belt of the Western Atlantic Ocean and the Caribbean Sea. Officially the hurricane season lasts from June to November, while the most frequent hits are from August to November.

From the website of the "Post-Georges Disaster Mitigation in Antigua & Barbuda and St. Kitts & Nevis" by the Organization of American States, http://www.oas.org/pgdm/hazmap/windsurg.htm the wind conditions for St Kitts and Nevis during a hurricane are predicted (Figure 5; Figure 6; Figure 7).

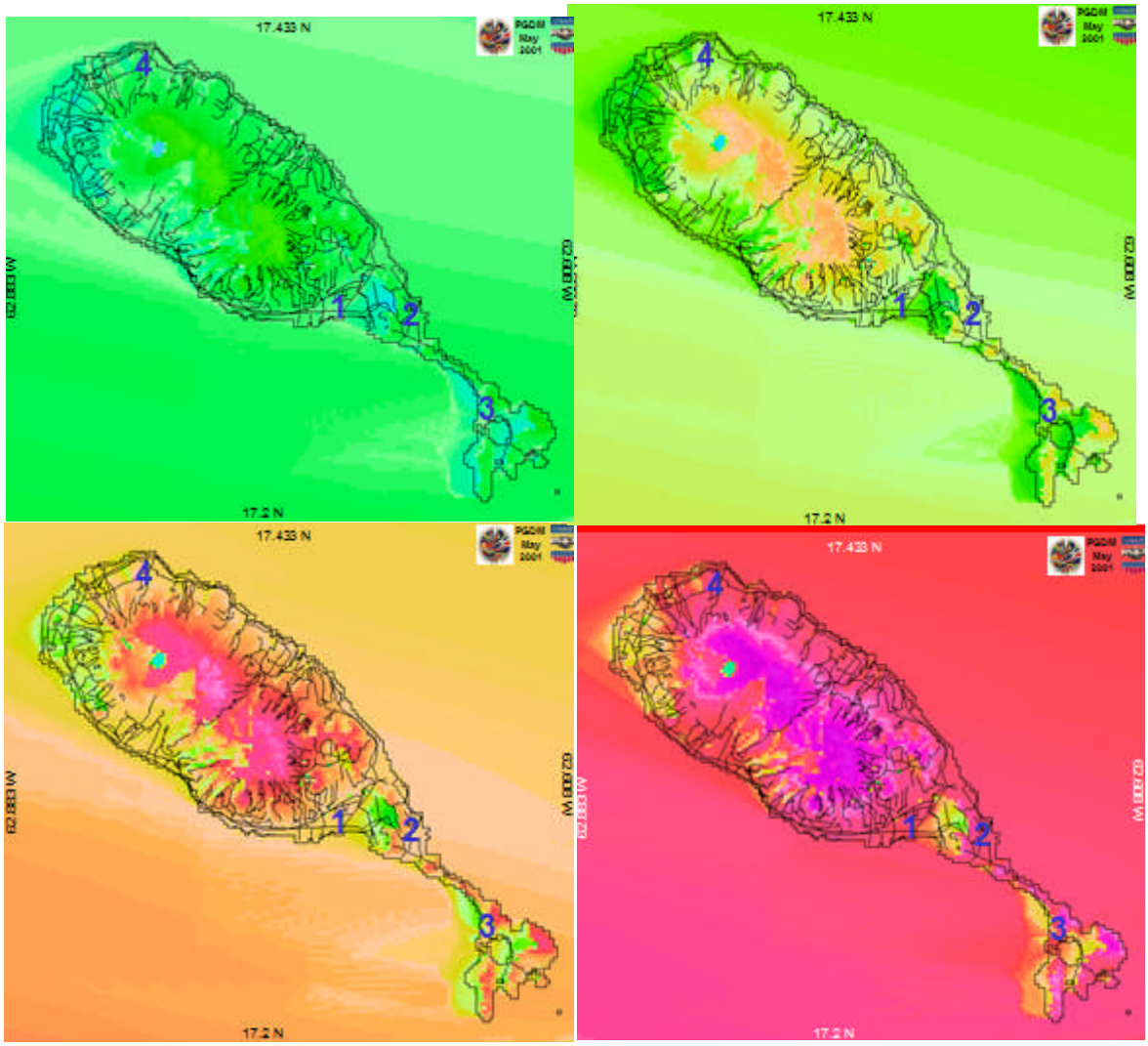


Figure 5: Extreme winds at St Kitts during a hurricane with a probability of "once every 10; 25; 50 and 100 year" (pls. refer to legend/colour codes in Figure 7)

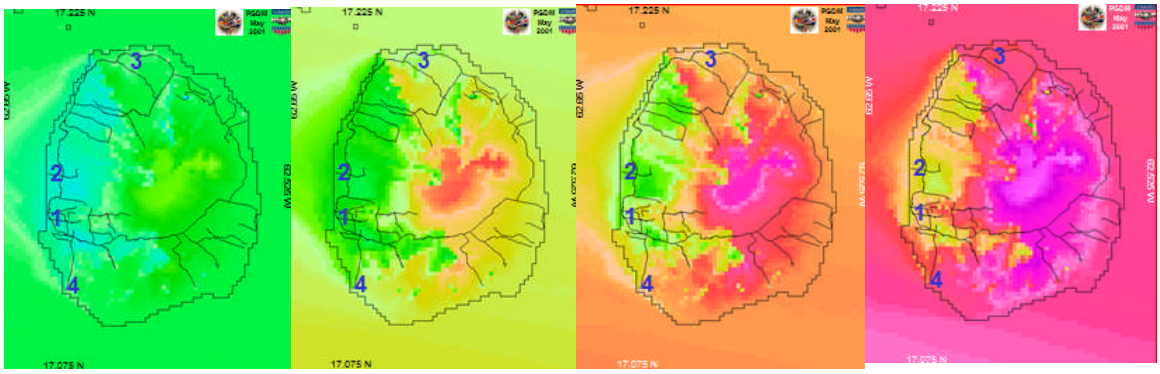


Figure 6: Extreme winds at Nevis during a hurricane with a probability of "once every 10; 25; 50 and 100 year" (pls. refer to legend/colour codes in Figure 7)

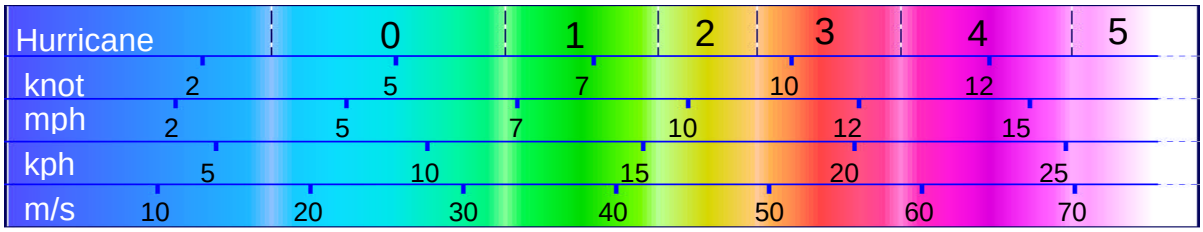


Figure 7: legend/colour codes used in Figure 5 and Figure 6 for wind speeds during hurricanes

The analyses of OAS shows that a hurricane category 1 is likely to hit the islands directly with a 10% probability – i.e. at least once in a 10-year period (a 10-year return period) – thus creating too risky or unfavourable conditions for around-the-year farming in traditional sea cages, mainly because of the waves generated by the storm (see next chapter).

Table 1: Probability of shore wind speed (m/s) at sites in St. Kitts (SK) and Nevis (N) during hurricanes

Probability	Basse-terre (SK)	North Frigate Bay (SK)	South Peninsula (SK)	Dieppe (SK)	Charles-town (N)	Pinney's Beach (N)	New-castle (N)	Long Point (N)
10% i.e. once in 10 years	33	34	31	33	28	29	34	34
4% i.e. once in 25 years	42	43	40	42	37	37	44	44
2% i.e. once in 50 years	48	49	41	48	24	43	50	50
1% i.e. once in 100 years	54	56	51	54	47	48	56	57

3.3 Oceanography

3.3.1 Tide and current

The tide varies between a semidiurnal and diurnal pattern (so-called "mixed mainly diurnal") – but as in most Caribbean area it does not have a large impact on the coastal environment as the amplitude varies from few cm to 30 cm. Very often the tide does not even show because of local weather conditions having stronger impact.

The small amplitude has both advantages and disadvantages for aquaculture (Pls. refer to Chapter 6).

The small amplitude also means that the tide generated currents are very weak. No general information on local water currents has been found, however overall the offshore area is influenced by the Caribbean Current, which in St Kitts and Nevis area is a West-Northwest-ward current flowing at an average speed of 38-43cm/s. In an 'Environmental Impact Assessment' arranged by a Norwegian company Carina during 2005 in connection with a (failed) plan to establish an offshore fish farm at Nevis two current meters were installed at the planned grow-out site about 3km S SE of Nevis from the coast (off Dogwood point) (45-60m deep site) and the other at the nursery site planned 600m off between Long Point and Charlestown (10m deep site).

Only the current meter from the nursery site was recovered and it showed daily alternate N NW and S SE currents from 0 to 0.28 cm/s, implying that at this shallow and protected site the tidal current was the most important. However it is envisaged by the consultant that at a site 1-2km offshore with 20-30 m depth the Caribbean Current will be more dominant creating better conditions for farming in cages (Chapter 6).

3.3.2 Waves and surge

The strength of the wind up to a hurricane 1 category is by itself rarely a problem for farming in cages – but it is due to the impact of the resulting waves and surface currents.

With reference to the abovementioned website of the "Post-Georges Disaster Mitigation in Antigua & Barbuda and St. Kitts & Nevis" http://www.oas.org/pgdm/hazmap/windsurg.htm the shore and ocean wave conditions for St Kitts and Nevis during a hurricane has also been estimated (Table 2 and Figure 8; Figure 9 and Figure 10).

Table 2: Probability of shore wave heights (m) at sites in St. Kitts (SK) and Nevis (N) during hurricanes

Probability	Basse-terre (SK)	North Frigate Bay (SK)	South Peninsula (SK)	Dieppe (SK)	Charles-town (N)	Pinney's Beach (N)	New-castle (N)	Long Point (N)
10% i.e. once in 10 years	2.0	4.4	2.6	2.9	2.0	3.0	2.2	4.1
4% i.e. once in 25 years	2.0	4.5	2.7	3.0	2.1	3.0	2.4	4.1
2% i.e. once in 50 years	2.1	4.7	2.7	3.1	2.1	3.1	2.5	4.2
1% i.e. once in 100 years	2.2	4.9	2.9	3.2	2.2	3.1	2.7	4.2

The potential heights of the shore waves may seem impressive and should be included when making a layout and dimensioning for any coastal facility including a land based sea farm, however if considering a sea cage farm the ocean waves generated show that with 10% probability there will be waves taller than 5.5-6.5m just a short distance like 1 km from the shore. Nevis seems more exposed to tall waves and south and east of Nevis the once in 100-year hurricane is predicted to create wave heights of more than 8m.

In calculations made by Smith Warner International, Jamaica, 2008 in NEVIS BUILDING CODES COASTAL AND MARINE DEVELOPMENT Nevis Island Administration Ministry of Communication & Works Public Utilities & Post Physical Planning Natural Resources & Environment the expected wave height of a hundred year return period is 13.9m!! These conditions have a direct influence on risks in using 'new generation' submersible cages for all-year-round fish farming (Chapter 6).

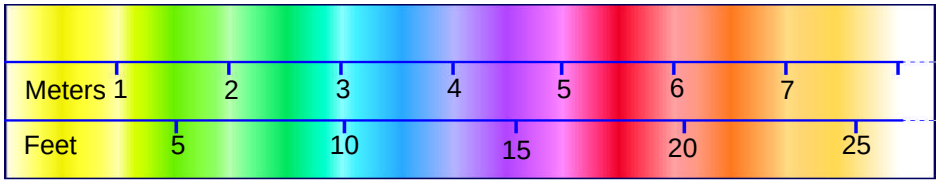


Figure 8: legend/colour codes used in Figure 9 and Figure 10 for wave heights during hurricanes

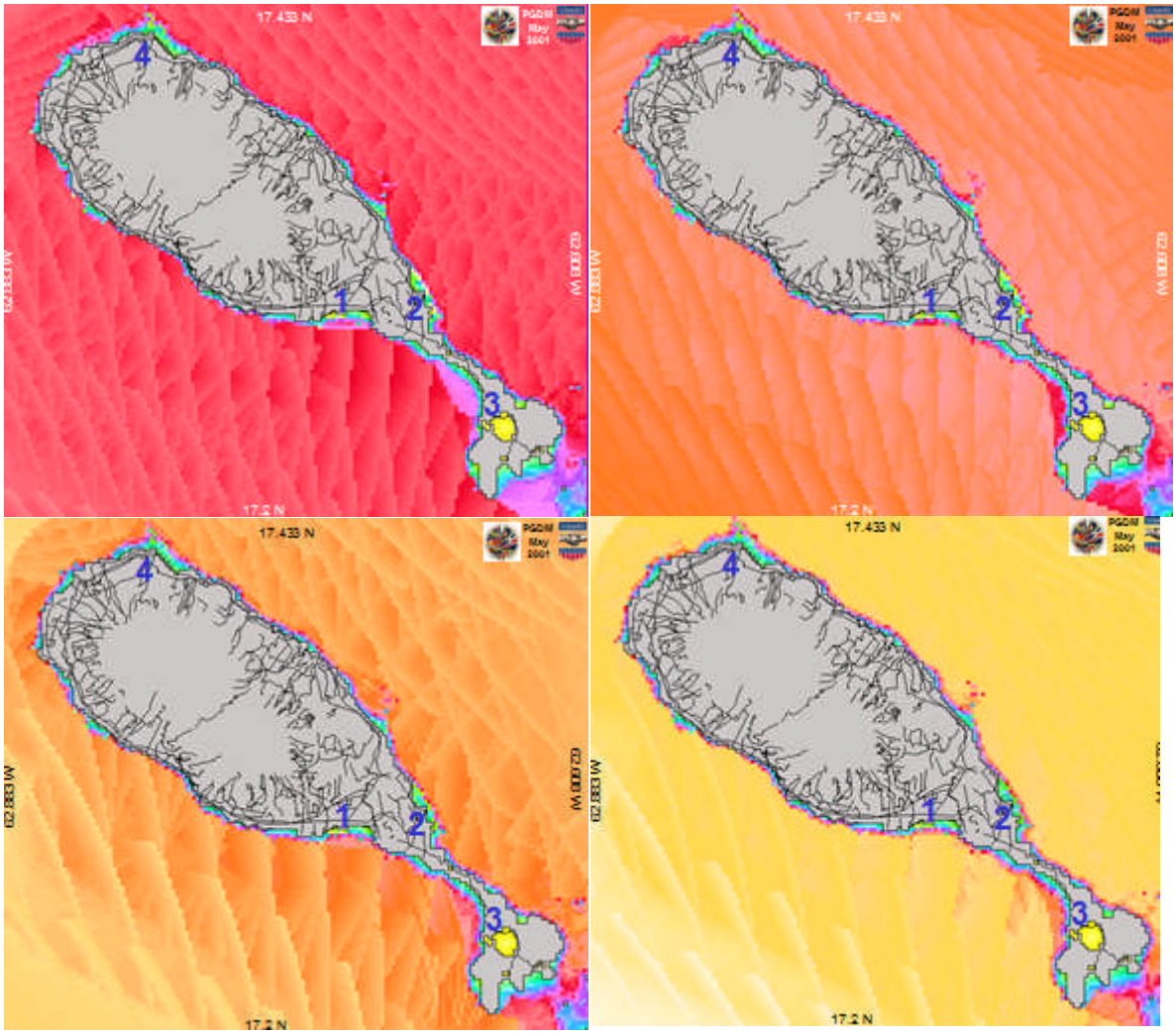


Figure 9: Extreme wave heights at St Kitts during a hurricane with a probability of 'once every 10; 25; 50 and 100 year' (heights, pls. refer to legend/colour codes in Figure 8)

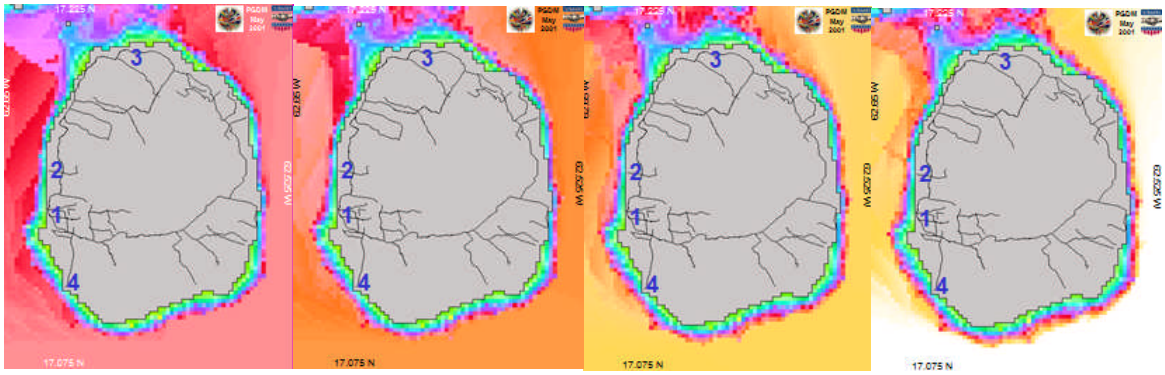


Figure 10: Extreme wave heights at Nevis during a hurricane with a probability of 'once every 10; 25; 50 and 100 year' (heights, pls. refer to legend/colour codes in Figure 8)

When having large weather systems (low pressures/hurricanes) approaching there is also a potential shore surge – increase in water level (Table 3). While this is of minimal importance to farming in cages it has to be taken into consideration when designing constructions in the coastal areas such as a land based sea farm. However it is seen that apart from at Frigate Bay and New

Castle the surge is at the level of the tidal amplitude and only if having a category 3 hurricane (2% probability) or above the surge becomes larger than the tide.

