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This investigation has been performed by order and for the account of Directorate-General for Environmental Protection, Directorate for Soil, Water and Rural Area (BWL), within the framework of the project "Standard setting for other relevant substances within the WFD".

Rapport in het kort

Environmental risk limits for captan

Dit rapport geeft milieurisicogrenzen voor het fungicide captan in water. Milieurisicogrenzen zijn de technisch-wetenschappelijke advieswaarden voor de uiteindelijke milieukwaliteitsnormen in Nederland. De milieurisicogrenzen zijn afgeleid volgens de methodiek die is voorgeschreven in de Europese Kaderrichtlijn Water. Hierbij is gebruikgemaakt van de beoordeling in het kader van de Europese toelating van gewasbeschermingsmiddelen (Richtlijn 91/414/EEG), aangevuld met gegevens uit de openbare literatuur.

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1 Introduction

1.1 Background and scope of the report

In this report, environmental risk limits (ERLs) for surface water are derived for the fungicide captan. The derivation is performed within the framework of the project 'Standard setting for other relevant substances within the WFD', which is closely related to the project 'International and national environmental quality standards for substances in the Netherlands' (INS). Captan is part of a series of 25 pesticides that appeared to have a high environmental impact in the evaluation of the policy document on sustainable crop protection ('Tussenevaluatie van de nota Duurzame Gewasbescherming'; MNP, 2006) and/or were selected by the Water Boards ('Unie van Waterschappen'; project 'Schone Bronnen'; http://www.schonebronnen.nl/).

The following ERLs are considered:

- Maximum Permissible Concentration (MPC) – the concentration protecting aquatic ecosystems and humans from effects due to long-term exposure
- Maximum Acceptable Concentration (MAC_{eco}) – the concentration protecting aquatic ecosystems from effects due to short-term exposure or concentration peaks.
- Serious Risk Concentration (SRC_{eco}) – the concentration at which possibly serious ecotoxicological effects are to be expected.

More specific, the following ERLs can be derived depending on the availability of data and characteristics of the compound:

$MPC_{eco, water}$	MPC for freshwater based on ecotoxicological data (direct exposure)
$MPC_{sp, water}$	MPC for freshwater based on secondary poisoning
$MPC_{hh food, water}$	MPC for fresh and marine water based on human consumption of fishery products
$MPC_{dw, water}$	MPC for surface waters intended for the abstraction of drinking water
$MAC_{eco, water}$	MAC for freshwater based on ecotoxicological data (direct exposure)
$SRC_{eco, water}$	SRC for freshwater based on ecotoxicological data (direct exposure)
$MPC_{eco, marine}$	MPC for marine water based on ecotoxicological data (direct exposure)
$MPC_{sp, marine}$	MPC for marine water based on secondary poisoning
$MAC_{eco, marine}$	MAC for marine water based on ecotoxicological data (direct exposure)

1.2 Status of the results

The results presented in this report have been discussed by the members of the scientific advisory group for the INS-project (WK-INS). It should be noted that the Environmental Risk Limits (ERLs) in this report are scientifically derived values, based on (eco)toxicological, fate and physico-chemical data. They serve as advisory values for the Dutch Steering Committee for Substances, which is appointed to set the Environmental Quality Standards (EQSs). ERLs should thus be considered as proposed values that do not have any official status.

2 Methods

The methodology for the derivation of ERLs is described in detail by Van Vlaardingen and Verbruggen (2007), further referred to as the 'INS-Guidance'. This guidance is in accordance with the guidance of the Fraunhofer Institute (FHI; Lepper, 2005).

The process of ERL-derivation contains the following steps: data collection, data evaluation and selection, and derivation of the ERLs on the basis of the selected data.

2.1 Data collection

In accordance with the WFD, data of existing evaluations were used as a starting point. For captan, the evaluation report prepared within the framework of EU Directive 91/414/EC (Draft Assessment Report, DAR) was consulted (EC, 2005; EFSA, 2006; further referred to as DAR). An on-line literature search was performed on TOXLINE (literature from 1985 to 2001) and Current contents (literature from 1997 to 2007). In addition to this, all potentially relevant references in the RIVM e-tox base and EPA's ECOTOX database were checked.

2.2 Data evaluation and selection

For substance identification, physico-chemical properties and environmental behaviour, information from the List of Endpoints of the DAR was used. When needed, additional information was included according to the methods as described in Section 2.1 of the INS-Guidance. Information on human toxicological threshold limits and classification was also primarily taken from the DAR.

