

'Quick scan' to assess the prevalence of dermal parasites among coral reef fishes of Bonaire.

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IMARES C055/15



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1. Introduction

In the past, diseases and infections have had dramatic impacts on Caribbean coral reef ecosystems (e.g. white band disease in corals (Pantos and Bythell, 2006); mass mortality of the sea urchin *Diadema* (Lessions, 2005)). Regular monitoring of reef organisms for signs of disease and infections may be important as an “early warning system” to possibly prevent devastating outbreaks.

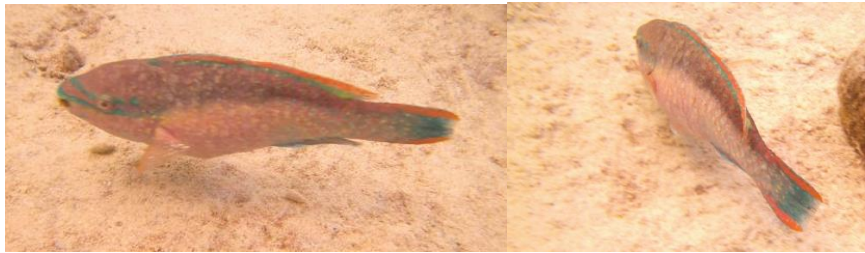


Figure 1.1 A princess parrotfish (*Scarus taeniopterus*) heavily infected with dermal parasites (Salt Pier, Bonaire, September 2013; photo's M. de Graaf).

In September 2013 an unusual number of reef fish species (e.g. Scaridae (Fig. 1.1 , Acanthuridae and Pomacanthidae) infected with dermal parasites were observed during a dive at Salt Pier (M. de Graaf, pers. obs.). In September 2014 one princess parrotfish infected with dermal parasites was dissected and internal and external samples were send to the Central Veterinair Institute (CVO) in Lelystad (Netherlands) for further histopathological examination. According to CVO the parrotfish suffered from a microspore parasitic infection of the skin, muscles and digestive tract. The cysts caused fibrotic abscesses and necrosis on the fins.

Similar dermal parasites were observed in a recent survey of coral reef fishes on Curaçao and the observed external blemishes were associated with infections by trematodes (digenean metacercaria), turbellarians and protozoans (*Cryptocaryon*) (Bernal et al., 2015). Bernal et al. (2015) reported that infection rates of coral reef fish on Curacao were almost ten times higher compared to infection rates of coral reef fish surveyed in Mexico and Belize. To date, only anecdotal observations exist of parasite infections on coral reef fish on Bonaire but no quantitative assessment of the prevalence of dermal parasites is available.

The objective of the Helpdeskvraag was to:

- 1) conduct a “quick scan” to determine the current prevalence of dermal parasites among the coral reef fish of Bonaire, and
- 2) advise EZ on possible consequences and future actions depending on the outcome of the “quick scan”.