Table 3: Probability of shore surge heights (m) at sites in St. Kitts (SK) and Nevis (N) during hurricanes

Probability	Basse-terre (SK)	North Frigate Bay (SK)	South Peninsula (SK)	Dieppe (SK)	Charles-town (N)	Pinney's Beach (N)	New-castle (N)	Long Point (N)
10% i.e. once in 10 years	0.2	0.4	0.2	0.2	0.2	02	0.4	0.2
4% i.e. once in 25 years	0.3	0.6	0.4	0.4	0.3	0.3	0.6	0.3
2% i.e. once in 50 years	0.5	1.0	0.5	0.6	0.4	0.4	0.8	0.4
1% i.e. once in 100 years	0.7	1.2	0.7	0.8	0.6	0.6	1.1	0.5

Smith Warner International, 2008 in NEVIS BUILDING CODES COASTAL AND MARINE DEVELOPMENT Nevis Island Administration, Ministry of Communication & Works, Public Utilities & Post Physical Planning, Natural Resources & Environment have calculated the 50 year static surge on the east coast of Nevis to be between 1.6 to 2.0m which is significantly higher than the values in Table 3. Design wise it is recommended to use the 50 year incident for coastal constructions.

3.3.3 Water temperature and salinity

The sea around St Kitts and Nevis is full oceanic and tropical. On the east side Atlantic Ocean and on the west side the Caribbean Sea. Temperatures in the top 10 meter, which are relevant in fish farming, does not show any variation i.e. no thermocline, and over the year are fluctuations are small between 27 to 30 ^{o}C. The sea environment of SKN does not show the high temperatures during 'summer' like 32 ^{o}C, which would be seen at the mainland coasts of Caribbean Sea such as Belize. For fish farming 30 ^{o}C would be considered more optimal as growth may be stunted when temperatures are higher.

The salinity is also stable - around 35ppt. Stable conditions are the less stressful for most fish.

3.4 Biological and environmental issues

There are several reasons why freshwater aquaculture is not thought to have a large potential in SKN (pls. refer to Chapter 5.2).

Thus the main water resource for aquaculture will be using seawater. However still the farming will be both land and sea based.

3.4.1 Issues related to land based aquaculture:

Due to being situated in the Hurricane Belt a farming strategy for St. Kitts and Nevis need to include land based seawater production, which either can produce all year round or in a combination with a seasonal sea based farming when outside the 6-month hurricane season (refer to Chapter 6). The land based systems are not anticipated placed in any biological vulnerable biotopes, as they should be elevated a little from the sea level to avoid the possible

risk of surges during hurricanes as well as any facility should be at least 37 meters inland from the high tide mark in flat beach conditions to avoid any impact from extreme shore waves.

Thus any land based aquaculture construction near the coast could be in full compliance with the 'setback categories' recommended when approving permanent constructions (i.e. having a foundation) in the near shore areas (Gillian Cambers, 1998; Coastal development setbacks in Nevis. COSALC Coast and Beach Stability in the Caribbean islands, planning for coastline change (UNESCO) (refer to Figure 11).

Due to the above considerations it is also not relevant to locate a coastal aquaculture farm in a wetland area whether a mangrove; coastal pond/lagoon or ghaut (i.e. a more or less temporary water course draining rainwater from the hills to the ocean). The compliance with conservation issues will be further discussed in Chapter 4.6

The effluent from the land based farms should pass a sedimentation tank to take out possible solids before draining directly to the sea. If situated on a porous sediment such as sand the effluent could be let into the sand, which then will filter the solids, however if having larger productions this method most likely is not feasible on a longer term as well as there may be a risk of 'contamination' of the top layer of the ground water which would be freshwater.

The water having passed a sedimentation pond will be crystal clear. The soluble nutrients will have no or only very local impact in the sea and in can be debated if it is a negative impact (see next chapter). However to make full use of the resources it is also suggested to grow seaweed (sea moss) in the effluent (see Chapter 6)

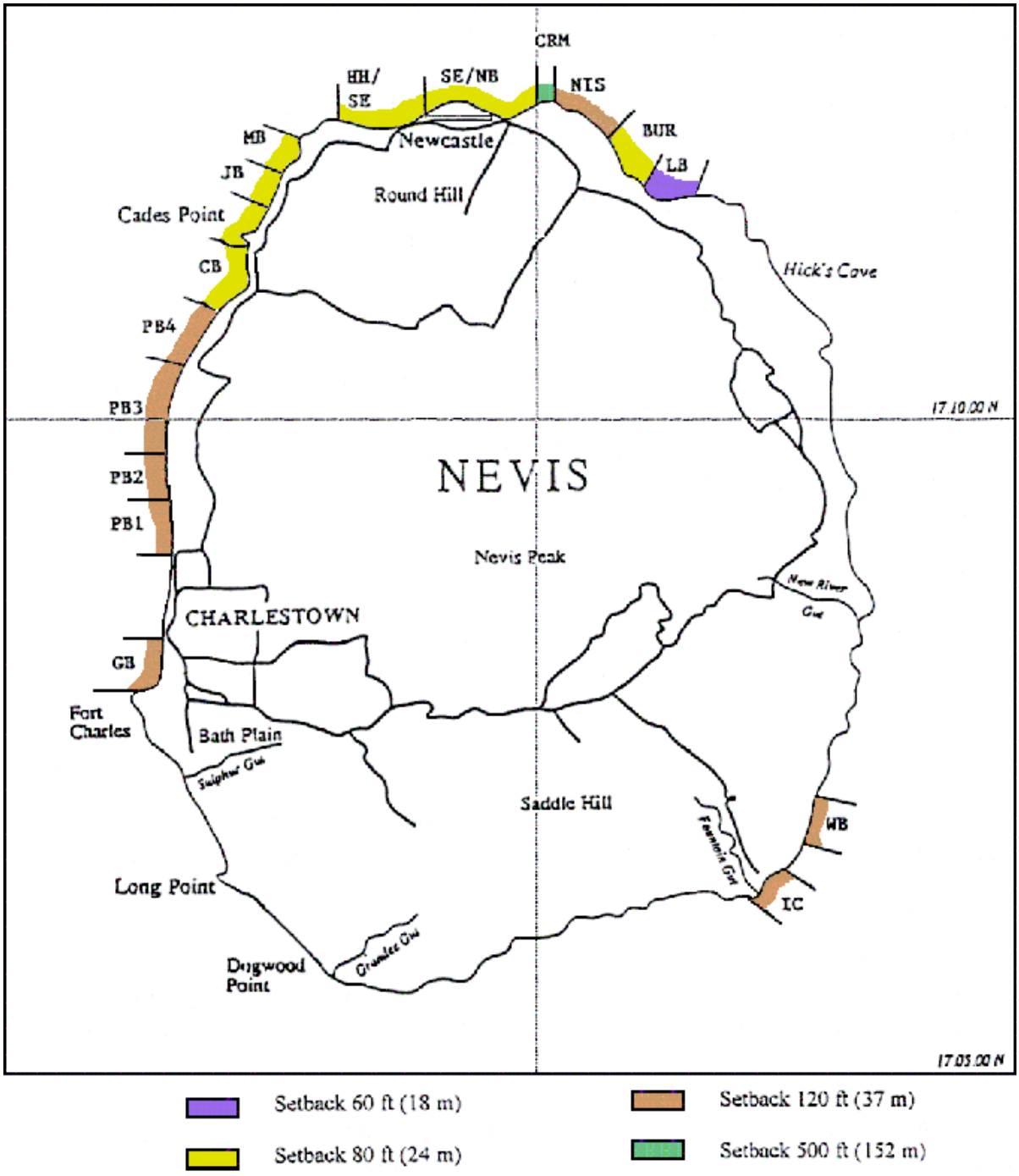


Figure 11: Beach setback categories in Nevis. The 152 m setback category is in a mangrove area

It is envisaged that the coastal aquaculture farms can be constructed in former coastal cane fields – or grazing land and thus not in biological vulnerable or untouched biotopes.

For any land based production in ponds or tanks it will be necessary to cover the surface area with bird netting to prevent sea gulls, herons, kingfishers or other birds to become specialised in pond fishing.

3.4.2 Issues related to sea based aquaculture

When outside the hurricane season it is possible to operate net cages. They are recommended installed at sites of 20-30 m depth thus being a few km from the shore (see further Chapter 7)

The main biological concern is to avoid any negative impact of the farming on the benthic habitats (the seafloor). Especially the coral reefs are vulnerable for any changes in sedimentation or turbidity and thus should be avoided being used for cage farming. But there are several other habitats which are much more resilient.

With reference to Figure 12 the following habitats are considered appropriate (resilient) for sea cage farming:

- Bare carbonate sand – Expansive sand sheets covering much of the benthic habitat particularly to the leeward side of the barrier reef system on the east coasts, and extending at least to 30 m depth on the west coasts.
- Unconsolidated sand with algae – Coarse, often rippled, sand sheets found in areas with higher energy flow along with small patches of *Halimeda* – a green calcareous seaweed .
- Sparse sea grass – Sand sheets with a sparse sea grass community (< 50% cover), dominated by turtle grass *Thallassia tesdudium*.
- Semi-consolidated rubble – Coral rubble originating from reef structures and bonded by coralline algae.

In the present context it should be appreciated that the St Kitts and Nevis farming model suggested (Chapter 7) is a seasonal farming of about 6 months a year, which is a farming strategy which would leave the site fallow for another 6 months before next farming season. In the tropical regions it is considered that a fallowing of 3 months after 1+ years farming is sufficient for complete restoration of a normal, resilient site. In addition to this the strong wind impact expected during the hurricane season would create waves which would affect into 20-30m depths and thus also contribute to removal or flushing of any organic sediment.

As to increased impact on nutrient loads of the water, it has to be appreciated that the oceans around SKN are typical tropical – and that apart from within the coral reefs/lagoons – the oceans are in general to be considered 'deserts' due to lack of nutrients. This is why tropical oceans typically have very large visibility – down to 40 m because very little phytoplankton growth can be supported. This ultimately affects the fishing as seen by the very limited capture of small pelagic fish such as anchovies, herrings etc.

Only when approaching the continental (mainland) areas upwelling (of nutrient rich bottom water) or river impact may carry nutrients to the surface water and create algae turbidity with many schools of small pelagics.

In this perspective it is therefore considered more a philosophic question if the farming will leave a negative environmental impact due to increased nutrient availability. On the contrary it is well documented that the fishermen will experience large congregations of wild fish around the cages as they will function as an improved FAD system.

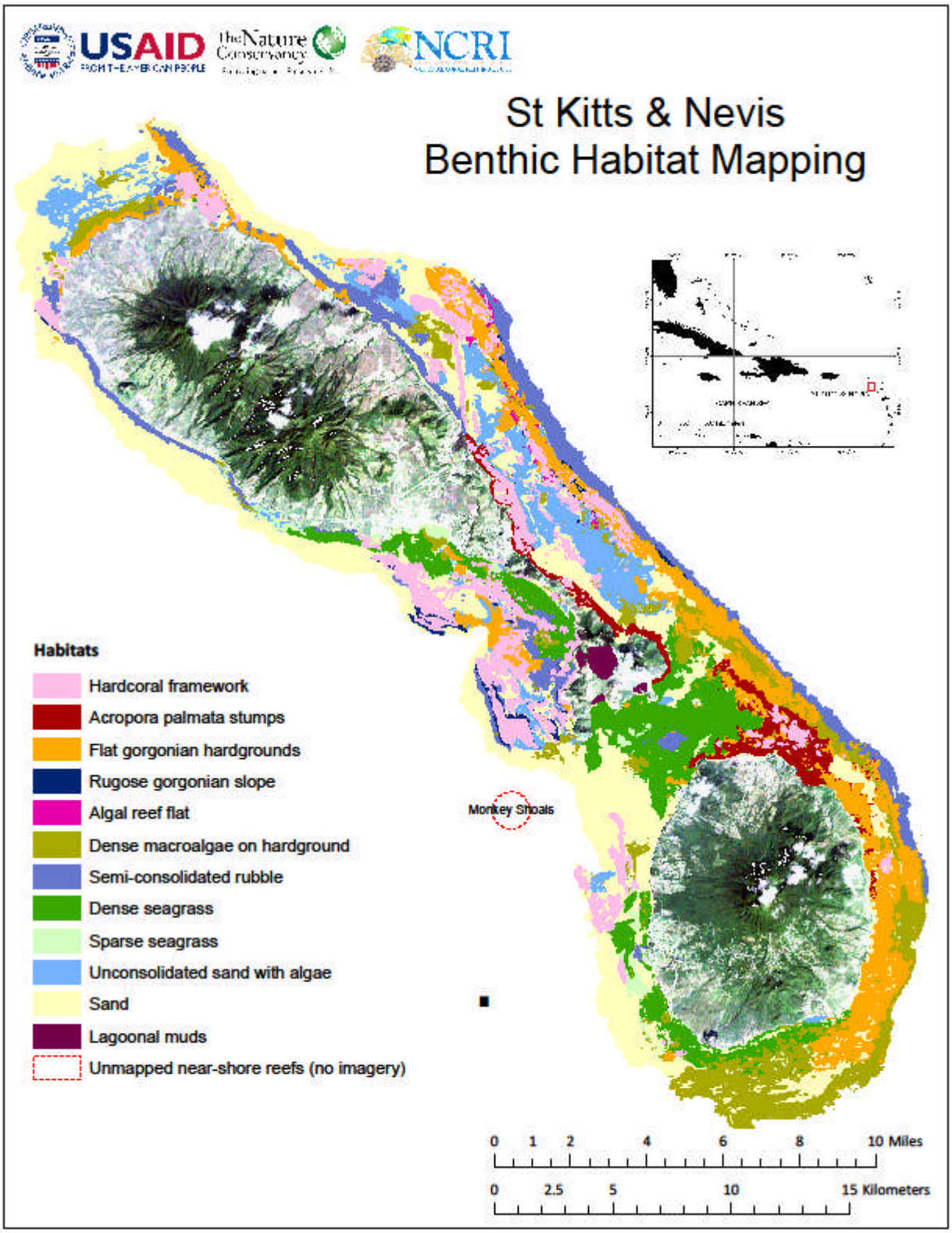


Figure 12: Benthic habitats in near shore areas of St. Kitts and Nevis

Among others the suitable biotopes/areas for seasonal cage farming based on resilience capacities are located west of the South Peninsula area of St Kitts and West-Northwest of Nevis.

As being a fully oceanic and tropical area there are several potential predators to the fish farmed in the cages. There are both abundant numbers of local, nesting frigate birds and brown pelicans in addition to earlier mentioned bird species so a top cover/bird net is compulsory on any cage.

The area is fairly rich in large pelagic predator fish of which mainly barracudas and sharks would pose a potential problem. Therefore the cages will be fitted with double netting i.e. a strong, coarse meshed predator net around the inner net bag to prevent the predators penetrating into the farmed fish.

To the information of the consultant there is no history of red tides in the area.

3.5 Infrastructure

With respect to develop an aquaculture sector to supply domestic market i.e. considering the small distances between production and market and the limited production volumes both islands have sufficient developed infrastructure, if choosing the present product form of fresh, descaled and degutted, whole fish. However if targeting larger volume productions for export markets there will be a need for special shore base facilities (piers) as well as larger processing and packing facilities.

Roads access to the coastal areas is in general good. Both islands have freshwater and electricity distribution system fairly well developed though of course there are areas which are outside the main supply network. As mentioned freshwater is limited and expensive and electricity is supplied by diesel fed generators – thus also relatively expensive. A small windmill park (Windwatt (Nevis) Ltd) has been established with Canadian cooperation at Maddens on the North-western part of Nevis. It would seem that the potential of using wind energy is only in the start of being investigated into.