Ecotoxicity studies (including bird and mammal studies) were screened for relevant endpoints (i.e. those endpoints that have consequences at the population level of the test species). All ecotoxicity and bioaccumulation tests were then thoroughly evaluated with respect to the validity (scientific reliability) of the study. A detailed description of the evaluation procedure is given in the INS-Guidance (see Section 2.2.2 and 2.3.2). In short, the following reliability indices were assigned:

- Ri 1: Reliable without restriction
  'Studies or data … generated according to generally valid and/or internationally accepted testing guidelines (preferably performed according to GLP) or in which the test parameters documented are based on a specific (national) testing guideline … or in which all parameters described are closely related/comparable to a guideline method.'
- Ri 2: Reliable with restrictions
  'Studies or data … (mostly not performed according to GLP), in which the test parameters documented do not totally comply with the specific testing guideline, but are sufficient to accept the data or in which investigations are described which cannot be subsumed under a testing guideline, but which are nevertheless well documented and scientifically acceptable.'
- Ri 3: Not reliable
  'Studies or data … in which there are interferences between the measuring system and the test substance or in which organisms/test systems were used which are not relevant in relation to the exposure (e.g., unphysiologic pathways of application) or which were carried out or generated

according to a method which is not acceptable, the documentation of which is not sufficient for an assessment and which is not convincing for an expert judgment.'

- Ri 4: Not assignable
  'Studies or data … which do not give sufficient experimental details and which are only listed in short abstracts or secondary literature (books, reviews, etc.).'

All available studies were summarised in data-tables, that are included as Appendices to this report. These tables contain information on species characteristics, test conditions and endpoints. Explanatory notes are included with respect to the assignment of the reliability indices.

With respect to the DAR, it was chosen not to re-evaluate the underlying studies. In principle, the endpoints that were accepted in the DAR were also accepted for ERL-derivation with Ri 2, except in cases where the reported information was too poor to decide on the reliability or when there was reasonable doubt on the validity of the tests. This applies especially to DARs prepared in the early 1990s, which do not always meet the current standards of evaluation and reporting.

In some cases, the characteristics of a compound (i.e. fast hydrolysis, strong sorption, low water solubility) put special demands on the way toxicity tests are performed. This implies that in some cases endpoints were not considered reliable, although the test was performed and documented according to accepted guidelines. If specific choices were made for assigning reliability indices, these are outlined in Section 3.3 of this report.

Endpoints with Ri 1 or 2 are accepted as valid, but this does not automatically mean that the endpoint is selected for the derivation of ERLs. The validity scores are assigned on the basis of scientific reliability, but valid endpoints may not be relevant for the purpose of ERL-derivation (e.g. due to inappropriate exposure times or test conditions that are not relevant for the Dutch situation).

After data collection and validation, toxicity data were combined into an aggregated data table with one effect value per species according to Section 2.2.6 of the INS-Guidance. When for a species several effect data were available, the geometric mean of multiple values for the same endpoint was calculated where possible. Subsequently, when several endpoints were available for one species, the lowest of these endpoints (per species) is reported in the aggregated data table.

2.3 Derivation of ERLs

For a detailed description of the procedure for derivation of the ERLs, reference is made to the INS-Guidance. With respect to the selection of the final MPC_{water} some additional comments should be made:

2.3.1 Drinking water

The INS-Guidance includes the MPC for surface waters intended for the abstraction of drinking water ($MPC_{dw, water}$) as one of the MPCs from which the lowest value should be selected as the general MPC_{water} (see INS-Guidance, Section 3.1.6 and 3.1.7). According to the proposal for the daughter directive Priority Substances, however, the derivation of the AA-EQS (= MPC) should be based on direct exposure, secondary poisoning, and human exposure due to the consumption of fish. Drinking water was not included in the proposal and is thus not guiding for the general MPC value. The exact way of implementation of the $MPC_{dw, water}$ in the Netherlands is at present under discussion within the framework of the "AMvB Kwaliteitseisen en Monitoring Water". No policy decision has been taken yet, and the $MPC_{dw, water}$ is therefore presented as a separate value in this report. The MPC_{water} is thus derived considering the individual MPCs based on direct exposure ($MPC_{eco, water}$), secondary poisoning ($MPC_{sp,}$

$_{water}$) or human consumption of fishery products ($MPC_{hh\ food,\ water}$); the need for derivation of the latter two depends on the characteristics of the compound.

Related to this is the inclusion of water treatment for the derivation of the $MPC_{dw,\ water}$. According to the INS-Guidance (see Section 3.1.7), a substance specific removal efficiency related to simple water treatment should be derived in case the $MPC_{dw,\ water}$ is lower than the other MPCs. For pesticides, there is no agreement as yet on how the removal fraction should be calculated, and water treatment is therefore not taken into account. In case no A1 value is set in Directive 75/440/EEC, the $MPC_{dw,\ water}$ is set to the general Drinking Water Standard of 0.1 µg/L for organic pesticides as specified in Directive 98/83/EC.