2. Materials and Methods

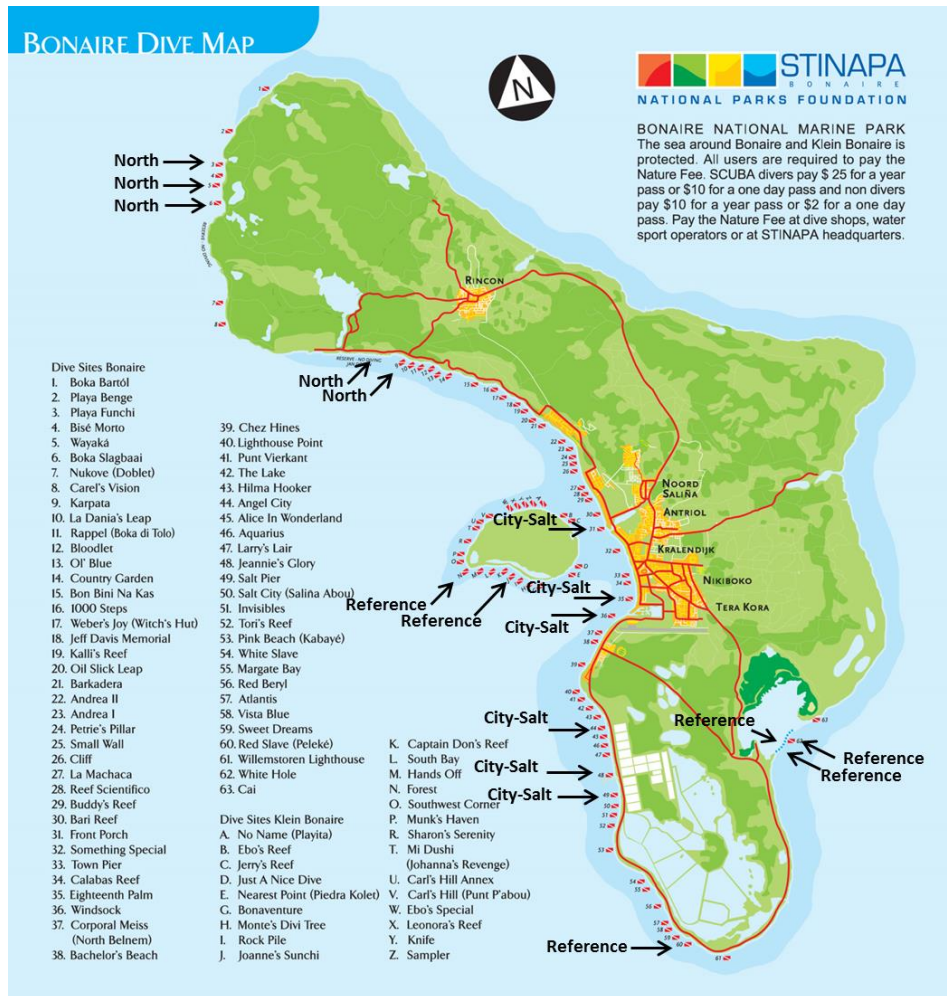


Figure 2.1 Location of the study sites on Bonaire.

On Bonaire visual surveys were conducted at 17 different sites (Fig. 2.1) between 7 and 16 March 2015. The selection of sites was largely based on the water quality study of Slijkerman et al. (2014), resulting in a selection of sites known to vary in water quality (e.g. City-Salt locations versus northern locations). Some sites were added to the 'quick scan' as a reference based on assumed good water quality (e.g. east coast with minimal human influence) or as additional sites potential eutrophic sites based on the presence of deep-water cyanobacterial mats (Salt Pier and Windsock; Becking & Meesters, 2014). In general, the reef system on the west coast begins at the waterline and gently slopes down to 10 m depth from where the reef steeply drops to 30-40m (Bak, 1977). The study sites were located on the shallow plateau (back reef) between 1-5 m depth and at the top of the drop off between 10-15 m depth. Two divers swam (3-5m distance between the divers) for 30 minutes parallel to the coast at each of the two reef zones. During each survey both observers recorded the presence or absence of dermal parasites on 41 selected common reef fish species belonging to 16 families (see Table 3.1). For highly abundant species like brown chromis the presence of dermal parasites was recorded for a maximum of 50-75 individuals recorded in each reef zone.

On the east coast the back reef at Lac Kai was surveyed by snorkel while the drop off reef zone was surveyed by SCUBA. Result of the 'quick scan' will be simply presented as infection rates per species, reef zone and/or geographical location.