The harbour facilities on St Kitts are concentrated at Basseterre, which has a deep water container/cargo harbour and the fisheries complex in the south of the town, and in between the cargo harbour and the complex there are additional two piers – one for shipment from former sugar storage and another for the coast guard. In central Basseterre there is a large cruise ship pier at reclaimed land at Port Zante as well as a marina and north of that the ferry docks mainly for the 45-minute fast ferry to Charlestown, Nevis. In addition one small harbour with brake water has been established at SKMW Boat yard, New Guinea/Halfway Tree on the West coast. This seems mainly to be used for lifting boats/yachts out of water for storing on land during hurricane season – in addition to some repairing. In Major's Bay on the southern tip of the South Peninsula a small pier/slipway has been constructed for the "Sea bridge" car ferry, crossing the Narrows to Cades Bay at Nevis.

On the South Peninsula there are construction and plans going on for making marinas. One at Turtle Beach and a larger one which is converting the Great (and Little) Salt Pond into a marina. Already they started excavating the ponds and the natural barrier to the sea. These ponds were unique in Caribbean and were earlier part of a large planned conservation zone/national park development, but now they are part of a large real estate development project.

On Nevis there is likewise a cargo/container deep water harbour south of Charlestown, while the ferry terminal to the St Kitts ferry is the main feature of the harbour inside Charlestown. Just few meters south of the ferry dock there are 2 smaller jetties for fishing boats in connection with a fisheries cooperative.

Nevis also has several marina plans – one Tamarind Cove Yacht Club between Cades point and the pier of the 'Sea bridge' link crossing the Narrows – and another planned marina a few kilometres further away on the north coast. For completion – Four Seasons Resort also has a pier used for bringing their guests from Basseterre by their own small ferry and at Oualie Beach there is another small jetty used by diving boats etc.

On St. Kitts the above mentioned fisheries complex in southern part of Basseterre was constructed with support from Japanese International Cooperation Agency (JICA). It has a solid breakwater, gear storage, fishermen rest rooms and a fish sales facility with 5 tons cold storage, freezer and ability to do simple manual processing such as descaling, gutting and filleting and

vacuum packing. JICA also assisted with one more, smaller facility at Old Road Town further up the west coast of St Kitts.

On Nevis a similar complex like the larger at St Kitts is under planning at Gallows Bay next to the ferry terminal in Charlestown, and next existing cooperative operated fisheries complex. The latter is targeting equipment sales in addition to some sales of fish. The coop has 3 freezers of about 700 litres size used for ice storing, degutted and descaled fish and round/unprocessed fish respectively. The planed JICA supported fisheries complex is a much larger scale facility and was to be constructed on private land just behind the Gallows Bay Beach, however it seems that it is considered to reclaim land in the bay instead of some "procedure" constraint in purchasing private land. If such a land reclaim is to be carried out it is strongly advised to include in the planning process to find an environmental neutral solution to avoid damaging the BIOTOPE of the outlet of the Hot spring which is an important fish nursery area (see next chapter). It would seem a paradox if a facility to assist the fisheries by improved sales and processing at the same time damage an important fish nursery ground and thus create a negative impact on the fisheries output .

If not there is no access to a pier/jetty the smaller-sized cage farms, which are anticipated at least in the start can be operated from a 'beach' shore base with a simple slipway as long as there is road access.

If starting seasonal fish farming in cages it would necessitate having shore base facilities with access to pier facility or at least a slipway and with good road access. Such a pier or slipway construction could be of shared facility unless it is for a large-volume farm of more than 500 tons, which would need total access of the facility.

While having introduced above harbour and pier facilities of the islands it should still be appreciated that the majority of the small fishing boats (some 200+) still use beach landing sites of which there are 11 on St Kitts and 8 on Nevis, even several of them are very small and only accommodate few boats.

Finally it should be mentioned that both islands have airports – with especially that of Basseterre having regular connection to USA. As there likely are many goods imported by air it would mean that they have empty capacity leaving the islands, which eventually could become an important asset for export of fresh, chilled fish.

3.6 Interaction with other aspects of coastal activity – stakeholders

3.6.1 Fishermen

One of the most important stakeholder groups traditionally related to ownership of the marine resources is of course the fishermen. There are several papers describing the 'make up' of the fisheries sector in St Kitts and Nevis for which reference is given (Charles Steinback et.al. 2010: St. Kitts and Nevis Fisheries Uses and Values Project Report by Ecotrust for The Nature Conservancy (sponsored by USAID), and the output such as landings and prices are analysed in Chapter 4.10. Therefore in the present context it is the role of the fishermen as being one of the most important stakeholders in a possible future aquaculture sector which will be dealt with.

There are about 700 people involved in fisheries – equal number on each island. Most of them (up to 75%) are involved in artisanal fishing in the near shore areas catching demersal fish species and lobsters mainly by trap or hook/line. Another 10% of fishers are involved in coastal pelagic fisheries, and actually catching 40% of the landed seafood volume, while the remaining people are either involved in conch fishing by diving or in oceanic pelagic fisheries by trolling and use of FAD's.

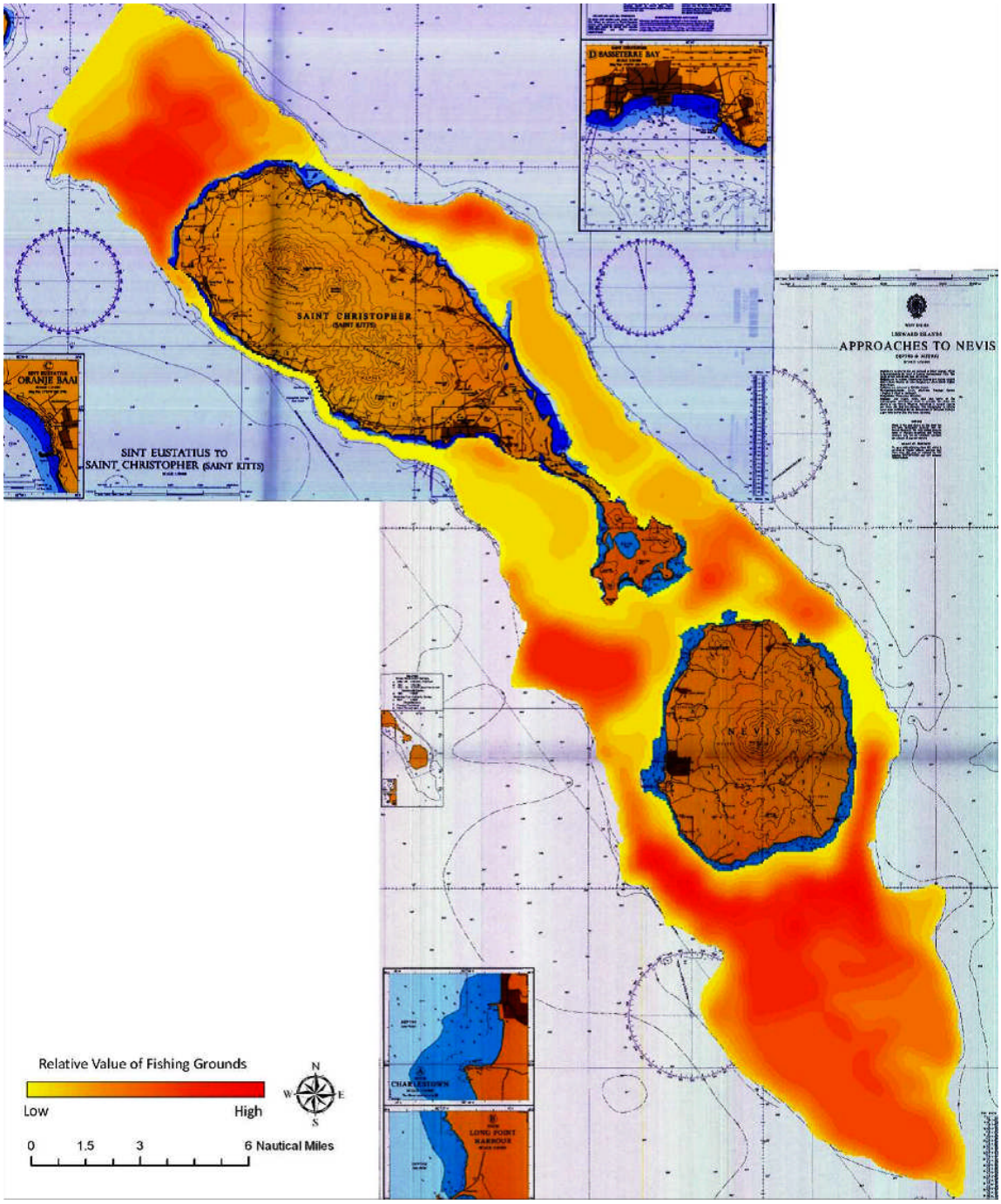


Figure 13: Importance of fishing grounds for coastal demersal fishermen of St Kitts and Nevis using traps (Charles Steinback et.al.)

Figure 13 shows the most important areas for the coastal demersal fishermen. Among the suitable areas for seasonal cage farming based on biotope resilient capacities, water depths (Figure 2) as well as being protected from prevailing winds and of suitable depths are sites located west of the South Peninsula of St Kitts and west-northwest of Nevis, which are of less importance to fisheries (ref to yellow colour on Figure 13).

For the fishermen any sharing of area resources with other uses such as cage farming may seem as interference in their traditional rights. However a cage site, which could produce similar to the present capture fisheries output would only occupy a mooring area of e.g. 270m by 210m and it is typically selected in an area, which has a flat, level bottom with little stone or vegetation. These

habitats are normally considered less good fishing areas (ref Figure 12 and Figure 13) unless for trawling/bottom gear - which however is not used in SKN.

In fact instead of seeing a constraining effect on capture fisheries it is often experienced that when establishing a sea cage farm there is a lot of fish attracted to the nets of the cages – it is like a FAD or an artificial reef creating more habitat in a 'flat desert'. Instead of losing fishing area the artisanal fishermen will experience increased fish captures by putting their gear in the vicinity of cage farms (see also previous Chapter 4.4). Thus introduction of cage farming is not anticipated to pose a real competition for area with the artisanal fishermen, but rather it will be an opportunity for alternative or additional livelihood – also to improve recruitment of the next generation of fishers or users of the sea.

Recent analyses show that the average age of the coastal, demersal fishermen is more than 50 years. Most fishermen (30-80%) are only part time fishermen with fisheries accounting up to 68% of their income – as they also are involved in other sectors such as construction. Very few young people obviously are recruited into the profession. This is of course a result of the very stagnant output from fisheries – the lack of opportunities – and therefor there is a real need to find other opportunities for livelihood – making use of the same marine resources. Here aquaculture gives the opportunity to make a better and more predictable income than capture fisheries including opportunity for production expansion if the market demand shows.

Irrespective of this of course the site selection should of course be carried out in close consultation with the local fishermen to avoid any dispute over real traditional fishing grounds.

Presently the fisheries sector by its supply of 450 tons of seafood a year only contributes a little more than 1 % to the GDP and thus it seems of little importance. The direct role in GPD however does not give a fair understanding of the importance of the sector. It has to be appreciated that in addition to livelihood fisheries is an important element in the "oceanic island' profile, providing marine seafood which is a traditional, quality food item for the residents, but also it fulfils the expectation of the 100.000 tourists visiting the islands and through this image, the seafood actually contributes a higher value to the GPD. All these beneficial elements of fisheries can be further improved or optimised through aquaculture (Chapter 4.11).

In the document by DMR 2011: Preparing to introduce an ecosystem approach to fisheries in St Kitts and Nevis: the final meeting - aquaculture is mentioned as an entry point to start as a pilot activity in the EAF process, thus awareness about the potential is present among the fishers.

3.6.2 Shipping/transportation

The other traditional use of the ocean and near shore is of course for shipping – transport of passengers and goods. The most notable around the islands are the ferries between Basseterre and Charlestown departing in each direction about once an hour during day time. In addition there is some mercantile navy traffic to the container harbours and oil storage area (in Basseterre) as well as the cruise liners.

When establishing a cage farm it should be marked clearly according to the IALA Maritime Buoyage System, which for areas used for special purposes requests the use of yellow coloured buoys such as spars or conical ones, which are fitted with a radar reflecting cross and sometimes yellow/white flashing light. If selecting areas for sea cage farming, which are not close to normal shipping lanes and through the use of approved marking it is not experienced that cage farming poses any risks for shipping. Boats in the coastal vicinity always have to be alert to avoid collisions with smaller unmarked dinghies, fishing equipment including FAD's and traps and divers in the water, and cage farming by being 'permanent' structures are often mapped on the naval charts and this will pose less of a surprise to the shipping than all other 'obstacles'.

3.6.3 Conservation and protection issues

Conservation issues are mostly advocated by different NGO's like heritage groups, bird and turtle watchers. However conservation is not only about protection of ethical values. Conservation and

protection measures actually also can help in having a sustainable commercial development. Clearly fishermen should appreciate this – through minimum mesh sizes of equipment used, minimum sizes of lobsters, possible closed fishing periods, banning of spear fishing in areas etc.

However in the context of management of fisheries most of protection measures are to prevent over exploitation and only little appreciation has been given the value of protecting the nursery grounds of juvenile fish from other impacts of other stakeholders. Juveniles of several marine fish species prefer to migrate into brackish waters bodies to benefit from being away from the larger predatory fish as well as they also benefit from the nutrient rich environment found in the ponds or lagoons. As mentioned earlier most of the tropical oceanic seas are actually nutrient poor environments with little phyto- and zooplankton production – seen clearly by the high light penetration or visibility in the water.

Islands like St Kitts and Nevis however have very few of these brackish water ponds/lagoons/ghauts (a few handfuls) – and regretfully they are not given a high awareness by the developers and planners. They do not appreciate damaging these biotopes is not only about dislocating a few birds/waders, or cutting some bushes, but in fact the continuing destruction of these very limited number of sites eventually will have a direct limiting impact on capture fisheries. The value of a good constant flow ghaut such as the hot water stream south of Charlestown could be compared to an 'artificial' marine fish hatchery and nursery with a construction cost alone in the scale of 1-2 million USD in addition to the annual operation costs – just to have similar number of juveniles produced for restocking for the fishermen! The most numerous fish species found in these biotopes are mullet, snooks, pompano, jacks, gars, snappers and groupers all of them contributing to capture fisheries with price levels between XCD 8-12/pound (USD 6.50-9.75/kg).

Therefore it is suggested that decision makers focus on keeping the health of these biotopes with a different perception than 'only refuge for birds'. Aquaculture can contribute to seafood production but it would seem in sharp contradiction at one hand wishing to support aquaculture development to increase availability of seafood while decision of the other hand adds pressure on capture fisheries.

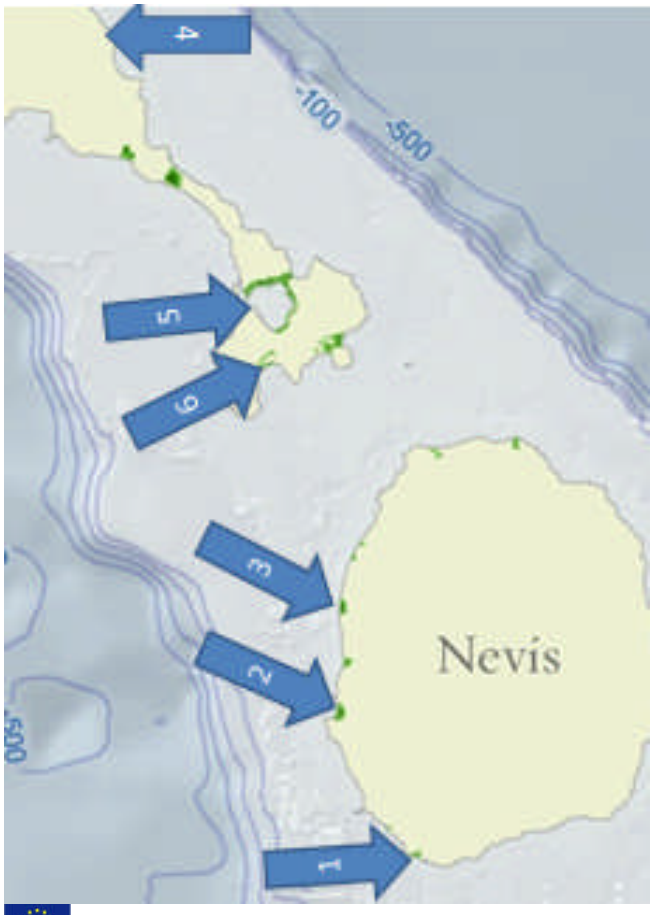


Figure 14: Mangrove areas according to The Nature Conservancy (pls. refer to text regarding reference numbers on arrows)

During the few days of field trips in August 2012 the consultant saw several recent destructions – legal or illegal – of wetland areas (Figure 14 and Figure 15) such as Dogwood pond (arrow 1: sand mining), Paradise beach (arrow 3: whole wetland forest area cleared), and the planned fisheries complex in Charlestown which is informed also to involve land reclaim at Gallows Bay – thus also affecting the above mentioned hot spring stream (arrow 2) – unless protection of this biotope is taking into the plans.