3 Derivation of environmental risk limits for captan

3.1 Substance identification, physico-chemical properties, fate and human toxicology

3.1.1 Identity

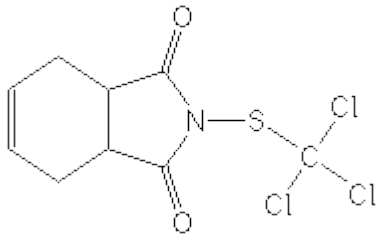

Figure 1. Structural formula of captan.

Table 1. Identification of captan.

Parameter	Name or number	Source
Common/trivial/other name	Captan	
Chemical name	*N*-(trichloromethylthio)cyclohex-4-ene-1,2-dicarboximide	Tomlin, 2002
CAS number	133-06-2	Tomlin, 2002
EC number	205-087-0	Tomlin, 2002
SMILES code	O=C(N(SC(Cl)(Cl)Cl)C(=O)C1CC=CC2)C12	U.S. EPA, 2007
Use class	Fungicide	
Mode of action	Non-specific thiol reactant	Tomlin, 2002
Authorised in NL	Yes	
Annex 1 listing	Yes	

3.1.2 Physicochemical properties

Table 2. Physicochemical properties of captan.

Parameter	Unit	Value	Remark	Reference
Molecular weight	[g/mol]	300.59		EFSA, 2006
Water solubility	[g/L]	0.0052	pH 7; 20 ºC	EFSA, 2006
pK_a	[-]	-	No dissociation	EFSA, 2006
log K_{OW}	[-]	2.57	pH 7; 25 ºC	EFSA, 2006
log K_{OC}	[-]	1.99	Uncertain value due to rapid hydrolysis	EFSA, 2006
Vapour pressure	[Pa]	4.2×10^{-6}	20 ºC	EFSA, 2006
Melting point	[°C]	172		EFSA, 2006
Boiling point	[°C]	-	Decomposition	EFSA, 2006
Henry's law constant	[Pa.m^3/mol]	2×10^{-4}	pH 7	EFSA, 2006

3.1.3 Behaviour in the environment

Table 3. Selected environmental properties of captan.

Parameter	Unit	Value	Remark	Reference
Hydrolysis half-life	DT50 [d]	0.1	pH 7, 25 ºC	EC, 2005
		0.5	pH 4; 25 °C	EC, 2005
Hydrolysis half-life (seawater)	DT50 [d]	1-2.3	13 ºC, pH 7.6-7.9	Caldwell et al., 1978
Photolysis half-life	DT50 [d]	-	No photolysis	EFSA, 2006
Readily biodegradable		No		EFSA, 2006
Degradation in water/ sediment systems	DT50,sytem [d]	< 1	Hydrolytically unstable	EFSA, 2006
Relevant metabolites	THPI		Max. 51% in water phase	EFSA, 2006
	THPAM		Max. 26% in water phase	EFSA, 2006
	THPAI		Max. 11% in sediment	EFSA, 2006

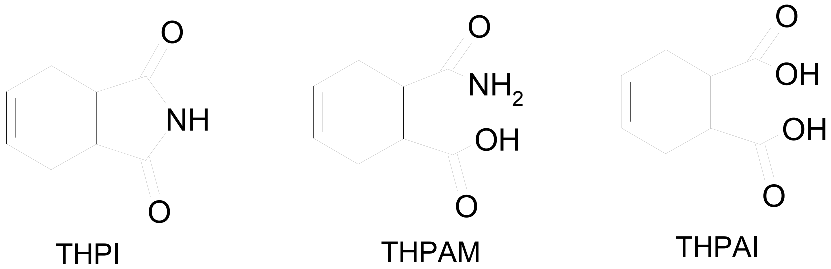

Figure 2. Structural formulas of water and sediment metabolites of captan.

3.1.4 Bioconcentration and biomagnification

An overview of the bioaccumulation data for captan is given in Table 4. Detailed bioaccumulation data for captan are tabulated in Appendix 1.

Table 4. Overview of bioaccumulation data for captan.

Parameter	Unit	Value	Remark	Reference
BCF (fish)	[L/kg]	153	Geometric mean of four values	EFSA, 2006
BMF	[kg/kg]	1	Default value for BFC < 2000 L/kg	Van Vlaardingen en Verbruggen, 2007

3.1.5 Human toxicological threshold limits and carcinogenicity

Captan has the following R phrases: R 23, 40, 41, 43, 50/53. The classification R 63 is not clear (EFSA, 2006). The ADI is 0.1 mg/kg bw. The AOEL is 0.1 mg/kg bw/day. Overall, captan did not show any genotoxic potential but was found to cause duodenal tumours in mice. A clear threshold for duodenal tumours in mice was established. The classification Category 3, R40 was proposed (EFSA, 2006).

3.2 Trigger values

This section reports on the trigger values for ERLwater derivation (as demanded in WFD framework).

Table 5. Captan: collected properties for comparison to MPC triggers.