3. Results, Discussion and Recommendations

3.1 Infection rate per species

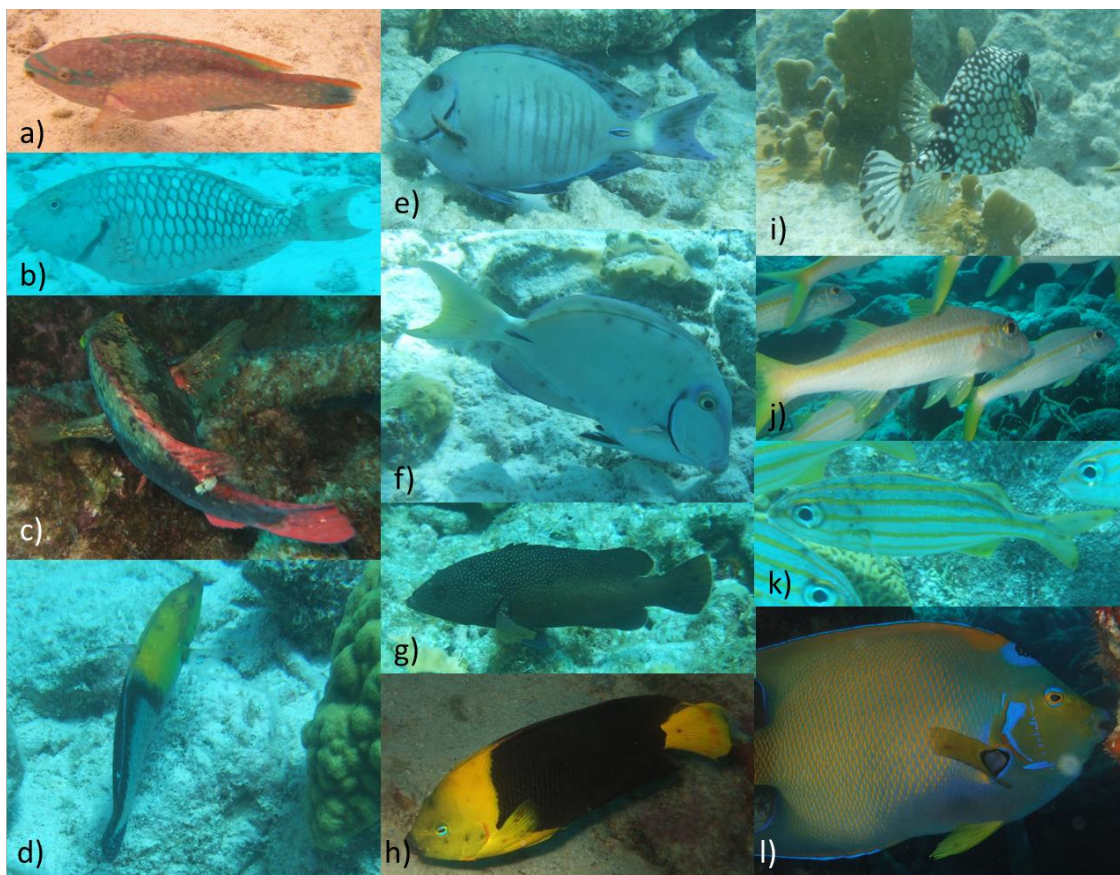


Figure 3.1 Examples of coral reef fish species infected with dermal parasites on Bonaire: a) *Scarus taeniopterus* (princess parrotfish), b) *Sparisoma viride* (stoplight parrotfish), c) *Sparisoma aurofrenatum* (redband parrotfish), d) *Halichoeres garnoti* (yellowhead wrasse), e) *Acanthurus chirurgus* (doctorfish), f) *Acanthurus tractus* (ocean surgeonfish), g) *Cephalopholis fulva* (coney), h) *Holacanthus tricolor* (rock beauty), i) *Lactophrys triqueter* (smooth trunkfish), j) *Mulloidichthys martinicus* (yellow goatfish), k) *Haemulon chrysargyreum* (smallmouth grunt) and l) *Holacanthus ciliaris* (queen angelfish). Photo's by Martin de Graaf.

In total 16040 coral reef fish were visually inspected for the presence of dermal parasites. Dermal parasites were absent on five of the 41 selected species (Table 3.1) in the survey. In comparison, zero of the 110 species in Mexico, one of the 79 species in Belize and 14 of the 96 species in Curaçao were reported to be infected with dermal parasites (Berbal et al., 2015).

On Bonaire the species with the highest infection rates were *A. tractus* (57%), *C. pullus* (54%), *L. triqueter* (50%), *S. aurofrenatum* (46%), *C. macrocerus* (36%), *A. polygonia* (34%), *A. chirurgus* (32%), *C. fulva* (31%) and *S. taeniopterus* (30%). In addition to the 41 selected species, dermal parasites were also observed incidentally on the sand tile fish (*Malacanthus plumieri*), palometta (*Trachinotus goodei*), sharpnose pufferfish (*Canthigaster rostrata*) and spotfin butterflyfish (*Chaetodon ocellatus*). Not only was the number of infected coral reef fish species on Bonaire considerably higher than on Curaçao, Belize and Mexico but also the proportion of infected individuals for nearly all species was markedly higher on Bonaire than on Curaçao (Table 3.2).