All the above examples are from Nevis – but also it seemed that Half Moon Pond on St Kitts were under threat (arrow 4: being diked and filled up?) in addition to the large marina development in the 203 ha large Great Salt pond of South Peninsula (arrow 5). Another pond on the peninsula, Major's Bay Pond (arrow 6) which likewise was full of fish juveniles during the visit may be under threat as all surrounding shore area had been marked and split into small lots for real estate development. Hopefully the developers and authorities will preserve

Figure 15: From top left Dogwood Pond, Nevis; Paradise Beach, Nevis; Gallowbay's pond/hot spring, Nevis; Half Moon Pond, St Kitts. Wetlands/ponds/mangroves – important marine fish nurseries under threat

the pond habitat including preserving a simple connection/outlet to the sea.

The DMR was established recently from the earlier Department of Fisheries with the aim of implementing a more holistic management approach of the marine resources. As part of applying an Ecosystem Approach to Fisheries one strategy is to enter zoning of the near shore sea areas including users like fisheries, transportation, tourism and protection. With support from USAID The Nature Conservancy (NGO) has made suggestions for such a zoning plan, which will make management more easy (Figure 16). To the information of the consultant the status is that it is under positive consideration (Chapter 4.7).

There are few areas declared marine parks under the laws of the Federation, however some are 'de facto' already functioning as such – like the northern bays in the Narrows and Lovers Beach with the turtle watch. Possibly Camps River of Nevis is the only establish marine park according to the Zoning Ordinance (1991), for establishing marine parks in Nevis. It is expected however that the zoning plan when it is adopted will lead to establishing of marine national parks or conservation zones.

A thriving, sustainable aquaculture sector without increasing incidences of fish diseases or parasites in the farmed fish is like the fisheries depending on the wellbeing (and management) of the environment. Well informed and trained fish farmers appreciate that a healthy environment is one of the best risk reduction interventions they can apply to their own operation. Thus it is in the interest of the fish farmer to have the correct siting for the farm, to use traceable disease free juveniles, to avoid overstocking and to use the least polluting feed, followed up by their own environmental impact monitoring. For other 'ethical' stakeholders, which try to preserve biotopes without documenting tangible economic benefits a thriving fisheries and aquaculture can go hand in hand with their efforts – as the commercial sector can provide the tangible impact that

decision makers and planners often seem to appreciate. Aquaculture can help saving nature – by putting commercial values into keeping a good quality of the environment.

Tourism developers are often considered an opponent to aquaculture due to competition for land area with sea access, however on both islands there seems to be ample land suitable for the land based aquaculture which are not amidst tourist resort developments or tourist zones like South Peninsula of St Kitts or the West and Northwest coasts of Nevis.

Tourists themselves – on the contrary to the developers – in general favour aquaculture, because they like availability of fresh, quality (marine) seafood – and even they like to look at 'events' such as people operating a fish farm. The latter postulate can surely be verified by the number of guests visiting Dr Barrington Brown's SNAPPER farm on St Kitts requesting a tour on the farm. As for the cage farms there does not need to be any conflict with tourism or tourism developers if proper planning is made as the farms are not anticipated to be located in the very near shore areas or in small bays.

The other very important 'general' stakeholder groups which should have a say in the development are the consumers in search of quality, marine seafood and those people interested in or seeking alternative livelihoods, of which there are limited options on the islands – and finally those interested in food production as an investor. But these are 'general' stakeholders not organised in any groups, thus their interests has to be taken into consideration by the decision makers i.e. the elected politicians and the higher ranking government officers.

3.7 Legal framework, regulations and planning

A review of the legal framework is complicated as it is unclear whether many acts and regulations 'available' are already adopted, in process of being adopted or just drafts. The governance history of the two islands also further complicates issues – especially regarding land related issues. It seems each island have their own decision structure (self-governance), guidelines, acts and codes and not having the exact same line agencies taking care of the same issues. As the governance in addition to the sometimes unclear status of acts and regulations also is very political it is considered outside the scope of this study to describe the structures and differences, which may influence the potential of introduction of especially land based aquaculture on each of the two islands.

Some general observation is that there are two larger fundamental differences related to land ownership, which is that private land ownership seems more common on Nevis than on St Kitts, where a lot of the abandoned sugar cane farm land is owned by Government development agencies/companies, which is less so on Nevis. Governmental ownership may show to be an advantage if Governmental decision makers decide to actively support aquaculture development.

As with regard to the utilisation of marine resources things are better harmonised as it is under clear Federal jurisdiction, handled by the newly (2010) formed federal DMR. This creation was a strengthening of the former (Federal) Department of Fisheries located on St Kitts, to become responsible for a holistic approach within conservation, protection, management, development and utilization of the coastal and marine resources including fisheries and aquaculture.

The Nevis Island Administration through its Department of Fisheries (Nevis) assists the DMR in the management of the marine resources however they have no jurisdiction over the marine area and implementation of any policies or plans for the marine area would have to be approved through the Federal DMR.

The multi-responsibility of the new DMR can easier be appreciated through the management strategy which is considered through zoning of the near shore sea areas including the different uses like fisheries, transportation, tourism and protection. The Nature Conservancy has drafted a suggestion for such a zoning plan (Figure 16), which is under positive consideration. It will include Marine Management Areas which will give provisions for approving aquaculture

activities.

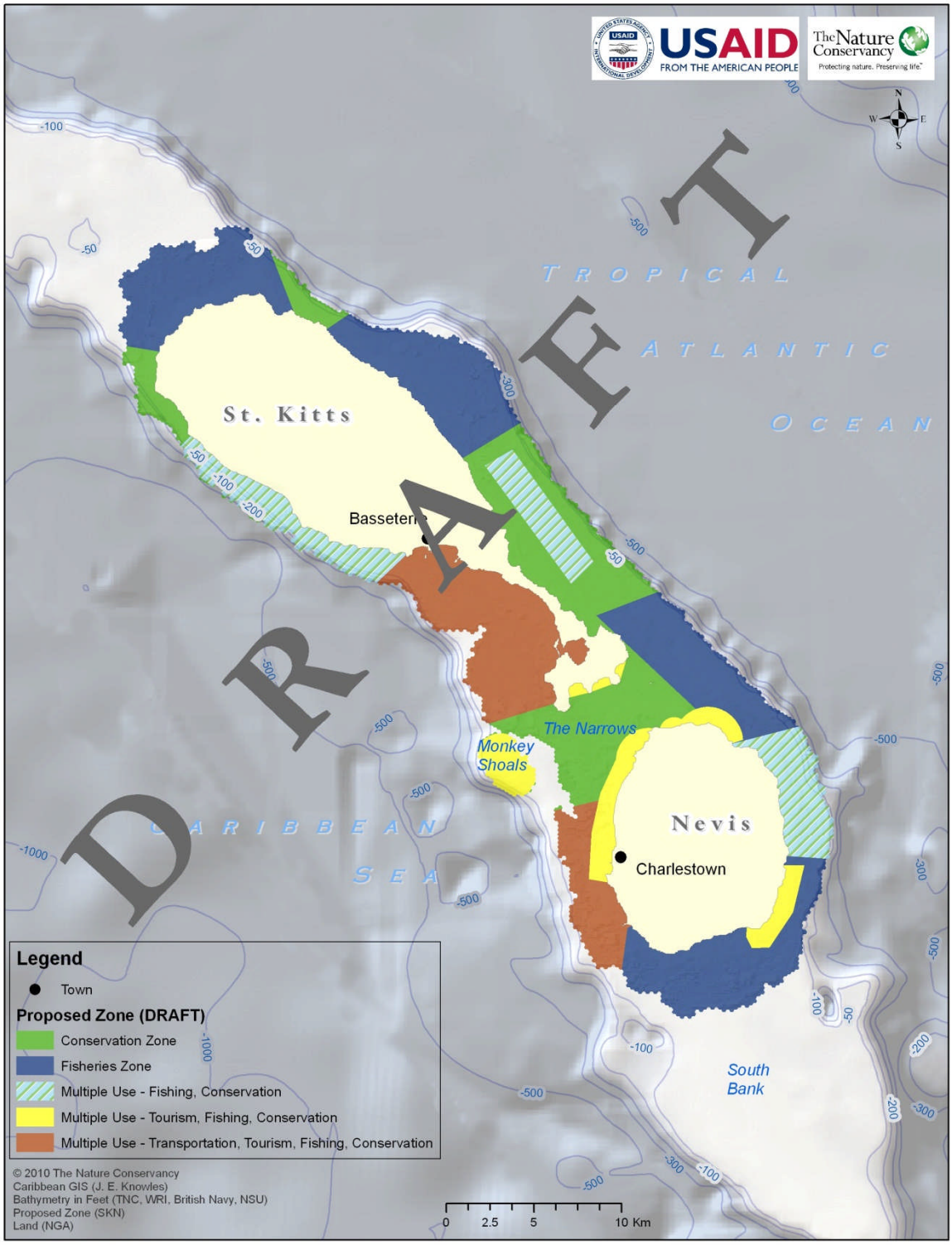


Figure 16: Suggested zoning plan for the near shore sea areas suggested by The Nature Conservancy

The primary legislation for fisheries (and aquaculture) is The Fisheries Act (1984) described in a revised edition dated 31st December 2002. In this provisions are given for leasing land, including foreshore or sea-bed for the purpose of aquaculture and that public may be denied access to these leased areas.

Also The Draft St. Kitts and Nevis Aquaculture Policy (2011, internal draft document) outlines a clear commitment by the Government:

The Government of St. Kitts and Nevis is committed to the development of Sustainable Aquaculture in all forms and will provide the enabling environment for the economic and social development of this industry. Further, the Government will ensure that the necessary regulatory framework is maintained to encourage and protect investments and incentives made in this industry. The government will support training and research for the advancement of the industry. With the closure of the sugar industry, it is envisioned that the fishing industry will contribute significantly to reducing the foreign exchange deficit and improve our efforts at enhancing our food security. Aquaculture will be a major player in achieving this goal.

Criteria for engaging in aquaculture within the Federation of St. Kitts and Nevis:

- Submit an application and a business proposal to the Department of Marine Resources.
- Applicants must reside in the Federation for ten (10) years prior to application.
- Applicants should successfully participate in the Aquaculture Basic Training Course sponsored by the Department of Marine Resources
- Successful applicants are required to submit fish statistics and other business data as deem necessary by the Government of St. Kitts and Nevis
- Successful applicants are required to make personal monthly social security contributions if no other monthly social security contributions are being paid.
- Successful applicants are required to join a fisherfolk organization as stipulated by the Department of Marine Resources.
- Successful applicants should adhere to the rules and regulations governing aquaculture.

Incentives for engaging in aquaculture within the Federation of St. Kitts and Nevis:

- Incentives will be the same as those given to fishers and farmers ("Duty-free concessions on boats, engines and truck but no rebate on marine fuel")
- Land and utilities will be allocated to successful applicants at concessionary rates.
- ALL equipment and materials (this includes feeds and chemicals) for the development of aquaculture will be duty free and VAT exempt.
- No sales tax.
- No tax on the earning of the business.
- Ongoing technical assistance from the Department of Marine Resources.

Finally it should be mentioned that already in the major historical 'ideological' strategic document made by Ministry of Sustainable Development, Government of St Kitts and Nevis 2006: "Adaptation Strategy in Response to The New EU Sugar Regime 2006-2013", produced when it was decided completely to shift from sugar cane farming a number of key strategies and priority actions that the Government would take are listed.

Within fisheries (page 46 bullet (g)) it is actually mentioned due to aquaculture devoted staff already then that "Evaluating the potential for aquaculture and request technical assistance for the establishment of a demonstration and training unit". At page 124 under the heading "support SME in fishing" the evaluation of potential is budgeted at EUR 30.000 while the pilot/demonstration is estimated at EUR 800.000. In the context of the present study it should therefore be appreciated that the evaluation of the potential in the present report is actually what has been on the priority list for a long time.

Thus DMR has a clear mandate to expand the aquaculture sub-sector in St Kitts and Nevis.

Given the complicated issue of differences between land governance of the two islands it is relevant also to note that the Nevis Island Administration in The Department of Physical Planning, Natural Resources and Environment, 2008 Deposit Draft Nevis Physical Development Plan "is committed to consider and likely support proposals for fish farms based on their merits but subject to no adverse environmental impacts", in addition to "normally support proposals that support the retention and expansion of the local fishing industry, including fish landing areas", the latter which also can be relevant in the context of land based pilot aquaculture, which could be established near a fish landing site to achieve maximum exposure to the main stakeholder.

How does a potential aquaculturist or investor apply for an aquaculture site concession?

If on St Kitts the applicant should apply to Ministry of Sustainable Development, which will arrange a star hearing involving the respective line department such as DMR. However if it is a foreign investor it seems that the Department of Sustainable Development can give approval without making consultations. If it is an application on Nevis it should first be given to the Department of Physical Planning of the Nevis Administration for approval including Department of Fisheries after which it should be forwarded to the Federal. Whether the latter procedure only includes aquaculture making use of the sea or also land based aquaculture is not clear to the consultant.

3.8 Capacity of local institutions and human resources

Already it has been mentioned that the Federation of St Kitts and Nevis is the smallest sovereign entity in the Americas. This undoubtedly put strong pressure on the human resources in the governance – not many countries have full administrative, line departments for a population of only 50.000 people – and what is even more challenging is the fact that both islands have built up nearly parallel administrative structures covering all institutional aspects. In best case this is a VERY expensive administrative system. But likewise the question is whether the islands have all the necessary staff, both in qualification and number, because the fact is that a large share of the draft policy documents are produced by external consultants.

In worst case this system becomes a "shadow" system which has all formalities, acts and directives in place (at least as drafts) but has no human resources to implement them or even to a lesser extend control and enforce them.

Therefore it is necessary to think different and find aquaculture development models, which are sustainable also from a governance point of view, without being as human resource demanding as in many other countries, which has completely different human and economic resources. This is why St Kitts and Nevis cannot just copy the approach suggested in many FAO Fisheries Technical Papers.

The DMR has a staff of 8 persons – totally – of which one person Mr Sam Heyliger has aquaculture background. The Department of Fisheries, Nevis has 4 staff of which none has aquaculture background.

It is therefore compulsory that if St Kitts and Nevis want to support an aquaculture sector development that at least 2 more persons will be trained for aquaculture governance in addition to 4 extension people who can train aquaculture farmers and have the operational management of the suggested pilots (see actions in the strategy document).

The Federation is a 'relative' top spender on human resource development – spending a full 10% of the GDP on education. This may partially be explained by the above governance situation which makes the relative need for educated people high. There are several universities and colleges with especially focus on medical and veterinary educations. It should of course also be appreciated that these facilities also attract many foreign, paying students.

The Clarence Fitzroy Bryant College (CFBC) in St Kitts has a biology education which includes a course in marine biology and ecology. The students graduate with a so-called associate degree. Recently a new education called 'agribusiness' in agriculture management in crops and livestock has started, which eventually could be expanded also to have an optional aquaculture on the curriculum (for further information consult Dr. Leighton Naraine). Students graduating from such an education could enter at production management levels in larger fish farms. However at CFBC there are at the moment no teachers/researchers with an aquaculture background.

The lack of local 'sector' expertise such as e.g. an institute of marine fisheries may at a certain aquaculture production level become a constraint as there will be no supportive institutions. This is however a fact – and it would seem beyond the capacity of 'the smallest federation in Americas' to have such institute. However it would seem possible that the veterinary university could show to be a relevant partner in certain aspects of aquaculture development, while in other areas SKN would have to depend on the regional network such as Caribbean Regional Fisheries Mechanism (CRFM).

As there are no traditions at all for aquaculture inside the Federation it will also be compulsory to develop an extension system for aquaculture. In the start it should be performed together with staff from the departments as they also will gain valuable feedback to appreciate the possible development constraints thus making their governance work more relevant.

If developing larger volume, modern fish farms with 20-30+ staff it is also see that there will be a need for specialised people – like within sales; biosecurity; environmental monitoring; production planning; feeding registration; diving; net repair, nursery, captain, shore base manager and site managers – many of these people would need some degree education incl. biology, veterinary, others need at least to be skilled (trained) workers. In fact to have "good human resources" is one of the larger risk factors when developing a large-volume farm, because the staff has to be skilled (and experienced) to be able to manage/handle appropriately a standing stock of fish worth maybe 2-2.5 million USD in production costs alone.

If doing small-scale farming one cannot of course have the same degree of specialisation and would depend very much on a good extension system – and farmer's network or association.

3.9 Linkages to regional/intergovernmental network including NGO's

In the previous chapter the constraint of the very limited human resources in the line departments, and its possible negative impact, have been duly noted. This however is not only a local St Kitts and Nevis problem but a common trait shared with many of the small Caribbean island states.

One strategy to balance this is putting a high priority to information sharing and exchange of expertise between line departments of different countries through regional cooperation. The Caribbean area therefore has several of these intergovernmental initiatives or organisations.

The Caribbean Regional Fisheries Mechanism (CRFM) is from 2003 and headquartered in Belize. Its mission is "To promote and facilitate the responsible utilization of the region's fisheries and other aquatic resources for the economic and social benefits of the current and future population of the region". Its members are Anguilla, Antigua and Barbuda, The Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago and the Turks and Caicos Islands. It has three bodies – the Ministerial Council; the Caribbean Fisheries Forum; and the CRFM Secretariat.