Parameter	Value	Unit	Method/Source	Derived at section
Log $K_{p,susp-water}$	1.0	[-]	$K_{OC} \times f_{OC,susp}$[1]	K_{OC}: 3.1.2
BCF	153	[L/kg]		3.1.4
BMF	1	[kg/kg]		3.1.4
Log K_{OW}	2.57	[-]		3.1.2
R-phrases	R 23, 40, 41, 43, 50/53.	[-]		3.1.5
A1 value	1.0	[μg/L]	Total pesticides	
DW Standard	0.1	[μg/L]	General value for organic pesticides	

1 $f_{OC,susp}$ = 0.1 kg_{OC}/kg_{solid} (EC, 2003).

- Captan has a log $K_{p,\ susp-water}$ < 3; derivation of $MPC_{sediment}$ is not triggered.
- Captan has a log $K_{p,\ susp-water}$ < 3; expression of the MPC_{water} as $MPC_{susp,\ water}$ is not required.
- Captan has a BCF ≥ 100 L/kg; assessment of secondary poisoning is triggered.
- Captan has an R40 classification. Therefore, an MPC_{water} for human health via food (fish) consumption ($MPC_{hh\ food,\ water}$) should be derived.
- For captan, no specific A1 value or Drinking Water Standard is available from Council Directives 75/440, EEC and 98/83/EC, respectively. Therefore, the general Drinking Water Standard for organic pesticides applies.

3.3 Toxicity data and derivation of ERLs for water

3.3.1 $MPC_{eco,water}$ and $MPC_{eco,marine}$

An overview of the selected freshwater toxicity data for captan is given in Table 6. Marine toxicity data are given in Table 7. Detailed aquatic toxicity data for captan are tabulated in Appendix 2.

Because of the extreme fast hydrolysis of captan in water the following criteria for validity were applied to experiments:
- In static tests if concentrations were *not* measured: Ri 3;
- in static tests if concentrations were measured (> 80%) and results were based on nominal concentrations: Ri 2;
- in static tests if concentrations were measured and results were based on initially measured concentrations (> 80%): Ri 2;
- in static tests if concentrations were measured and results were based on mean measured concentrations: Ri 2;
- in flow-through tests if concentrations were *not* measured: Ri 3.

Table 6. Captan: selected freshwater toxicity data for ERL derivation.

Chronic[a]		Acute[a]	
Taxonomic group	**NOEC/EC10 (mg/L)**	**Taxonomic group**	**L(E)C50 (mg/L)**
Algae	0.50[b]	Algae	7.14 [c]
Pisces	**0.017**	Crustacea	3.44
		Pisces	0.37
		Pisces	0.072
		Pisces	0.296[d]
		Pisces	0.065
		Pisces	**0.034**

[a] For detailed information see Appendix 2. Bold values are used for ERL derivation.
[b] Geometric mean of 0.72 and 0.34 mg/L for *Pseudokirchneriella subcapitata* (growth rate)
[c] Geometric mean of 10 and 5.1 mg/L for *Pseudokirchneriella subcapitata* (growth rate)
[d] Geometric mean of 0.47 and 0.186 mg/L for *Oncorhynchus mykiss* (mortality)

Table 7. Captan: selected marine toxicity data for ERL derivation.

Chronic[a]		Acute[a]	
Taxonomic group	**NOEC/EC10 (mg/L)**	**Taxonomic group**	**L(E)C50 (mg/L)**
Crustacea	0.0031		

[a] For detailed information see Appendix 2.

3.3.1.1 Treatment of fresh- and saltwater toxicity data

ERLs for freshwater and marine waters should be derived separately. For pesticides, data can only be combined if it is possible to determine with high probability that marine organisms are not more sensitive than freshwater organisms (Lepper, 2005). For captan, not enough marine data are available to make this comparison and ERLs for the marine compartment cannot be derived.

3.3.1.2 Mesocosm and field studies

No mesocosm studies are available.

3.3.1.3 Derivation of $MPC_{eco, water}$ and $MPC_{eco, marine}$

For captan, the base set (algae, *Daphnia* and fish) is complete. Two long-term NOECs of two trophic levels (algae and fish) are available. Therefore, the $MPC_{eco, water}$ is derived using an assessment factor of 50 on the lowest NOEC, i.e. the 96-h NOEC for *Pimephales promelas* of 0.017 mg/L. The $MPC_{eco, water}$ is 0.017/50 = 0.00034 mg/L (0.34 µg/L).

No $MPC_{eco, marine}$ can be derived because of the insufficient amount of data available.

3.3.2 $MPC_{sp,water}$ and $MPC_{sp,marine}$

Captan has a BCF > 100 L/kg, the assessment of secondary poisoning is triggered.