Table 3.1 Overview of observed dermal parasites infection rates among 41 species (16 families) of coral reef fish on Bonaire.

| Species | Total (#) | Infected (#) | Infected (%) | Species | Total (#) | Infected (#) | Infected (%) |
|--|-----------|--------------|--------------|--|-----------|--------------|--------------|
| Acanthuridae | | | | Mullidae | | | |
| <i>Acanthurus coeruleus</i> (blue tang) | 955 | 94 | 10 | <i>Mulloidichthys martinicus</i> (yellow goatfish) | 1388 | 262 | 19 |
| <i>Acanthurus chirurgus</i> (doctorfish) | 185 | 59 | 32 | Ostraciidae | | | |
| <i>Acanthurus tractus</i> (ocean surgeonfish) | 1266 | 720 | 57 | <i>Acanthostraco polygiona</i> (honeycombed cowfish) | 32 | 11 | 34 |
| Aulostomidae | | | | <i>Lactophrys triqueter</i> (smooth trunkfish) | 165 | 83 | 50 |
| <i>Aulostomus maculatus</i> (Atlantic trumpetfish) | 137 | 16 | 12 | Pomacentridae | | | |
| Carangidae | | | | <i>Stegastus partitus</i> (bicolor damselfish) | 568 | 6 | 1 |
| <i>Caranx ruber</i> (bar jack) | 231 | 40 | 17 | <i>Chromis cyanea</i> (blue chromis) | 737 | 17 | 2 |
| Chaetodontidae | | | | <i>Chromis multilineata</i> (brown chromis) | 1584 | 5 | 0 |
| <i>Chaetodon striatus</i> (banded butterflyfish) | 127 | 3 | 2 | <i>Abudefduf saxatilis</i> (sergeant major) | 516 | 35 | 7 |
| <i>Chaetodon capistratus</i> (four-eye butterflyfish) | 281 | 1 | 0 | <i>Microspathodon chrysurus</i> (yellowtail damsel) | 146 | 2 | 1 |
| Haemulidae | | | | Pomacanthidae | | | |
| <i>Haemulon flavolineatum</i> (French grunt) | 683 | 4 | 1 | <i>Pomacanthus paru</i> (French angelfish) | 68 | 0 | 0 |
| <i>Haemulon chrysargyreum</i> (smallmouth grunt) | 1041 | 148 | 14 | <i>Holacanthus ciliaris</i> (queen angelfish) | 18 | 5 | 28 |
| Holocentridae | | | | <i>Holacanthus tricolor</i> (rock beauty) | 68 | 14 | 21 |
| <i>Myripristis jacobus</i> (blackbar soldierfish) | 391 | 20 | 5 | Scaridae | | | |
| <i>Holocentrus adscensionis</i> (squirrelfish) | 146 | 0 | 0 | <i>Scarus taeniopterus</i> (princess parrotfish) | 872 | 258 | 30 |
| Labridae | | | | <i>Scarus vetula</i> (queen parrotfish) | 484 | 36 | 7 |
| <i>Thalassoma bifasciatum</i> (bluehead wrasse male) | 178 | 2 | 1 | <i>Scarus iseri</i> (striped parrotfish) | 223 | 12 | 5 |
| <i>Clepticus parrae</i> (creole wrasse) | 465 | 7 | 2 | <i>Sparisoma aurofenatum</i> (redband parrotfish) | 575 | 263 | 46 |
| <i>Halichoeres radiatus</i> (puddingwife) | 46 | 12 | 26 | <i>Sparisoma viride</i> (stoplight parrotfish) | 707 | 58 | 8 |
| <i>Bodianus rufus</i> (Spanish hogfish) | 124 | 21 | 17 | <i>Sparisoma chrysopteryum</i> (redtail parrotfish) | 119 | 12 | 10 |
| <i>Halichoeres garnoti</i> (yellowhead wrasse male) | 110 | 7 | 6 | <i>Sparisoma rubripinne</i> (yellowtail parrotfish) | 156 | 19 | 12 |
| Lutjanidae | | | | Serranidae | | | |
| <i>Lutjanus mahogoni</i> (mahogany snapper) | 265 | 6 | 2 | <i>Paranthias furcifer</i> (creole fish) | 151 | 14 | 9 |
| <i>Lutjanus apodus</i> (schoolmaster) | 353 | 5 | 1 | Serranidae | | | |
| Monacanthidae | | | | <i>Cephalopholis fulva</i> (coney) | 167 | 52 | 31 |
| <i>Cantherhines pullus</i> (orange-spotted filefish) | 24 | 13 | 54 | <i>Cephalopholis cruentata</i> (grasby) | 200 | 0 | 0 |
| <i>Cantherhines macrocerus</i> (whitespotted filefish) | 88 | 32 | 36 | | | | |