The Organisation of Eastern Caribbean States (OECS) has several very hands-on functions and could be considered an East Caribbean common market (CARICOM single market and economy). It includes 15 member states (Antigua & Barbuda, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, St. Lucia, St Kitts and Nevis, and St Vincent and Grenadines,

Suriname and Trinidad and Tobago. One important function is that the islands share the same currency the Eastern Caribbean Dollar (XCD) and that it has free movement of labour and capital. But many other hands-on improvement of the economy e.g. perform cost savings such as "centralised tendering for pharmaceuticals". Within fisheries governance OECS supports introduction of an Ecosystem Approach to Fisheries (EAF) through it environmental treaties. Likewise OECS has project activities regarding Ocean Governance and Climate Change, which also relate to fisheries

The DMR is presently preparing to introduce an Ecosystem Approach to Fisheries in St Kitts and Nevis, which will insure a more comprehensive management of the fisheries – just like the change from the name Department of Fisheries has signalled. At the University of West Indies, Cave Hill Campus, Barbados the Centre for Resource Management and Environmental Studies (CERMES) receives grant funding from the International Development Research Centre (IDRC) of Canada among others to assist in introducing EAF via the Marine Resource Governance in the Eastern Caribbean (MarGov) project. MarGov offered a small grant in 2010 to help DMR (St Kitts and Nevis) to prepare for this transition.
Some of the identified actions included aquaculture such as:

- Assessing the potential and impacts of marine and freshwater aquaculture at an ecosystem level
- Training farmers and fishers in aquaculture techniques and financing for aquaculture enterprises
- Examine the St. Kitts & Nevis Aquaculture Pilot Project & Environmental Research (SNAPPER) for the pros and cons of aquaculture and build on the existing infrastructure for rapid development

The NGO's active on St Kitts and Nevis directly related to fisheries (and aquaculture) are actually not domestic but professional agencies with regional representation, i.e. actually similar to any larger consulting company – only working under a more clear political agenda. However the work is mostly professional, but the possible political part of their Terms of Reference has to be appreciated and be in the open.

For the small-scale farmers the linkage to a local farmer's association or fishermen associations will be conducive while larger farmers and government staff may benefit from being members of World Aquaculture Society, which publishes magazines in addition to arranging conferences, which are very good for networking.

3.10 Present seafood market, demand and trading structure

3.10.1 Volumes

When talking with local people on the islands - even some related to fisheries – impression given is that families only eat seafood once a week and it would be marine fish, unless maybe in a restaurant if they are served a dish with freshwater fish (tilapia or pangasius).

However according to Charles Steinback et.al., Ecotrust 2010: St. Kitts and Nevis Fisheries Uses and Values Project Report to The Nature Conservancy (sponsored by USAID) they found that nearly half of interviewed (90 unspecified/unclassified persons) consumers purchased 5-10kg of FRESH fish every week, which would indicate that possibly 50% of the families on the islands would eat fish several times a week. This would seem however a contradiction to the little availability of fresh!! marine fish.

According to Wurmann, C.G. Regional Review on Status and Trends in Aquaculture in Latin America and the Caribbean – 2010 FAO Fisheries and Aquaculture Circular. No. 1061/3 the Federation has one of the higher seafood consumptions in the Caribbean – about 31.4 kg per capita per year (2007) against an average in the region of 10.8 kg. The 31.4kg figure would imply

an average consumption of about 0.65 kg of ANY seafood per week per person, far from the 5-10 kg of FRESH fish consumed per week for a family from the interview analyses of Charles Steinback et.al.

Likely even the figure 0.65 kg seafood consumed per person per week may be a little high. Because if making a simple analyses on the macro-figures of available seafood – the fishermen land in average 450,000+ kg of fresh seafood/year – of this about 11.000 kg (conch, 2009) is exported. With 50,000 citizens, it means 8.8 kg of fresh seafood is available per person per year or 0.183 kg per week – if adding the imported volume of 859.000 kg (2009) it would give an average consumption of 25.96 kg seafood/year or 0.541 kg/week.

The per capita consumption figure is likely even lower as St Kitts and Nevis in addition to its 50.000 citizens also has a lot of people from other Caribbean countries especially due to the free labour movement of the OECS. An estimate of the number of expats has not been found by the consultant, but it could easily be 4-5 %. In addition to these people the island has a very high number of tourists all of them also eating seafood (Table 4).

Table 4: Tourist arrivals by air and sea port for St Kitts and Nevis

Year	Stay over	Excursionist	Air Arrivals	Cruise Ship	Total Arrival
2001	70,565	3,662	74,227	259,134	333,361
2006	132,859	3,893	136,752	203,075	339,827
Source: Website of Government Statistical Department (SKN)					

Other figures are reported by different sources like the CIA World Factbook 2012 quotes 200.000 tourists arriving in 2009, while Wikipedia quotes Tourism Department that there were 587,479 arrivals to Saint Kitts in 2009. One explanation of the latter figure could be that people counted in Air arrivals' has been counted twice by Wikipedia as many of them also are listed in 'Stay over' category?

According to UNWTO Tourism Highlights 2012 Edition www.unwto.org there were 93.000 arrivals in 2009 which was reduced to 92.000 in 2010. Each of these tourists spends about USD 980 in St Kitts and Nevis.

It would seem like' stay over' tourism in St Kitts and Nevis is stabilising just below 100.000 tourists during the 3 last years - the same stabilising trend seen in other countries in Caribbean. Still it has been a significant drop since 2005 when the 'stay over' figure was 143.000.

The tourist season normally extends from October/November to April. If there are 100,000 'stay over' tourist staying in average 7 days it would be similar to have an increase in population of 4% full year residents. And these extra residents would likely be larger contributing factor to 'local' seafood consumption as they have an extra high preference for seafood – due to their expectations when staying on an oceanic tropical island.

Contrary to this stagnation in 'stay over' tourism and the lower number of cruise ship tourists experience the last couple of years the SKN Tourism reports that already after the first quarter of 2012 St Kitts had 280.000 cruise ship passengers visiting, which is a significant increase.

However the cruise ships normally stay only 10 hours arriving in the morning and leaving just before dinnertime. They do not source any food when at St Kitts, apart from earlier a few times buying locally produced tomatoes. The passengers during their short stay on land may however eat seafood during lunch in a local restaurant, but question is how much of this would have been locally sourced apart from a possible conch chowder or spiny lobster, simply because very little local marine fish are available in the restaurants. But this actually shows a large untapped potential.

St Kitts and Nevis is not the only Caribbean country with a negative seafood trade balance. In 2006 the region imported 132,000 tonnes, and it was estimated that this negative trade balance would grow at a rate of 1,675 tons per year. This also shows a large untapped regional demand also in the very nearby islands.

3.10.2 Trading

Trading is split up into two fairly distinct segments – fresh seafood and frozen/dried/salted.

Nearly all fresh seafood from capture fisheries are consumed locally. The only products exported are conch to St Martin and St Thomas, and occasionally spiny lobster to Guadeloupe and St Martin.

Compared to many other countries the fresh seafood trading involves very few vendors. According to the website of CRFM there are 15 middlepersons/vendors on St Kitts while none? on Nevis.

The major outlet channel of fresh coastal marine fish is direct from fisherman to domestic consumer at the landing sites as the private consumers purchase more than half the landings (Table 5; Report to The Nature Conservancy by Charles Steinback et.al., Ecotrust 2010: St. Kitts and Nevis Fisheries Uses and Values Project). The volume landed by one coastal, demersal fisherman after one trip is often between 10-20 kg (up to twice a week – as they use traps). The fish are sold within very short time like half an hour – and if very rarely some fish are not sold at the beach it may be sold to one of the fisheries complexes or given away.

Table 5: Percentage importance of customer segments of catch from different fishing activities on St Kitts and Nevis

	Personal use	Private consumers	Hotels/ restaurants	Fisheries complexes	Exporter
Ocean pelagics	4	30	57	7	2
Coastal pelagics	6	57	16	5	16
Demersal	7	64	16	13	0
Conch	1	32	15	0	51
Lobster	3	33	54	4	6
Squid	0	0	100	0	0

Table 5 also shows that a large share of the ocean pelagics and all squids are sold to hotels and restaurants, which is expectedly as they serve well as BBQ which is a safe choice for tourists.

In CADENCO 2010: Charlestown community fisheries center, baseline surveys. Prepared for ECOH CORPORATION it was found that the consumers buy 53% of their seafood purchase from the fisherman, 21.5 % from the Coop and only 18.8 from the supermarket.

If consumers buy from the fisheries complexes the complex of course takes a share of the profit margin. In Nevis the coop would add 30-50% on the round fish while the profit margin made on the descaled fish would be 40-60%. The advantage for the consumer to purchase from the fisheries complexes is convenience – i.e. that they can visit the shop at any time during opening hours and find a fish while when buying from the fisherman one has to be at the landing site when the fisherman returns – unless the customer has made own arrangements.

Different types of frozen, processed seafood are imported and sold through supermarkets or via restaurants/hotels. According to the website of the intergovernmental organisation CRFM there are 3 importers on St Kitts while none on Nevis, but when looking at the frozen food counters at 5 different supermarkets it would seem they have own imports as they have different mixes of species, preparations, labels and country of origin. In the supermarkets – the frozen seafood is informed to especially target the expats – as locals normally do not eat frozen fillets of freshwater fish as well as the expensive imports of like salmon, smoked herring etc.

Table 6: The 15 most important imported seafood commodities ranked by value and by volume, modified from 2009 (FAO FishstatJ)

Commodity (ranked by value)	USD '000	Commodity (ranked by volume)	tons
Misc. dried fish, whether or not salted	799	Fish, frozen	211
Fish fillets, frozen	378	Misc. dried fish, whether or not salted	113
Codfish, salted or in brine	248	Fish fillets, fresh or chilled	80
Fish meat, whether or not minced, frozen	217	Fish fillets, frozen	72
Tuna prepared or preserved, not minced,	197	Tuna prepared or preserved, not minced	68
Fish, frozen	174	Fish meat, whether or not minced, frozen	66
Fish fillets, fresh or chilled	164	Codfish, salted or in brine	50
Lobster tails or meat, prep. or pres.	112	Codfish, frozen	31
Shrimp, frozen	66	Shrimp, frozen	22
Pacific salmon, frozen	57	Lobster tails or meat, prep. or pres.	15
Marine fish, minced or preserved	55	Marine fish, minced or preserved	13
Codfish, frozen	50	Mackerel prepared or preserved	12
Shrimp, prepared or preserved	48	Pacific salmon, frozen	11
Mackerels, smoked	44	Fish, fresh or chilled	11
Shrimp, not cooked, frozen	39	Toothfish (Dissostichus spp.), meat, frozen	10
Others – lump sum	442	Others – lump sum	74
Grand total (volume)	3,090	Grand total (volume)	859

The FAO statistic FishStatJ (Table 6) shows that SKN in 2009 imported about 859 tons of seafood of a registered value of USD 3.09 million.

The statistic however does not inform country of origin in the trade flow and therefore a large file "fish_and_vegetables_-_imports_-_2009-2011" provided by Statistical Department on St Kitts was analysed. Even the species coding was very 'coarse' it was seen that the exporting country does not reflect origin of production. Likely because imported volume is small in SKN and only few importers and some supermarkets are involved. Thus they may tend to seek the easy, feasible solution, which is to buy from some major regional distributors, which can offer a wider range of products and in small volumes. USA accounts for 53% of the value imported by St Kitts and Nevis; Canada 27%; Guyana 8%; Trinidad and Tobago 5%; Suriname and Jamaica totally 4% other Caribbean countries 1% and finally UK 2%

The main worldwide exporters of seafood such as China, Thailand, Vietnam and Norway are not in the list of countries exporting to St Kitts even their products are found in all the supermarkets. Instead USA appears the major exporter, but it is itself the largest seafood importer in the world meaning that many products are only transit in USA and re-exported. As mentioned above it may seem a paradox why not making direct imports from producer country but on the other hand the logistics involved and small volumes may make it less feasible for St Kitts and Nevis to make their own direct imports apart from that seen from other Caribbean countries. Opposite to USA the other exporting countries including Canada are mainly selling their own products.

3.10.3 The Seafood Products

Locals would traditionally eat the local, fresh, marine species and especially demersal coral reef species in the XCD 10/pound group (doctor, hind, angels, boxfish etc.), which on the other hand would rarely be purchased by expats, because the fish are 'too small' apart from trevally and snappers. Species like squids and mullets are said to be sourced by expats – in specific it was said that especially people from Guyana would buy those. Locals consider squid as bait for hook and line – just like they did in Norway 20 years ago.

Table 7: Total 2011-landings in St Kitts and Nevis by species group (in pounds) and prices per pound of fresh/iced seafood at fisherman and coop

Species	St Kitts	Nevis	total	XCD at fisher	XCD at coop
Snapper	82,790	34,687	117,477	12	16-17
Grouper	20,590	38,419	59,009	10	13-15
Grunt	15,220	23,928	39,148	10	
Trigger	13,000	17,720	30,720	10	12.5-13
Squirrel	17,290	26,850	44,140	10	
Parrot	44,170	30,685	74,855	10	13.5
Doctor	13,760	40,562	54,322	10	
Porgy	0	4,079	4,079	10	
Goat	1,210	6,004	7,214	10	
Angel	38,890	4,448	43,338	10	13.5
Jacks	3,110	13,114	16,224	8	
Ballyhoo	51,910	19,992	71,902	5	
Gar	129,310	51,319	180,629	10	
Skip Jack; bonito; mackerel	4,690	4,760	9,450	8	15-16
Mullet	-	1,499	1,499	10	
Spiny Lobster	47,400	58,825	106,225	14 (12-16)	20
Spotted Lobster	-	501	501	10	
Slipper Lobster	-	160	160	10	
Green Lobster	-	2,210	2,210	14	
Conch	162,070	225,735	387,805	8	15
Dolphin	43,400	6,857	50,257	14	
Marlin	7,180	188	7,368	14	
Wahoo	-	34,810	34,810	14	
King Fish	-	1,125	1,125	14	
Tuna	18,420	5,976	24,396	14	
Shark	-	2,763	2,763	10	
Barracuda	-	3,822	3,822	8	

Shell Fish	-	9,865	9,865	5	
Crab	-	852	852	5	
Squid				10	
Lion fish				10	
Blue Runner				8	
Tarpon (bass)				10	
Total in pounds	**714,410**	**671,755**	**1,386,165**		
Total in kg	**324,732**	**305,343**	**630,075**		
Tilapia (SNAPPER farm)				14	

Table 7 shows that in 2011 the capture fisheries had higher output (630 tons) than earlier years which had an average of 450 tons. It is a remarkable increase as a percentage, but it has to be appreciated that it is small figures and thus easier to have large percentage variations.

The prices in the second column from the right in Table 7 are those paid the fisherman, partly informed by DMR and DF/Nevis but also informed/verified by the consultant at interviews during the fieldtrips.

Seafood is more expensive that red meats and frozen seafood is cheaper than fresh – considering the higher 'meat yield' of frozen fillets compared to round fresh fish (Table 8).

Table 8: Prices of (imported) frozen seafood and red meats at 5 supermarkets in St Kitts and Nevis as collected by the consultant

Seafood	XCD/pound
Mahi mahi (dolphin) cutlet	30
Mahi mahi (dolphin) baby loin	21
Wild pacific salmon round, Canada	30
Marlin boneless cutlet	7
Tilapia, fillets (in 0.25p bags), China	11.07
Tilapia, large fillets, China	10-13
Tilapia, round, China	6.5
Blue runner, round,	7.7
Grouper, fillet	14.6
Grouper, burger	30
Pangasius, fillets, Vietnam	13.5
Bangamary (King weakfish) fillet, Guyana	10
Sea trout (green weakfish) cuts, Guyana	7.5
(Spanish?) Mackerel, cutlet	14.7
Herring smoked/chilled Canada	20
Mullet round 0.5p/pcs	9
Salmon, fillet cuts	25

Red meats	
Chicken cuts and whole	2-4
Turkey cuts/defrosted	5
Pork cutlets/local	7.5-10
Pork imported	4-6
Beef local	7.25
Beef imported	10
Beef tail imported	18
Mutton local	8.5

Analysing the import data (Table 6) does not reveal any obvious item that could be produced domestically in aquaculture. It is seen that dried or salted fish as well as frozen fillets account for 50% of the import value and these products are either traditional 'fasting' meats or low cost fillet products of tilapia and pangasius, which will be difficult to compete against. The pricing of the latter 2 is only a little cheaper than other fish, which means that the distributors have a very high profit margin which will make it easy for them to lower the price if they have to go into a competition 'mode' against other seafood products.