The lowest MPC_{oral} is 2.78 mg/kg diet for the rat (see Table 8). Subsequently, the $MPC_{sp, water}$ can be calculated using a BCF of 153 L/kg and a BMF of 1 (Table 4) and becomes 2.78 / (153 × 1) = 0.018 mg/L

Table 8. Captan: selected bird and mammal data for ERL derivation.

Species[a]	Exposure	Criterion	Effect	Assessment	MPC_{oral}

	time		concentration (mg/kg_{diet})	factor	(mg/kg_{diet})
Rat	2 year	NOAEL	446	30	14.9
Rat	102 d	NOAEL	250	90	**2.78**

[a] For detailed information see Appendix 3. Bold values are used for ERL derivation.

Because toxicity data for marine predators are generally not available, the $MPC_{oral, min}$ as derived above is used as a representative for the marine environment also. To account for the longer food chains in the marine environment, an additional biomagnification step is introduced (BMF_2). This factor is the same as given in Table 4. The $MPC_{sp,marine}$ is 2.78 / (153 × 1 × 1) = 0.018 mg/L (18 µg/L) .

3.3.3 $MPC_{hh\ food,\ water}$

Derivation of $MPC_{hh\ food,\ water}$ for captan is triggered (Table 5). $MPC_{hh\ food}$ is calculated from the ADI (0.1 mg/kg bw), a body weight of 70 kg and a daily fish consumption of 115 g as $MPC_{hh,\ food}$ = 0.1 x 0.1 x 70/0.115 = 6.09 mg/kg (Van Vlaardingen en Verbruggen, 2007). Subsequently the $MPC_{hh\ food,\ water}$ is calculated according to $MPC_{hh\ food,\ water}$ = 6.09/(BCF_{fish} x BMF_1) = 6.09/153 x 1 = 0.040 mg/L (40 µg/L).

3.3.4 $MPC_{dw,\ water}$

The Drinking Water Standard is 0.1 µg/L. Thus, the $MPC_{dw,water}$ is also 0.1 µg/L.

3.3.5 Selection of the MPC_{water} and MPC_{marine}

The lowest MPC value should be selected as the general MPC. The lowest value of the routes included (see Section 2.3.1) is the $MPC_{eco,\ water}$. The MPC_{water} is 0.34 µg/L.

No MPC_{marine} can be selected due to the insufficient amount of data.

3.3.6 MAC_{eco}

3.3.6.1 $MAC_{eco,water}$

The $MAC_{eco,\ water}$ may be derived from the acute toxicity data. Seven short-term L(E)C_{50} values for three trophic levels (fish, *Daphnia* and algae) are available, captan has a potential to bioaccumulate (BCF > 100 L/kg), the mode of action for the tested species is non-specific and the interspecies variation is high. Therefore, an assessment factor of 1000 is applied to the lowest L(E)C_{50}, i.e. the LC_{50} for *Salvelinus fontinalis*: 0.034 mg/L. Therefore, the MAC_{eco} is derived as 0.034/1000 = 0.000034 mg/L (0.034 µg/L). However, because the MPC_{water} is higher (0.34 µg/L), the $MAC_{eco,\ water}$ is put level with the MPC_{water} and becomes 0.34 µg/L.

3.3.6.2 $MAC_{eco,\ marine}$

Because not sufficient data are available for marine organisms, no $MAC_{eco,\ marine}$ can be derived.

3.3.7 $SRC_{eco,\ water}$

Two long-term NOECs of two trophic levels are available. The geometric mean of all NOECs (0.0922 mg/L) is higher than the geometric mean of all E(L)C_{50}s divided by 10 (0.0330 mg/L). Therefore, the $SRC_{eco,\ water}$ is derived from the geometric mean of the available L(E)C_{50}s with an assessment factor of 10. The geometric mean is 0.330 mg/L, the $SRC_{eco,\ water}$ is 0.330/10 = 0.0330 mg/L (33.0 µg/L).

3.4 Toxicity data and derivation of ERLs for sediment

The log $K_{p,\ susp\text{-}water}$ of captan is below the trigger value of 3; therefore, ERLs are not derived for sediment.

4 Conclusions

In this report, the risk limits Maximum Permissible Concentration (MPC), Maximum Acceptable Concentration for ecosystems (MAC_{eco}), and Serious Risk Concentration for ecosystems (SRC_{eco}) are derived for captan in water. No risk limits were derived for the marine compartment because data were not available. Derivation of ERLs for sediment was not triggered.

The ERLs that were obtained are summarised in the table below. The MPC value that was set for this compound until now, is also presented in this table for comparison reasons.

Table 9. Derived MPC, MAC_{eco}, and SRC values for captan.