Table 3.2 Observed dermal parasites infection rates among 13 species of coral reef fish on Bonaire and Curaçao (Bernal et al., 2015).

| Species | Bonaire | | | Curacao | | |
|---|-----------|--------------|--------------|-----------|--------------|--------------|
| | Total (#) | Infected (#) | Infected (%) | Total (#) | Infected (#) | Infected (%) |
| <i>Acanthurus coeruleus</i> (blue tang) | 955 | 94 | 10 | 241 | 17 | 7 |
| <i>Acanthurus chirurgus</i> (doctorfish) | 185 | 59 | 32 | 52 | 6 | 12 |
| <i>Acanthurus tractus</i> (ocean surgeonfish) | 1266 | 720 | 57 | 147 | 29 | 20 |
| <i>Caranx ruber</i> (bar jack) | 231 | 40 | 17 | 17 | 3 | 18 |
| <i>Haemulon chrysargyreum</i> (smallmouth grunt) | 1041 | 148 | 14 | 151 | 2 | 1 |
| <i>Halichoeres garnoti</i> (yellowhead wrasse male) | 110 | 7 | 6 | 266 | 2 | 1 |
| <i>Lutjanus apodus</i> (schoolmaster) | 353 | 5 | 1 | 36 | 1 | 3 |
| <i>Cantherhines pullus</i> (orangespotted filefish) | 24 | 13 | 54 | 11 | 2 | 18 |
| <i>Mulloidichthys martinicus</i> (yellow goatfish) | 1388 | 262 | 19 | 27 | 6 | 2 |
| <i>Lactophrys triqueter</i> (smooth trunkfish) | 165 | 83 | 50 | 20 | 1 | 5 |
| <i>Sparisoma viride</i> (stoplight parrotfish) | 707 | 58 | 8 | 221 | 1 | 0.5 |
| <i>Scarus iseri</i> (striped parrotfish) | 223 | 12 | 5 | 224 | 2 | 1 |
| <i>Sparisoma rubripinne</i> (yellowtail parrotfish) | 156 | 19 | 12 | 13 | 1 | 8 |

3.2 Infection rate: spatial variation

Based on this 'quick scan' study, infection rates of dermal parasites seem to be different in the two reef zones (Fig. 3.2, left). The percentage of infected individuals of four abundant reef fish species and 'all fish pooled' appeared to be higher on the shallow back reef compared to the drop-off zone. A similar result was reported by Grutter (1998) for the blackedge thicklip wrasse, where infection rates were much higher on the shallow reef flat compared to the deeper reef slopes due to a higher abundance of parasitic (monogenean) eggs on reef flats.