To illustrate: In September 2012 the Vietnamese farmers are paid USD 1.1/kg for pangasius – and with a fillet yield of about 35% it means that raw material consumption to produce 1 kg of pangasius fillet is 2.85 kg i.e. actual USD 3.14. The processing plants sell just at just about USD 3.10, which is likely possible because they add 20-30% glazing - meaning that in the end the consumer actually only gets 700-800 g of fillet for each kg the buy (likewise the processing plants sell the 65% offal and make in the end a large share of their profit margin from this). The SKN supermarket sales price is USD 11/kg (same price in e.g. Canada) which leaves a high 250% profit margin to the traders/ distributors. Similar calculations can be made on tilapia. Therefore if going to compete with pangasius and tilapia products one has to appreciate that the traders have ample profit margin to operate within. The fish farmers in Asia hardly have any profit margin.

Above calculations show that in long term it is not likely to be a good **country** strategic choice for SKN to enter freshwater farming of tilapia etc. and it is suggested that aquaculture should focus on the 'normal' marine demersal fish species. Likely the demand is higher than present supply if more volume was available. This is verified by the fishermen rarely have unsold fish – and that the price level in general is high and – even as can be seen in Table 7 there is only a smaller price segmentation between the marine species. In addition to the local demand it has already been indicated above that there are further potential untapped "local" market opportunities if volume is sufficient and reliable – the cruise liners.

Wurzman et al in FAO Latin America- Caribbean review, describes the 'protein meat' consumption per capita in St Kitts and Nevis (Table 9). For comparison this is presented together with 2010 figures from NOAA FISHERIES: Fisheries report of the United States 2011.

Table 9: Seafood and red meat consumption percentages and kg per capita in St Kitts and Nevis (2007) compared to USA (2010)

Meat source	SKN 2007 (%)	USA 2010 (%)
Seafood	33	7
Poultry	51	44
Beef, sheep and others	10	27
Pork	6	22

Meat consumption	SKN 2007	USA 2010
Total kg per capita per annum	95	101

In the total context of origin of the meat protein it should be appreciated that whether pangasius and tilapia are low-cost fish competing against other fish is not the real issue. The real competition is in how to influence people to eat more seafood instead of chicken (broilers) which the consumers normally would do. From Figure 17 it is clearly illustrated from "the world's largest seafood market" – the USA – that seafood is not the major choice of the consumer – and it has been like that for decades – opposite chicken, which has shown very large growth.

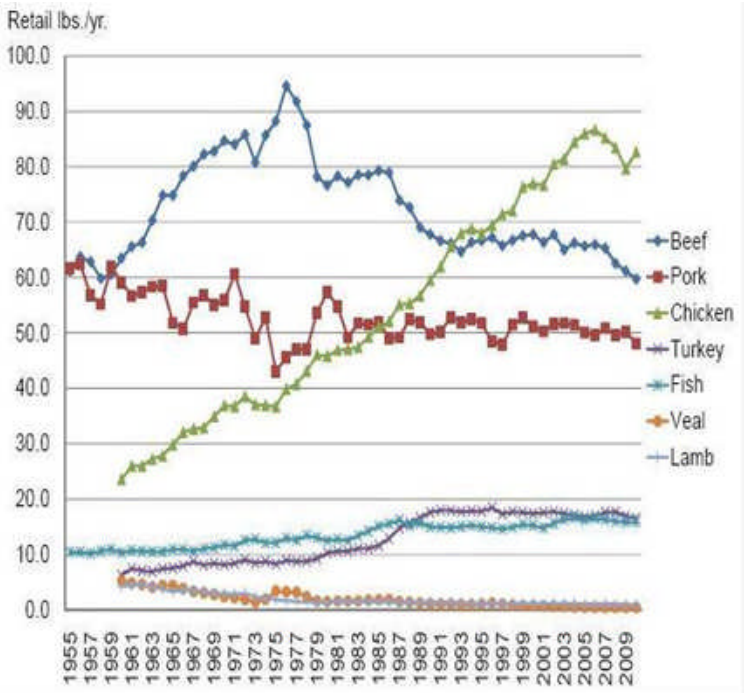


Figure 17: Development of USA per capita consumption of different meat sources (NOAA Fisheries: Fisheries report of the United States 2011)

Maybe tilapia and pangasius –if cheaper – could make consumer choose seafood protein against the other sources as fish protein has a better digestibility than chicken protein. But the extreme high profit margin taken on those two cheap fish species seems to prevent competition with chicken.

Figure 16 also shows a sign of warning for investors with an ambition to farm fish with the aim to export seafood into the USA market. Imports are stagnating – per capita consumption stagnating. The consultant would recommend instead that the investor look into supplying the Caribbean market which has a seafood trade deficit of more than 130.000 tons – such as firstly the CARICOM – a market where a production at SKN has a competitive edge.

4. Introducing aquaculture in St. Kitts and Nevis

4.1 Historical review of planned and/or performed activities

According to Horwith B. and Lindsay K. 1999 A biodiversity profile of St. Kitts and Nevis, trout, tilapia and carps (goldfish) have been introduced for stocking water bodies during the last century.

A trout species was stocked in estate ponds, but they are believed to have died out after the divestment of the sugar cane estates and the subsequent deterioration of the ponds due to lack of maintenance of the ponds.

Goldfish/carp was introduced by the Water Authority to stock in rainwater reservoirs to keep them clean and to reduce mosquito larvae.

Figure 18: Nest 'pits' made by male tilapia, now exposed to air due to low water level of pond at Lovers Beach, Nevis

Tilapia species and hybrids have been introduced several times and while it says in the biodiversity profile that their current status is not known, others inform that it has gone feral many places. The consultant saw clear nest pits made by male tilapias in the 'pond' or ghaut next to the sea at Lovers Beach (Figure 18)

Till date SKN has only had 2 aquaculture activities.

The first activity was on St Kitts during the 1980's when a shrimp farm was constructed inside the Half Moon Pond on the Atlantic coast (Figure 19). The privately owned pond was permanent saline, originally 50cm deep and 17 ha large surrounded by mangrove. The pond receives rain water from the hills but salinity has been measured up to 184ppt.

No detailed written information has been found about the shrimp farm, but it is understood that it was financed by some grant facility and that it rented the area of Half Moon Pond.

Figure 19: Half Moon Pond which had a shrimp farm during 1980's. Now it seems some of the pond is being reclaimed for land

The farm consisted of a small hatchery and 3-4 ha ponds made inside the salt pond by making impoundments. The salinity of the water was reduced by pumping in ocean water and inorganic fertilisers were added.

This would indicate a rather extensive approach but also it has been informed that pellet feed was used. The farm should have produced about 700kg of white legged shrimp per month, which was marketed locally. After a short time (half? A year) the farm ceased operations most likely due to flooding by the freshwater runoff, but also theft was been mentioned as the cause. During the site visit of the consultant the dikes of the previous farm were all below water level due to recent rain fall. The pond was now likely to be filled up with soil for land reclaim? (see Chapter 4.6)

The other aquaculture activity started in 1999 and is still going on.

At the Conaree Beach Dr Barrington Brown, originally from Jamaica, started growing tilapia hybrids in a land based farm using full strength oceanic water for the grow out. As a market gimmick the farm is called the St. Kitts and Nevis Aquaculture Pilot Project and Environmental Research (SNAPPER farm) (Figure 20).

Figure 20: Dr Barrington Brown at a pendulum feeder at the raceways of SNAPPER tilapia farm at Conaree Beach

The principle is pumping in water from behind the reef edge into a flow through system added some additional water treatment such as protein skimming and trickling filter aeration. The water outlet from the farm is into the 'soil' in the sand dune area thus avoiding having direct outlet to the sea. This would prevent risk of escapees of the tilapia, which are exotic to SKN.

The farm has a small hatchery producing enough fry for the present operation. The fry is kept for 21 days in freshwater after which they are exposed to full salinity seawater. The fry are fed special juvenile feed from Philippines containing 'male hormones' to manipulate the sex. 95% all-males are achieved. Male fish have a better performance such as better growth rate and they do not produce offspring which eventually would compete for food ('thousand brother society'). The remaining 5 % functional females are separated manually and grown separately.

The grow-out feed is imported chicken feed added farm grown duckweed for improvement of protein content. Growth was informed to be 1 pound in 9 months at 34 ppt salinity. Selling price is up to XCD 14/pound. Presently there is a yearly production up to 2,000 pounds or nearly 1 tons. The farm has just increased its pond area which should lead to a production expansion up to 10-20tons. Present sale is up to EC 1.400/month (USD 516). It was understood that most product was sold to restaurants.

At Nevis a tilapia trial farm was under construction at Prospect and operated by or in cooperation with Nevis Island Administration (Ministry of Agriculture etc). Detailed information was not given, but it was appreciated that the project will grow tilapia (imported from Florida) in plastic liner raceways fed municipality water.

In 2005 Carino Fish Farm Ltd submitted an environmental study to the Nevis Island Administration for a marine cage farm with a planned production of 2,500 tons cobia. The farm never materialised – it was part of a Norwegian investors ambitions for investments in real estate, condominiums etc.

The sites chosen on 50- 60m water south southeast of Nevis would have been very exposed for farming – but they anticipated use of submersible circular HDPE cages moored in a so called frame mooring. But to the opinion of the consultant this set up would not have been able to withstand even a smaller category hurricane as the waves would have impacted even the submersible cages. The project was also calculated to have only 10 staff – using the productivity of salmon farming as a model. To compare – in Vietnam another Norwegian investor started a cobia farm – also using modern cage technology and management – but when producing 1200 tons cobia/year the staffing was 60 persons. Therefore the consultant would consider the Carino Fish farm as a fantastic or rather a fantasy project. There are many other issues which could be highlighted as very risky settings for the farm – but likely the project was an activity among many and as such served its purpose just as 'a project'.

However it is known to the consultant that there are possible similar projects promoted by developers –and it is suggested that SKN administration are very careful in allocating (area) resources to these on the cost of local investors/farmers. It should also be appreciated that if a fish farm is started and fails the bad reputation itself can obstruct the development of the sector – even the possible farm in question made their own mistakes which could have been avoided.

4.2 Competitive advantages of aquaculture productions

The advantage of developing an aquaculture sector is that it will provide a domestic food production, using natural resources to achieve food security and nutrition. It will create both livelihood and investment opportunities and will in its most developed version create many job opportunities for educated, specialised and skilled people including all management levels.

As mentioned in Chapter 4.6 fisheries and aquaculture can go hand in hand and preserve biotopes by documenting tangible economic benefits in keeping the quality of environment towards planners and decision makers. Thus well managed aquaculture and fisheries can assist 'ethical' stakeholders in their argumentation for a conservation request.

4.2.1 Competitive advantage in the market

Well managed aquaculture has several competitive advantages to fisheries as it can target:

- the species in demand,
- the sizes in demand,
- the volumes in demand
- the time of highest demand

And this means that aquaculture can target special market segments, which fisheries cannot (i.e. increase volume of demand) – and which will pay premium prices.

As examples: Aquaculture can in addition to supplying the domestic fresh fish market also make special target towards the tourism season, the periods of stormy weather, the restaurants and resorts or possibly the cruise ships, when production predictability and volume have been developed. Selling to the latter segment will not support domestic consumption directly, but it

may become one of the elements making it more attractive for the cruise ships to come to SKN, and it would thus make a larger economic impact of the arrival of cruise ships than at present.

As an example – if a cruise ship order 2000-3000 pompano – plate size – degutted fresh on ice (i.e. about 1 tons) logistics can be developed for the fish to be harvested at 10 am, degutted and then delivered to the ship at 3 pm in time for the preparations for the evening meal. NO place in Caribbean can at present deliver like this – which could make going to St Kitts a special event. If at present a cruise ship wanted to serve the passengers (of mostly US origin) the highest priced marine fish in Florida – the pompano – they would have to prepare the dish based on imported frozen pompano fillets from Asia.

It was however informed to the consultant that the cruise ship segment notoriously was very difficult to target as the ships tend to be fully supplied with all goods before starting the cruise – to avoid having lack of supplies during the trip. However this would depend on the ability of the producers to develop the logistics and document to/ or convince the cruise liners that the product can be supplied with full guaranty.

The prevailing sales structure on SKN of seafood – i.e. the direct sales from fisherman to the consumer offers also large advantages to the fish farmer as they can make similar direct sales – by making an advance order system or by having holding tanks on shore where fish can be harvested on demand and sold through the 'farm outlet'. Farms can likewise also provide the supermarkets fresh fish, which would be a new segment for the supermarkets, and this could likely also be developed without the need to share profit margin to any other intermediate traders.

4.2.2 Food security and livelihood

Tourism development was one of the main strategic choices for income and livelihood generation made by the SKN government when leaving the sugar production. It leaves an interesting profit margin – especially the 'stay over' tourists spending in average nearly USD 1,000 inside SKN. However it is also known that the tourism sector is volatile, influenced by factors both outside and inside St Kitts and Nevis such as world economy, acts of terrorism and local incidences including hurricanes. As an example the stay-over tourists have dropped from 143,000 arrivals in 2005 to 92,000 in 2010.

The consultant recommends that due consideration should be given making a mix between the industry sectors (the primary, secondary and tertiary sectors)to be less vulnerable and not only to use the natural resources of SKN for tourism and real estate development, but also for production of more human food instead of the dependency on imports. Since SKN has the natural resources domestic food production "FOOD SECURITY" should be given more focus. If having a balanced domestic food production the country will be much more resilient to external influences or impacts of fluctuating world economy impacting number of tourists or sudden souring food prices. However it is appreciated that historically local food production is not a tradition. SKN have for centuries produced 'sugar cane cash crop' and supplied the world market with sugar while depending on a large share of imported food items for its residents. While having left the sugar production several years ago it seems to the consultant that there is still a remaining issue in developing the domestic food production sector – making use of the present available natural resources i.e. the vacated cane fields to something more than the mentioned real estate and tourism development. Even strong economies such as several oil producing countries in the Arabian Gulf have started appreciating the need for domestic food security, which should make that priority even more obvious to a less strong economy like SKN.

It was informed that unemployment is an issue on the islands – but also it is appreciated that many people work in several fields at the same time. E.g. the majority of fishermen are part time fishermen also working in e.g. construction. Likewise there are many part time farmers. This could be a result of living in small island communities where many people have to have an opportunistic approach – taking the job opportunity which shows – and without being too specialised. Especially if having a higher degree opportunities to get the relevant job in SKN may be limited, which the high mobility of skilled/ educated people seems to indicate.

The following indicative income levels were informed:

- 'Full time' coastal demersal fisherman[3]: XCD 3,600/month (USD 1,333)
- Carpenter XCD 150/day: XCD 3,300/month (USD 1,222)
- Electronics worker (trained): XCD 2,076/month (USD 770)
- Garment worker (trained) XCD 1,782/month (USD 660)
- Unskilled worker XCD 75/day: XCD 1,650/month (USD 611)
- Minimum salary: XCD 1,280/month (USD 475)
- Full time (2 crops) farmer: XCD 10,000/year
- Part time (1 crop) farmer: XCD 7,000/year
- Poverty line Nevis XCD 9,788/year
- Poverty line St Kitts XCD 7,329/year

It would seem as if the full time farmer (Nevis) has an income less than the minimum salary and actually at the poverty line XCD 9,788 (Nevis); question is if it is full time work or underreported income?

The minimum salaries of SKN are higher than SE Asia. E.g. in Vietnam the minimum salary varies from USD 70 to 100/month depending on region – and thus any production from aquaculture should not be in competition with SE Asian products. However the relative high, local price of fresh marine fish would easily accommodate local salary levels in the before mentioned levels and even more – if efficiently performed. To compare with the other end of the salary segment – a salmon farm worker in Norway would have a monthly salary of close to USD 5,000 and still it is feasible – but each person in average produce 370 tons of fish per year – just a little less than total output from fisheries in SKN.

It should be noted that in modern larger volume fish farming there are many specialisations in the productions requesting highly skilled staff. Management and risk reduction are increasingly important tasks which necessitates highly trained and educated people in the production – hence also the higher salary levels.

Traditionally most sea based work – like fishermen – is performed only by men, however if developing a combination model with land based fish farming women will have equal job opportunity just like in agricultural farming

4.3 Potential species for farming based on market demand and biological criteria

The present study does not intend to present feasibility analyses on different species suitable for aquaculture in SKN, but will attempt to make some general observations of which are the criteria for species in general to have a potential – and then make a short listing of candidates. For different reasons discussed elsewhere only marine (fish) species are considered.

4.3.1 Species selection criteria

The following selection criteria could be used when selecting a species to farm in SKN. They cover the local conditions in market and the conditions lay out by the SKN farming model

[3] 'Full time' coastal demersal fisherman using traps would catch 50(-300) pounds per trip (average XCD 450) and 2 trips per week

(Chapter 6) and thus would not be the same for any tropical country. It should likewise be appreciated that a species does not need to qualify to all criteria:

Biological qualities

- Marine, tropical/subtropical finfish
- schooling, free-swimming fish,
- attractive growth rates (i.e. marketable size in less than one year)
- low FCR (max up to 1.5),
- control over lifecycle/ consistent availability of juveniles
- indigenous?