ERL	Unit	MPC	MAC_{eco}	SRC
Water, old[a]	µg/L	0.11	-	-
Water, new[b]	µg/L	0.34	0.34	33.0
Drinking water[b]	µg/L	0.1[c]		
Marine	µg/L	n.d.[d]	n.d.[d]	n.d.[d]

[a] MPC based on total content, source: Risico's van Stoffen http://www.rivm.nl/rvs/

[b] The $MPC_{dw, water}$ is reported as a separate value from the other MPC_{water} values ($MPC_{eco, water}$, $MPC_{sp, water}$ or $MPC_{hh food, water}$). From these other MPC_{water} values (thus excluding the $MPC_{dw, water}$) the lowest one is selected as the 'overall' MPC_{water}.

[c] provisional value pending the decision on implementation of the $MPC_{dw, water}$, (see Section 2.3.1)

[d] n.d. = not derived due to lack of data

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Appendix 1. Information on bioconcentration

Species	Species properties	Test substance	Substance purity [%]	Analysed	Test type	Test water	pH	Hardness [g/L]	Exp. time [d]	Temperature [°C]	Exp. conc. [µg/L]	BCF [L/kg$_{ww}$]	BCF type	Method	Ri	Notes	Reference
Lepomis macrochirus		[^{14}C-trichloro-methyl] captan	92	LSC	F	nw			28+14 d	17	5	140	Whole fish	Equilibrium	1	1	EC, 2005
Lepomis macrochirus		[^{14}C-cyclo-hexene] captan	92	LCS	F	nw			28+14 d	17	5	113	Whole fish	Equilibrium	1	1	EC, 2005
Cyprinus carpio	7.5-9.5 cm, 14-22 g	Captan	>98	GLC/FTD GLC/ECD	F	dtw	6.7-6.9	36-38	14+7 d	23-25	1.1	100	Whole fish	Equilibrium	2		Tsuda et al., 1992
Gnathopogon caerulescens	3.8-4.3 cm, 0.93-1.43 g	Captan	>98	GLC/FTD GLC/ECD	F	dtw	6.7-6.9	36-38	14+3 d	20-21	0.16	350	Whole fish	Equilibrium	2		Tsuda et al., 1992

1 The BCF is based on the total radioactivity in fish, not on the concentration of captan in fish.

Appendix 2. Detailed aquatic toxicity data

Table A2.1. Acute toxicity of captan to freshwater organisms.