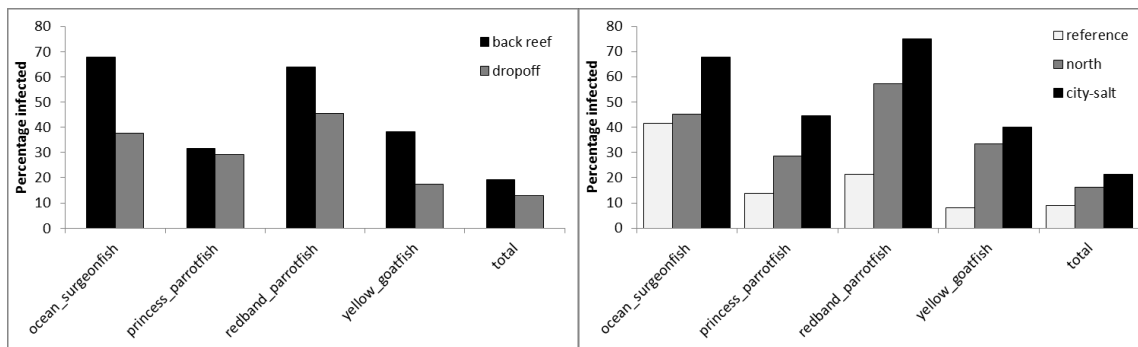


Figure 3.2 Trends in infection rates between reef zones (left graph) and among geographical areas (right graph).

In addition, infection rates of dermal parasites did not appear to be similar all over Bonaire (Fig. 3.2, right; Fig. 3.3). The highest infection rates of the four common reef fish species and "all fish pooled" seem to occur along the west coast between the Salt Pier (Cargill Salt Bonaire N.V.) and Kralendijk. The lowest infection rates were observed on reference study sites (Red slave in the south, the three sites on the east coast and the two sites on Klein Bonaire). The northern study sites (around BOPEC) showed intermediate infection rates.