Demand qualities

- If targeting domestic market
  - Species does not need to have large market volumes
  - Species does not need to have value added, processing abilities because sold fresh
- If targeting export market
  - Large-volume species, meaning market should not collapse if supplying 25 tons of product in one consignment
  - Local preference for the species in the regional/Caribbean white fish market segment
  - Can enter chilled, value added processing i.e. consistent and medium low cost production

Figure 21: Species blend landed by coastal demersal fisherman using traps (Nevis)

Demand wise most species caught are sold within a narrow price range i.e. XCD 10-12/pound (USD 8.15 – 9.75/kg) which are excellent prices for most farmed fish. However it should be noted that prices likely will be reduced if having improved supply. In SE Asia a farm gate price of more than USD 6/kg for fresh, chilled marine fish is considered good.

If looking at the species mix from fisheries only few of them have the necessary biological qualities. In Figure 21Figure 21: Species blend landed by coastal demersal fisherman using traps (Nevis) it can be seen that hinds, groupers and true coral fish like surgeon/doctor fish take up a large share. Most of these are slow growing, not schooling and live cycle not closed. They would therefore not qualify as true aquaculture species – but if a fisherman combined the capture fisheries with aquaculture he could stock the smaller individuals and surplus fish in a cage/tank for keeping and fattening, thus making value added to the fisheries. In the picture only Yellowtail snapper, *Ocyurus chrysurus* is a species with full aquaculture potential.

4.3.2 Snappers

Snappers are locally the fish with the highest demand. There are several regional species – the highest rated is Northern red snapper, *Lutjanus campechanus.* The life cycle has been closed but to the knowledge of the consultant no commercial farming takes place yet. The lifecycle of the Yellowtail snapper, *Ocyurus chrysurus* (Figure 22) has also been also closed but likewise it is not farmed commercially. This is not a sign of lack of feasibility but rather because of the very limited efforts being done in the region within marine fish farming. The only snapper species that has been commercially farmed has been the Mutton snapper *Lutjanus analis* however the present farming status is likely 'idle'. Only recent information is that a few tons of 'snappers' are produced in Mexico and Costa Rica based on wild captured juveniles.

Figure 22: Yellowtail snapper

The snappers are in general performing well in aquaculture; growth for most species is medium good, they school nicely in the cages or tanks and their feed conversion is not high (FCR<2). The hatchery technology is known but it is not 'beginner's fish' for a hatchery – especially if trying to do it intensively – Asian approach is easier. In Asia snapper is produced in large volumes (?20-30,000 tons) and are considered medium valued fish for the house hold or family restaurants – but in Americas snappers are among the higher priced marine fish. In SKN the present price is XCD 13-14/pound i.e. up to USD 11.40/kg, which should provide the basis for a profitable production. The export potential is good within the Americas.

4.3.3 Pompano

There are 2 regional species Florida pompano *Trachinotus carolinensis* and Atlantic permit *Trachinotus falcatus,* both of them being farmed, however the permit only in Asia (where it has been introduced via Taiwan). The growth data available seems to indicate that permit is the much better regional species for farming – permit grows to a large size and thus holds a better growth potential that can be triggered in farming. The species have in general the best farming characteristics, easy to mass produce in hatchery, normally not burdened with many diseases, grows fairly uniform, a feed conversion rate(FCR) around 1.5 – and if using permit even a chance to have 2 production cycles a year in full tropical conditions and if marketable size is around 1.2 pound (550g). The world production is more than 25,000 tons, mainly China, but it does not appear in statistics as most countries report the pompano under 'other species' (Figure 23).

Florida pompano is among the higher priced marine fish in the USA (though it has to be appreciated that prices of fish in SKN are higher). Overall pompano has very good market characteristics. The meat is juicy, the skin has very small scales (thus it does not get damaged easily), use of the meat is very versatile – from BBQ to sashimi. The species is considered by the consultant to have the highest potential for fish farming in SKN.

Figure 23: Pompano farmed in Asia. Fish in left picture about 2 kg ready as broodstock; fish in right picture 1 pound fish vacuum packed for USA market.

Figure 24: The trevallies or jacks are like the pompano Carangids, but more common in fisheries. They also have good farming qualities however the market demand is less than pompano.

4.3.4 Mullet

For whatever reason mullet has a dubious reputation in the markets – but only in those where it is not eaten – or by single persons not eating it! Those who eat it consider it tastier than normal white meat fish. In SKN it commands XCD 8.5-10/pound (more than USD 7/kg) and it is said especially to be sourced by Guyanese expats.

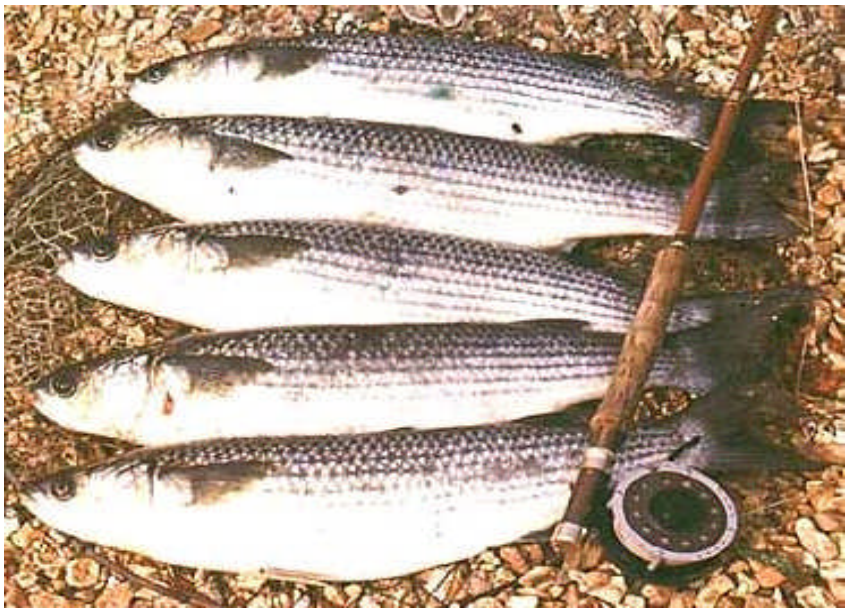


Figure 25: Striped or grey mullet, found all over the world in warmer waters

The grey or striped mullet *Mugil cephalus* (Figure 25) is the most common mullet found in the sea and coastal warmer waters all over the world. In temperate zones they are summer migrants (water should be more than 16 ^{0}C).

There are several advantages in farming mullets – the feeding habits and the availability of juveniles in the wild - capture-based juvenile production (only few places hatchery grown juveniles are used).

The mullet feeds at a lower trophic level than most white fish as they are adapted to suck up the top layer of the sediments removing detritus and microalgae as well as plant debris. This makes it possible to feed them with less expensive inert feed, with little marine ingredients, such as feed for carps or tilapia.

Figure 26: 15-20 cm mullet juveniles in the Major's Bay Pond, St Kitts.

The other advantage of mullet is using wild caught juveniles for grow-out. This method is widely used in all countries where they are farmed such as in the Black Sea, Mediterranean countries and China – all places farming is done with wild caught juveniles as mullet especially when young seeks into brackish water ponds and streams, where they easily can be 'collected'. It has been carried out for decades and is considered a sustainable practise even considering the very large volume produced (

Table 10). It can be seen that Guyana ranks no 14 on the list of produces of mullet, hence a likely explanation why expats from Guyana are sourcing mullet in SKN. It should be appreciated that the statistics are not complete as a major producer China has not specified its mullet production, but included it in the 'other species' group.

Table 10: Worlds aquaculture production of mullet (tons)

Country	2010
Egypt	116,029
Indonesia	8,822
Korea, Republic of	4,680
Taiwan	2,555
Israel	2,100
Iraq	1,000
China, Hong Kong SAR	811
Italy	571
Singapore	519
Tunisia	354
Greece	280
Ukraine	165
Spain	128
Guyana	71
Saudi Arabia	38
Others	7
Total	138,130

Especially in a condition like SKN it is likely that the very limited brackish water ponds available put a limitation to the number of juveniles which can sustain a living inside the pond areas (Figure 26). Those in excess likely have to stay along the coast with less favourable conditions such as increased predator pressure and less nutrients. In SKN it is therefore likely that a controlled harvest of mullet juveniles from the ponds juts would open space for recruitment of other mullet juveniles – so that the overall output of larger juveniles to the 'capture fisheries' eventually would be the same. This however would have to be researched – meaning that the collection of juveniles would have to be recorded over some years and monitored if the pond production is stable or not.

The growth rate and performance in aquaculture is considered good – and it would be appropriate for the SKN seasonal farming approach (see later). In Egypt they reach a size of 0.75-1 kg after 7-8 months in a pond, which means that even 2 cycles could be made a year if producing about 1 pound size. The semi-intensive production cost of mullet in Egypt is quoted to be USD 1/kg. An overview of farming of mullet can be found on http://www.fao.org/fishery/culturedspecies/Mugil_cephalus/en

4.3.5 Red drum

Red drum *Scianops ocellatus* (Figure 27) is not known to SKN. It is a euryhaline fish species (enters freshwater) distributed along the Atlantic and Gulf of Mexico coasts from Cape Cod, Massachusetts to Tuxpan, Mexico. It is a very easy fish in farming and lifecycle is closed. An overview of farming of Red drum can be found on http://www.fao.org/fishery/culturedspecies/Sciaenops_ocellatus/en

Figure 27: Red drum

As can be seen in

Table 11 it has been introduced to many countries because of its farming qualities and fairly good acceptance in the market (medium value fish). Only about 2% of the production takes place in its natural distribution area the rest in countries where it is exotic. A large share of the production takes place in ponds with more or less brackish/freshwater. It has also been introduced to Vietnam and is called “USA snapper” directly translated from Vietnamese.

Table 11: Worlds aquaculture production of red drum (tons)

Country (Country)	2010
China	52,243
USA	1,134
Mauritius	498
Israel	460
Mayotte	100
Réunion	50
Martinique	45
Guadeloupe	3
Mexico	3
Total	54,536

The Caribbean island history of farming red drum dates back to 1985, when the Association for Aquaculture Development in Martinique (ADAM) introduced red drum from USA to substitute their trials with European seabass as they showed prone to diseases. By end 1995 ADAM and IFREMER had developed the full protocol for farming achieving size of 500g in 8 months and 800 g in 10 months (Jean-Claude DAO: Aquaculture development of red drum (Scianops ocellatus) in Martinique and the French West Indies in FAO Fisheries Report No. 704: Sub regional workshop to promote sustainable aquaculture development in the small island developing states of the Lesser Antilles 2002)

The results show the red drum to be a good candidate for the SKN farming model which only permits up to 12 month farming cycle. The advantage of farming the red drum is that the farming protocol is well documented and that the red drum is showing to be a strong fish. Likewise the juveniles are available from many hatcheries in the region – in USA they are also produced in large number for restocking purposes. Likely it can also be sourced from Martinique which would make disease control easier due to the isolation. Also at Martinique one could get experience if there has been any negative impact of introducing this ‘semi-exotic’ species to Martinique.

4.3.6 Cobia

Figure 28: Cobia, 6 kg size in processing plant in Vietnam – sturdy shape shows it has mainly been fed trash fish

Cobia *Rachycentron canadum* (Figure 28) is a special fish – the only species in its group and the nearest relatives are the remoras, which follows large fish. Cobia is a circum-tropical species apart from the west coast of America. Apart from some loose spawning aggregations it is a lonely straggler found together with tuna and mahi mahi.

A lot of media noise and consultant reports have been made about the aquaculture potential of cobia – especially made by people who never was involved in practical farming of the fish . The present consultant worked 8 years with farming the species. It has some qualities and some constraints, which however should not be underestimated.

The main quality is that the growth rate from fish larvae is among the fastest, but not as perfect as promoted. Individual growth rate may be 6-7kg/year, but the average size after 1 year is more likely between 3.5 to 4.0 kg. FCR (using quality pellets) becomes as high as >3 for fish larger than 4 kg – meaning the cost of USD 4.5 just for the feed.

Other constraints are that it seems that the pellet feed available is not appropriate compared to trash fish. The cobia fed good trash fish has a much healthier – sturdy – appearance.

Finally – and most important is that it does not have the general market acceptance, which the versatile meat quality has been anticipated to command. People do not know the fish and are not willing to pay the premium for the fish, which is necessary considering the very high production price. The main market is in Taiwan where it has been promoted actively for 15 years – but they prefer only more than 7kg sizes.

Overall world production is about 40,000 tons most of which is produced in China, Taiwan and Vietnam. Likely another 30 countries are experimenting with it, but the commercial activities normally only lasts 2-3 years. In the region Belize is producing 85 tons again after a near failure, Netherland Antilles 40 tons cobia and Martinique possibly 25 tons.

It is said to be a very rare fish in the SKN area and not known to the consumer, thus it is highly recommended NOT to start production of this species in the present phase of development.

The farming of the fish is described at http://www.fao.org/fishery/culturedspecies/Rachycentron_canadum/en

The latest strategy of some cobia farmers is to harvest the cobia already at 3.5 kg, when the FCR still is acceptable low – but then the share of the cost of juvenile is too high and the major market (Ta.

4.3.7 Spiny lobster

Farming of spiny lobster takes place in several Asian countries and is very profitable even in small scale. A full farming protocol has been developed based on attracting the free swimming puerulus (lobster) larvae by different submerged devises – and then grow the juvenile until harvest size. Depending on species this may take up to 2 years. It is the export market for China which is the driving force – many of the species commanding more than USD 30-35/kg to the farmer.

The Chinese market for live lobsters is also said to be the driving force for the pricing of lobsters in Florida (however lower as transport costs are high). The Florida fisherman receives USD 6/pound for iced lobsters and up to USD 9/pound for the live, however in 2009 the price fell to

Figure 29: Caribbean spiny lobster, to the left 4 pounds. Sold live to resorts or private consumers

only USD 3.12/pound due to large landings. This small market introduction shows that it is not likely under the present conditions that SKN can export to USA (and China), as the local price in SKN is about USD 6/pound for the 'half dead' ones.

However it is recommended to develop more live lobster holding facilities and exploit better the domestic resort market and the regional (island) market which already buys lobster from SKN

It was informed that the resort Four Seasons on Nevis purchases 150pounds/day from one local dealer who keeps the lobsters stored in boxes in the sea.

4.3.8 Shrimp

A short comment on potential of shrimp farming in SKN. It is not competitive to other regional producers. SKN does not have any significant tidal amplitude, it does not have the right area resources, the lowland and wetlands are too few and would be very vulnerable to the surge if there is a hurricane hit.

Therefore it is recommended that the government does not divert focus from what would be the main thrust which can have a long and lasting impact for the federation – i.e. marine fish farming.

4.3.9 Seaweed

It was informed that in the Narrows (the strait between the islands) locals were collecting seaweed which either was used for a local drink/dish or exported to Dominican Republic

In FAO Aquaculture development in the Caribbean, Mission to Caribbean 1981 this activity is described more detailed for St Lucia

There is a seaweed fishery and seaweed is considered a prime candidate for aquaculture by the Government. Its culture would be possible throughout the region. Edible seaweed, *Gracilaria debilis*, grows around the island, but mostly on the south side from Choiseoul to Sayarnes Bay. Fishermen dive to harvest the seaweed, breaking it off or pulling it loose, being sure to leave the holdfast. The harvest occurs three times a year for about two weeks each time. It is collected only when the water is clear, and cannot be collected during the rainy season when river runoff keeps the water turbid. Fishermen report that it is best to wait three months between harvests, during which the seaweed will grow to 40 or 50 cm. Anywhere from 10 to 50 divers may take part in a harvest. One fisherman reported that he collected about 200 kg of seaweed (wet weight) in one week. It takes about 3 kg of wet seaweed to make 1 kg of dry. It is common for the fisherman to dive and for his family to transport, bleach and dry the seaweed. Bleaching is done by spreading the seaweed in the sun and sprinkling it with sea-water to keep it moist, or by covering it with clear plastic film. The bleaching takes about two days. Afterwards the seaweed is dried for two or three days, and then it is bagged in 40 kg sugar sacks. The producer is paid from USD 4.25 to 6.80/kg for dried seaweed.

The dried seaweed, known locally as 'sea moss', is found in the local market in season. It is usually made into a drink, but is sometimes eaten as porridge. Most fishermen sell to agents who apparently, in turn, sell to inter-island traders who sell it in Barbados, Trinidad and Guyana. In Barbados and Trinidad the retail price is said to be about USD12.75/kg.

Figure 30

The dried seaweed, known locally as 'sea moss', is found in the local market in season. It is usually made into a drink, but is sometimes eaten as porridge. Most fishermen sell to agents who apparently, in turn, sell to inter-island traders who sell it in Barbados, Trinidad and Guyana. In Barbados and Trinidad the retail price is said to be about USD12.75/kg.