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Cyanobacteria																
Anabaena azollae		N	S	Captan		am	7.5	room		8 d	LOEC	biomass	≤ 0.01	3	16,4	Bharati and Angadi, 1981
Anabaena cycadeae		N	S	Captan		am	7.5	room		8 d	LOEC	biomass	≤ 0.01	3	16, 4	Bharati and Angadi, 1981
Protozoa																
Spirostomum ambiguum		N	Sc	Captan		am	7.4±0.2	25	4.44	24 h	LC50	lethality	0.005	3	27,24,41, 42, 3	Nałęcz-Jawecki et al., 2002
Spirostomum ambiguum		N	Sc	Captan		am	7.4±0.2	25	4.44	24 h	EC50	deformation	0.004	3	27,24,41, 42,3	Nałęcz-Jawecki et al., 2002
Algae																
Chlorella pyrenoidosa	10^4 cells/mL	N	S	Captan	60.2	am	near 8	20±1		96 h	IC50	biomass	44.4	3	6,12,14, 15	Antón et al., 1993
Hapalosiphon welwitschii		N	S			am	7.5	room		8 d	LOEC	growth	≤ 0.01	3	16,41,2	Bharati and Angadi, 1981
Pseudokirchneriella subcapitata	104 cells/mL	Y	S	Captan	90	am	7.4	24		96 h	EC50	growth rate	10	2	44,45,52	EC, 2005
Pseudokirchneriella subcapitata	104 cells/mL	Y	S	Captan	90	am	7.4	24		96 h	EC50	biomass (AUG)	1.5	2	44,46,53	EC, 2005
Pseudokirchneriella subcapitata	10^4 cells/mL	Y	S	83% WP	83	am	7.3-7.4	24.1-24.2		72 h	EC50	growth rate	5.10	2	54	EC, 2005
Pseudokirchneriella subcapitata	10^4 cells/mL	Y	S	83% WP	83	am	7.3-7.4	24.1-24.2		72 h	EC50	biomass (AUG)	1.18	2	54	EC, 2005
Pseudokirchneriella subcapitata	5 x 10^3 cells/mL			Captan	>98	am	7.7-7.9	21		72 h	EC50	growth rate	> 5.6	3		Kikuchi, 1993
Pseudokirchneriella subcapitata	5 x 10^3 cells/mL			Captan	>98	am	7.7-7.9	21		72 h	EC50	biomass (AUG)	2.60	3		Kikuchi, 1993
Scenedesmus subspicatus	10^4 cells/mL	Y	S	Merpan 80 WDG	79.6	am	7.2-8.9	23±2		72 h	EC50	growth rate	271.8	3	47	EC, 2005
Scenedesmus subspicatus	10^4 cells/mL	Y	S	Merpan 80 WDG	79.6	am	7.2-8.9	23±2		72 h	EC50	biomass (AUG)	50.7	3	55	EC, 2005
Macrophyta																
Azolla pinnata	bilobed, symbiose with Anabaena azollae	N	S	Unknown form.	50	nw				21 d	EC50	biomass dwt	0.015	3	45,49,51	Kalita and Sarma, 1995
Vallisneria americana	non-mycorrhizal laboratory grown	N	S			am		25		4 h	NOEC	phosphate uptake	≥ 50	3	12,31,41	Wigand and Stevenson, 1997
Vallisneria americana	field collected, 80% infected with esicular-arbuscular mycorrhizae	N	S			am		25		4 h	LOEC	phosphate uptake	≥ 50	3	12,31,36, 41	Wigand and Stevenson, 1997
Vallisneria americana	field collected, 80% infected with esicular-arbuscular mycorrhizae	N	S			am		25		4 h	LOEC	ammonium uptake	≤ 50	3	12,31,35, 36,41	Wigand and Stevenson, 1997
Mollusca																
Indoplanorbis exustus										48 h	LC50	mortality	1.4	4	25,28	Hashimoto and Nishiuchi, 1981
Physa acuta										48 h	LC50	mortality	1.0	4	25,28	Hashimoto and Nishiuchi, 1981
Semisulcospira libertina										48 h	LC50	mortality	1.2	4	25,28	Hashimoto and Nishiuchi, 1981
Crustacea																
Daphnia magna	< 24 h old	Y	S	Captan	93.5	dtw	7.9	20	170	48 h	EC50	Immobilisation	> 3.25	2	56	EC, 2005
Daphnia magna	< 24 h old	Y	S	Captan	93.5	dtw	7.9	20	170	48 h	NOEC	Immobilisation	1.10	2	56	EC, 2005
Daphnia magna		Y	S	Captan		nw	8.2	20	255	48 h	EC50	Immobilisation	> 7.1	2	57	EC, 2005
Daphnia magna		Y	S	Captan		nw	8.2	20	255	48 h	NOEC	Immobilisation	≥ 7.1	2	57	EC, 2005
Daphnia magna	6-24 h old	Y	R	Merpan 80 WDG	80	rw	7.9	19.1-19.9	247	48 h	EC50	Immobilisation	3.44	2	58	EC, 2005
Daphnia magna	6-24 h old	Y	R	Merpan 80 WDG	80	rw	7.9	19.1-19.9	247	48 h	NOEC	Immobilisation	0.248	2	58	EC, 2005
Daphnia magna	< 24 h old	Y	S	83% WP	84.6	rw	7.9-8.5	20	203	48 h	EC50	Immobilisation	2.8	3	59	EC, 2005
Daphnia magna	< 24 h old	Y	S	83% WP	84.6	rw	7.9-8.5	20	203	48 h	NOEC	Immobilisation	0.46	3	59	EC, 2005