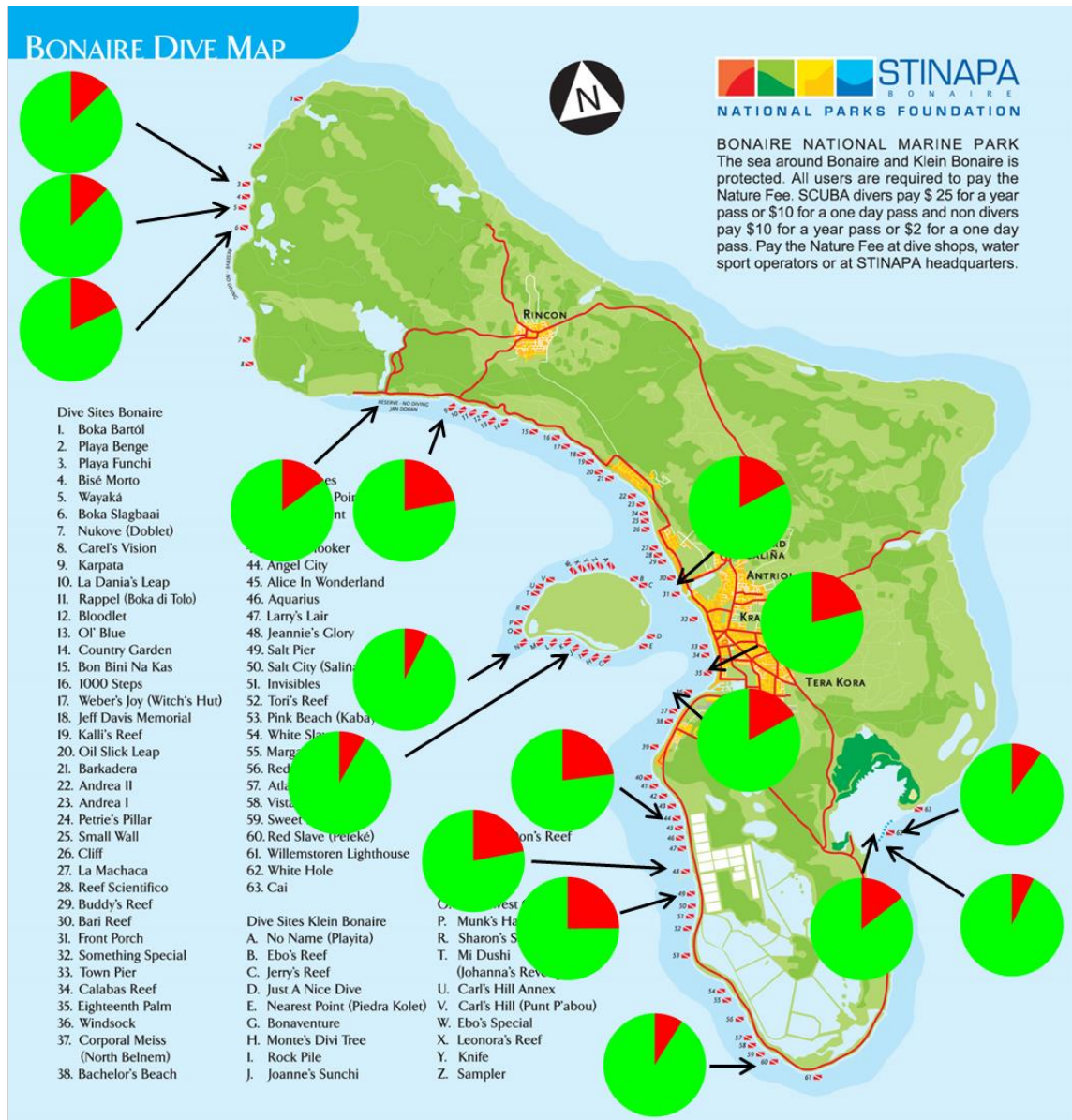


Figure 3.3 Spatial variation in dermal parasite infection rates among the 17 study sites.

3.3 Parasite infection rates in an environmental context

Increased parasite rates maybe correlated with water quality. The spatial differences in infection rates were roughly similar to the spatial differences in water quality reported by Slijkerman et al. (2014). Slijkerman et al. (2014) showed that threshold level for nitrogen were exceeded for urban and southern locations (i.e. ~City-Salt study sites), indicating eutrophic conditions, probably due to outflow of sewage water and to brine leaching into the sea from salt works.

A decline in environmental conditions (water quality) cause by wastewater or industrial pollutants can increase the prevalence of parasites in fish due to a diminished resistance to infections and decline in immunological defences (Sasal et al. 2007 and references therein).

In impoverished environments parasites with simple, single host life cycles (monoxenous) will proliferate. Monogenean parasites can be an indicator of water quality as these parasites are usually more abundant in eutrophic water (Valtonen et al., 1987) or other polluted areas (Skinner, 1982). Lafferty (1997) reported a similar increase in digenean abundance with eutrophication. However, anthropogenic activities such as increased pollution or fishing pressure can also cause a decline in the abundance and prevalence of heteroxenous (multi-host complex life history) parasites due to a lack of intermediate hosts (Sasal 2007 and references therein; Lafferty 2008).

The identification of the dermal parasite(s), their associated life cycles and the possible causes and/or ecological consequences of the widespread and extremely high prevalence of dermal parasites was not part of the 'quick scan' study and remain unknown. Since 2003 regular fish surveys have been conducted at several sites along the west coast of Bonaire (Steneck et al., 2013). Future co-operation with the research team of Dr. B. Steneck (University of Maine, USA) during a potential follow-up project may enable us to analyse trends in density and abundance of several heavily infected herbivorous species (e.g. ocean surgeon fish, redband parrotfish and princess parrotfish) in the geographic zone zones.

3.4 Recommendations for future research

Based on the results of the 'quick scan', we advise to a stepped follow up on this study, focusing on the type of parasite(s) and possible factors influencing the infection rate. More specifically:

- collect infected coral reef fish to identify the dermal parasite species,
- determine the life cycle of the dermal parasite species, i.e. heteroxenous (complex, multi host life cycle) or monoxenous (simple single host life cycle),
- a detailed study in the spatial and temporal patterns in the occurrence of dermal parasites, and
- determine the cause and effect of the extreme high prevalence of dermal parasites, including co-factors steering the high infection rates.

4. Quality Assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 124296-2012-AQ-NLD-RvA). This certificate is valid until 15 December 2015. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Fish Division has NEN-EN-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 1th of April 2017 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

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Justification

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The scientific quality of this report has been peer reviewed by the a colleague scientist and the head of the department of IMARES.

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Onderzoeker

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A handwritten signature in blue ink, appearing to read 'Diana', with a large, stylized flourish extending downwards and to the right.

Date: 1 April 2015

Approved: Drs. J.H.M. Schobben
Hoofd afdeling Vis

Signature:

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Date: 1 April 2015