The price of the seaweed was increasing as it now was being used in an 'ecological' product with even higher demand. It should be considered to grow it in the effluent/sedimentation tank of the land based farm units (Chapter 6)

4.4 Input factors

A good way to appreciate importance of the input factors to the production costs a small comparative analyses made by the consultant is presented in Table 12

Table 12: Contribution of input factors in percentage (%) to production budget of different fish species[4]

Species	salmon	salmon	yellow-tail	Cobia	Yellow croaker	Tiger grouper	mouse grouper	grouper
Country	Nor	Nor	Jap	Taiw	Chi	Indo	Indo	Thai
Year	2002	2010	2002	2002	2006	2005	2005	2003

[4] Modified and calculated from:
Norwegian Directorate of Fisheries website; http://www.fiskeridir.no/english
Hsu 2003; in Yang, Y. et al. editors, 2009: Cage Aquaculture in Asia, Proceedings. Asian Fisheries Society;
Economics and market analysis of the live reef-fish trade in the Asia–Pacific region. ACIAR Working Paper No. 63

Feed	53.5	53.8	48.9	59.2	34.3	44.1	29.8	57.1
Fingerlings/juveniles	11.8	11.5	29.3	4.8	40.4	28.3	31.0	24.0
Labour	7.6	7.9	7.9	25.5	4. 5	7.0	9.9	-
Depreciation	5.0	5.2	3.0	3.0	5.6	7.3	10.4	3.2
Others	16.0	15.7	9.7	6.2	10.1	7.0	9.9	15.7
Interest	4.9	5.1	1.0	1.2	5.1	6.5	9.0	-
Insurance	1.5	0.8	-	-	-	-	-	-
Total Cost	100.3	100	99.8	99.9	100	100.2	100	100
production cost USD/kg	2.13	3.16	7.1	3.17	-	8.80	14.90	5.95
Processing	+14.9	+12.8						

Especially 2 budget lines are noteworthy: Feed and Depreciation.

4.4.1 Feed

Feed is the major single cost factor, which normally will account for more than 50%. Feed quality is therefore important – and even so feed management. This is why skilled, trained farm workers and production managers are important. Good quality marine fish feed is not produced in many countries. The companies need a certain scale of operation. Therefore it is common in fish farming that the feed is transported –even long distances – e.g. USA to Belize or Canada to Vietnam. Container ship transport is not expensive compared to road transport.

Depreciation covers the investments in e.g. equipment, and this is here many newcomers to the aquaculture make the wrong focus. They spend endless time in searching equipment and in negotiating small savings and possibly to end up with a cheaper solution – but 'cheap is never cheap' if on the cost of risk mitigation. It is appreciated that purchases will put pressure on the bank account – but during operation it actually has a minor role.

As for the important issue of feed it is often seen that new farmers focus on finding a factory with the shortest distance to the farm as a criteria for feed purchase, while feed quality itself is not researched. To appreciate the volume of money involved – if having a 1,200 tons production of cobia the fish are fed about 12 tons of feed a day Figure 31 – i.e. a cost of USD 18,000/day.

Figure 31: Marine Farms Vietnam, which were feeding 14 tons of pellets every day while producing 1,200 tons of cobia in 2010. Feed blower seen in dinghy.

4.4.2 Juveniles/stocking material

Another important input factor is the juveniles or stocking material.

They can either originate from capture fisheries (or collected from the wild) i.e. capture-based juvenile production like the mullet juveniles but it could also be directly as an output from fisheries in the case of the demersal coastal fishers using traps or hooks for catching the fish. Even though the traps have to fulfil a minimum mesh size many of the caught fish are juvenile stages of fish, meaning that they still hold a growth potential.

It was informed that amount of fish in a trap is gradually declining. If the fisherman instead of selling the juveniles stocked them (if keeping them alive) into a cage and sold them later with a value added weight gain it could be a good example of entry point to the fisherman (or his family) to the aquaculture sector and it would be value adding to a resource which already was destined to be taken out of the sea.

The other solution and more widely used is to get the juveniles from dedicated fish hatcheries.

During the start-up of marine fish farming SKN would need to import juveniles from a regional hatchery already in production. There are many in the region – but most of them are for research purposes and do not produce larger, commercial numbers of fingerlings and maybe not the species requested. The exact production capacity, capabilities and availability would have to be looked into when relevant as this is changing.

The following hatcheries and species focus are known to the consultant: Martinique (Red drum and ?cobia); Puerto Rico (snapper); Dominican Republic (pompano); the United States (red drum, cobia, pompano, ?snappers, ?Seriola); Mexico (?cobia, ?snapper), Belize (cobia, ?pompano), Panama (yellowfin tuna), Colombia, Ecuador and Brazil (cobia) and Cuba (?cobia).

If purchasing juveniles from abroad biosecurity should be in focus (FAO Fisheries Technical Paper 402: Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals) as SKN has no history of farming of marine fish. This is a competitive

advantage which should not be put at risk as it also means that many of the diseases and parasites which have spread all over the world through farming activities has not arrived in SKN.

It is important to look careful into the potential supplier – take samples and have them analysed by external experts – and to analyse the biosecurity procedures performed by the hatchery, making sure that they don't mix their productions with outsider productions – making sure the traceability is intact.

If having identified the hatchery able to deliver the species, number and quality requested it is important to share this information with other farmers – to avoid the risk of starting imports from many different hatcheries. The more hatcheries supplying – the higher the risk of introducing more diseases.

As this can be difficult to implement on a volunteer basis the authorities may have to regulate imports and procedures – and not only by requesting a 'certificate of origin' which was the only procedure requested from the previously planned Carina Cobia farms.

It is highly recommended that DMR arrange for samples to be taken before imports are permitted as health certificates also show to be of less value – often produced once a year by the local authorities – and photocopied or each shipment.

Smaller scale enterprises often do not possess the ability to organise the logistics of a juvenile import from abroad – and this could then either be arranged by the authorities or a certified/trusted private importer, who maybe even have a nursery facility which could serve as a quarantine facility. If this is done prudently (high focus on biosecurity) it could be a niche production – and fingerlings would have the ultimate high per kg price of any products.

It could also show to be a very good strategic investment considering the isolated location of SKN to develop a hatchery to supply mainly the local sector development – but eventually also the whole Caribbean region with certified disease free stocking material.

A marine fish hatchery consists of following principle sections: broodstock/parental stock unit; spawning; incubation; larvae rearing; live food production; weaning (to inert feeds); and nursery section.

To speed up the development it is suggested to develop the hatchery in steps or phases of intensiveness.

Firstly make a simple/cheap, extensive Southeast Asian style hatchery, which leaves much to the natural processes. There is less management, less need for skilled staff and several of the above processes actually take place in the same environment (pond).

In its most simple version it consists of two ponds – one for broodstock keeping, spawning and egg collection and another one for incubation of eggs, live food (plankton) production achieved through using fertilizer in the pond , larvae rearing and finally weaning of the fish fry. It is however recommended to combine this model with a few Westerner elements in live food production to achieve better control and biosecurity.

Depending on availability of broodstock the production in this extensive hatchery could be started with few preparations and a result (juveniles) can be achieved in half a year.

The other more technology demanding approach is the one having every step including the live food produced in separate cultures i.e. algae, copepods, rotifers and artemia. This is a larger investment and needs very skilled staff – and the investment is much higher. The advantage is however that the productions are more predictable (when it works) and likewise the biosecurity is normally better – meaning that the risk of introducing diseases and especially parasites through the juveniles is less than if using the extensive systems.

An intensive, commercial hatchery will often cost minimum 1 million USD as many of the processes are performed indoor and it will realistically take 2 years including the construction before a pilot production can be achieved.

The recommendation of the consultant is to focus on production of marine fish species, but in the above context it has to be noted that the strength of e.g. tilapia is that the hatchery process of the

latter is very easy – the feeding process – and actually it is a problem that often too many juveniles are produced – inside the grow out pond. That is why it is normal to manipulate the sex and have all males for grow out only.

4.4.3 Other input factors

The other input factors including equipment are not really constraining factors and detailed discussion is outside the scope of the present study – although some mentioning will take place in Chapter 6 and when discussing risk mitigation.

4.5 Size of suitable land and sea farming areas of St Kitts and Nevis

This Chapter summarises and transform the area findings from the GIS mapping (pls. refer to working report 3) into aquaculture potential.

The size of the areas reflects the *suitability – not the availability* as the availability can/may be a political issue and thus it is up to the decision makers and planners. It has to be emphasized that the suitability criteria laid down does not include using submersible cages. At the present stage of development (and experience) of aquaculture in SKN the consultant would strongly recommend to use well proven technologies (Chapter 6), which can be operated from surface and without VERY large investments. The submersible cages still need to show their feasibility – including in hurricane prone areas.

12 cages on a sea site of 210 x 280 m (in combination with a land based nursery) can produce equivalent to the present average output from capture fisheries – 450 tons/ year

If 'translating' the size of suitable areas into overall rough production potential – it could become an astonishing xxxx tons (xxx times the present output from fisheries), however this estimate is not based on analyses of carrying capacity. As for the land based farming the carrying capacity eventually is a matter of investments in clean technologies – for effluent treatment – if it is found to have a negative impact. As for the farming in sea cages carrying capacity estimates would have to be calculated – based on currents and resilience of biotopes. But for sea cage farming it is likely that the main limiting factor in volume would be biosecurity considerations – i.e. which distance one should have between the farms to avoid transfer of possible diseases.

The following criteria have been used in choosing the suitable areas:

Land site criteria – for suitability:

- Land in connection to the sea (or very close – like opposite side of coastal road)
- 1st grade suitable: up to 10 m above sea level
- 2nd grade suitable: up to 20 m above sea level (reason is to avoid too high pumping costs)
- 1st grade suitable: inclination max 4 %
- 2nd grade suitable: inclination 4-6 % (reason is to avoid too much levelling work)
- Areas divided into private and public (company) owned
- Sites should not already be in use by other permanent/long term stakeholder like housing, ports, resorts, natural reserves, mangroves/ponds etc

Sea site criteria – for suitability:

- On leeward side of islands (not because of need for the cage structures, but for making operation easier)

- 1st grade suitable: between 15-30 m depth (minimum should be 15m to have the net in good distance from the seafloor. The 30m depth is because of limitation in normal diving during inspection of moorings and when installing the cages)
- 2. grade suitability between 30 to 60 m depth (technically possible but more difficult to operate)
- Seafloor of sites should not have steep inclination (this will complicate the installation of the mooring – and make it more expensive and less safe)
- Sites should not be directly on top of ecologically vulnerable ecological biotopes such as coral reef. Therefore the following resilient habitats are recommended for farming (reference given to the TNC biotope map Figure 12):
  - Bare carbonate sand; Unconsolidated sand with algae; Sparse sea grass; Semi-consolidated rubble
- Sites should not be in established shipping channels – like leading into a port (sites however should be marked with appropriate yellow, light buoys according to IALA rules)

4.6 SWOT resume of introducing aquaculture

A SWOT analysis is a methodology to identify the Strengths and Weaknesses (internal factors), and to exam the Opportunities and Threats (external factors) faced. This should help to focus the interventions or elements of a government or company aquaculture strategy into areas where SKN has competitive advantages (i.e. strength are used to matched the opportunities) and finally to evaluate how or if weaknesses and threats can be solved or prevented. I.e. if the threats or weaknesses cannot be solved they should be *minimize* or *avoided.*

Strengths:

- Tropical, oceanic island conditions
  - no permanent rivers (no mud flats, no turbidity, stable salinity)
  - no pollution (no large industries, no large cities)
  - stable temperatures (not too hot during seasons in coastal)
  - high oxygen level (also during night as little phytoplankton)
  - likely no too strong currents - apart from the Straights? (as there are little tidal movements. Exact current data are not known to consultant)
- Many suitable areas available for land based and sea based farming (using seawater)
- Fresh marine fish are in high domestic demand (high priced)
- Demand is for pound sized fish (easy/fast to produce in aquaculture)
- Simple seafood value chain. The fishers sell directly to the consumer, i.e. the whole profit margin is left at the fisher (producer) level
- Exotic marine fish diseases and parasites have not been introduced into SKN, because there is no history of marine fish farming
- There is a genuine focus by government on development of aquaculture to improve food security and nutrition.

Weaknesses:

- Small tidal amplitude
  - possible risk of low current speeds for cage farming i.e. optimally it is ½-1 knot (25-50 cm/sec). (to be solved by site selection)
  - which cannot provide water exchange in coastal ponds constraining feasibility of shrimp farming (weakness avoided as shrimp farming is not promoted)

- Limited low laying areas/wetland/mangroves constraining feasibility of shrimp farming (weakness avoided as shrimp farming is not promoted)
- No local fish feed production, and lack of trash fish resources to be used for fish meal/feed production (most aquaculture countries have to import feed or at least ingredients for feed thus this does not affect competitive edge of SKN)
- Lack of marine fish juvenile production (to be addressed by imports and the strategy)
- If developing the SKN aquaculture model (see Chapter 6) there is a risk off oversupply of fish when harvesting the cages just before the hurricane season (to be solved by farming strategies/management and by using land based tanks as holding facilities, as well as processing and cold storage)
- Market (weaknesses) for aquaculture products
  - No market for freshwater fish apart from cheap, imported frozen fillets (weakness avoided as freshwater farming is not promoted)
  - No price premium at producer level for live lobsters compared to Asian countries (weakness avoided as lobster farming is not promoted at present)
- Labour cost high if producing low valued freshwater fish, where SKN have no competitive edge (weakness avoided as freshwater farming is not promoted)
- No real fishermen organisations (apart from sales cooperatives) which also could become the platform for introduction of aquaculture (to be addressed by the strategy)
- No tradition for aquaculture i.e. no experienced aquaculturist and no experience in governing aquaculture (to be addressed by the strategy)
- Possible divergence (or unclear) procedures regarding land and sea leases including between the two islands administrations (to be addressed by the strategy)
- No planning in aquaculture including spatial planning with other users (to be addressed by the strategy)
- No aquaculture HR, HRD incl. extension staff in aquaculture (to be addressed by the strategy)
- No aquaculture R&D (realistically put aside as resources of SKN are limited. Instead focus on use of proven technologies and technology transfer - to be addressed by the strategy)

Opportunities:

- The very consistent trade winds from the east can be used for wind driven pumping, aeration and electricity generation
- Make use of government owned land (originating from sugar cane farming) for improving food security instead of lying idle or only used for real estate and tourism development. Make spatial planning.
- Market (opportunities) from aquaculture products:
  - Logistics can be developed to deliver the species, size, quality and quantity in demand – and when in demand
  - Traceability, high food safety - no risks of ciguatera
  - Volume from capture fisheries has stagnated
  - Open direct farm gate sales to local consumers (high profit margin to farmer)
  - Because of the predictable and consistent production restaurants enters sales of dishes prepared from fresh seafood from aquaculture (high profit margin to farmer)
  - Because of the predictable and consistent production supermarkets enters sales of fresh seafood from aquaculture (medium to low profit margin to farmer)

- Because of the predictable and consistent production from aquaculture the cruise ships starts purchasing fresh, degutted fish on ice for the evening meal on SKN – like 2,000-3,000 fish portion sized fish per ship (high to medium profit margin).
- The Caribbean area has a negative seafood trade balance. SKN can supply the regional seafood market with farmed, quality fresh marine fish i.e. same traditional marine species which are in demand – instead of going on world market and introduce new species (medium profit margin to farmer)
- Enter processing for the supermarket and export market segments when volumes from aquaculture have picked up to expand market segments (medium to low profit margins to farmers – but high volume)
- Multi-species marine fish market because of a tropical multi-species fish fauna. Researchers have already closed the life cycle of many species which thus can be farmed
- Isolated location – hatchery opportunity for production of certified disease free marine fish juveniles for the whole (tropical) Central America (high profit margins) of a selected number of regional species.

- Marine fish farming would be compliable with the skills of the fishermen, if they are in need of additional livelihood option
- Mullet fingerling available from the wild (for farming)

Threats:

- Hurricanes/waves/swells/surge. The risk/probability that a hurricane category 1 is to hit the islands is a 10% – i.e. once in a 10-year period – this is too risky for an "around-the-year" farming in sea cages, For marine infrastructure in the Caribbean, a minimum 50-year return period design condition is recommended. (can be solved – SKN farming model).
- No permanent freshwater bodies apart from few small streams, only few irrigation reservoirs, and risky due to occasional draughts. Marriott Hotel took the consequence of supply situation and totally depends on desalinated water even for irrigation of golf course (threat avoided as freshwater farming is not promoted).
- Tropical island work attitude? Will people be interested in aquaculture?
- Overlapping area resource utilisation with tourism and real estate development?
- Market (threats) of aquaculture products:
  - Competition with other imported, protein resources such as red meats and especially chicken. (if focusing on marine fish farming this will not be an issue within foreseeable production – the cheaper, imported, frozen freshwater fish eventually will be in competition with imported chicken)
  - There is no tradition to eat freshwater fish i.e. there is no premium and the market is already supplied by imports of cheap and processed products from Asia towards which SKN has no competitive edge (threat avoided as freshwater farming is not promoted).

The listing in a SWOT analyses can be lengthy – but that does not serve the purpose of the SWOT tool – which is to focus interventions – made by government or company structure, when they enter a new sector – and therefor it has to address relevant issues to the present stage of development to make any sense.