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Daphnia pulex	female ad	N	S	Captan	tg			24-26		3 h	LC50	mortality	1.50	3		Nishiuchi and Hashimoto, 1969
Daphnia pulex										3 h	LC50	mortality	1.5	4	25,28	Hashimoto and Nishiuchi, 1981
Daphnia pulex	female ad	N	S	Captan	tg			24-26		3 h	LC50	mortality	1.5	3	28	Nishiuchi and Hashimoto, 1969
Moina macrocopa										3 h	LC50	mortality	6.6	4	13,25,28	Hashimoto and Nishiuchi, 1981
Moina macrocopa	female ad	N	S	Captan	tg			24-26		3 h	LC50	mortality	6.8	3	13,28	Nishiuchi and Hashimoto, 1969
Procambarus clarkii	immature, 25-36mm	N	S	Captan 80WP		dtw	8.4	20±3	100	96 h	LC50	mortality	15631	3	12,22	Cheah et al., 1980
Insecta																
Cloëon dipterum	larvae			product						48 h	LC50	mortality	1.5	4	25,28	Hashimoto and Nishiuchi, 1981
Pisces																
Abramis brama	1.88 g, 4.7 cm	N	S	Captan	95.2	dtw	7.9-8.5	12.7-13.3	172-184	96 h	LC50	mortality	0.119	3	44,60	EC, 2005
Abramis brama	1.88 g, 4.7 cm	N	S	Captan	95.2	dtw	7.9-8.5	12.7-13.3	172-184	96 h	NOEC	tox. symptoms	0.0423	3	44,60	EC, 2005
Carassius auratus	4-8g, 6cm	N	S	tg	60.2	dtw		20±1		96 h	LC50	mortality	0.89	3	5,6,14	Antón et al., 1993
Carassius auratus	4-8g, 6cm	N	S	tg	60.2	dtw		20±1		96 h	LC100	mortality	1.86	3	5,6,14	Antón et al., 1993
Carassius auratus										48 h	LC50	mortality	0.037	4	25,28	Hashimoto and Nishiuchi, 1981
Clarias batrachus	ad, 70-75g, 18-19cm	N	R	Captan 75%WP	75					96 h	LC50	mortality	4.1036	3	32,33,34,1	Tripathi, 1992
Cpyrinus										48 h	LC50	mortality	0.25	4	25,28	Hashimoto and Nishiuchi, 1981
Cyprinus auratus	4.01cm, 1.04g	N	S	Captan	tg			23.5±0.5		48 h	LC50	mortality	0.037	3	28	Nishiuchi and Hashimoto, 1969
Cyprinus caprio	4.5cm, 1.10g	N	S	Captan	tg			23.5±0.5		48 h	LC50	mortality	0.25	3	28	Nishiuchi and Hashimoto, 1969
Cyprinus carpio		N	F	Captan	90	dtw	7.6-7.9	22	40	96 h	LC50	mortality	0.216	3	44,45,61	EC, 2005
Cyprinus carpio		N	F	Captan	90	dtw	7.6-7.9	22	40	96 h	NOEC	tox. symptoms	0.16	3	44,45, 61	EC, 2005
Cyprinus carpio	1.7 g, 4.0 cm	N	S	Captan	95.2	dtw	8.1-8.5	20.6-21.1	172-174	96 h	LC50	mortality	0.492	3	44,61	EC, 2005
Cyprinus carpio	1.9 g, 5.3 cm	N	S	Captan	95.2	dtw	8.1-8.5	20.6-21.1	172-174	96 h	NOEC	tox. symptoms	0.113	3	44,61	EC, 2005
Danio rerio	larvae, 4 d	N	S	Captan	Recrystallised	dw				90 min	LC50	mortality	0.67	3	43	EC, 2005
Gasterosteus aculeatus	0.6 g, 3.46 cm	N	S	Captan	95.2	dtw	7.9-8.4	12-13.6	174-190	96 h	LC50	mortality	0.275	3	44,61	EC, 2005
Gasterosteus aculeatus	0.6 g, 3.46 cm	N	S	Captan	95.2	dtw	7.9-8.4	12-13.6	174-190	96 h	NOEC	tox. symptoms	0.0233	3	44,61	DAR, Jenkins, 2002d
Gasterosteus aculeatus	0.57 g, 3.85 cm	Y	S	Captan	95.4	dtw		12-15	180	96 h	LC50	mortality	0.370	2	62	Addendum to EC, 2005
Gasterosteus aculeatus	0.57 g, 3.85 cm	Y	S	Captan	95.4	dtw		12-15	180	96 h	NOEC	mortality	0.172	2	62	Addendum to EC, 2005
Ictalurus punctatus	1.2 g	N	S	Captan	90		7.4		44		LC50	mortality	0.078	3		Mayer & Ellersieck, 1986
Lepomis macrochirus	1.5 year old	Y	F	Captan	88.4	nw	7.5		45	96 h	LC50	mortality	0.072	2	50,63	Hermanutz et al., 1973
Lepomis macrochirus	1.1g	N	S	Captan	90		7.1		44	96 h	LC50	mortality	0.140	3		Mayer & Ellersieck, 1986
Misgurnus anguilicaudatus										48 h	LC50	mortality	0.34	4	25,28	Hashimoto and Nishiuchi, 1981
Oncorhynchus clarki	0.4 g	N	S	Captan	90		7.4		44	96 h	LC50	mortality	0.056	3		Mayer & Ellersieck, 1986
Oncorhynchus kisutch	0.8 g	N	F	Captan	90		7.5		314	96 h	LC50	mortality	0.057	3		Mayer & Ellersieck, 1986
Oncorhynchus kisutch	0.8 g	N	S	Captan	90		7.5		44	96 h	LC50	mortality	0.140	3		Mayer & Ellersieck, 1986
Oncorhynchus mykiss	34 mm	N	F	Captan	90	dtw	7.5-7.7	15	39	96 h	LC50	mortality	0.045	3	44,61	EC, 2005
Oncorhynchus mykiss	34 mm	N	F	Captan	90	dtw	7.5-7.7	15	39	96 h	NOEC	tox. symptoms	0.016	3	44,45,61	EC, 2005
Oncorhynchus mykiss	1.9 g, 5.3 cm	N	S	Captan	95.2	dtw	7.8-8.5	12.4-13.5	178-180	96 h	LC50	mortality	0.205	3	44,61	EC, 2005
Oncorhynchus mykiss	1.9 g, 5.3 cm	N	S	Captan	95.2	dtw	7.8-8.5	12.4-13.5	178-180	96 h	NOEC	tox. symptoms	0.031	3	44,61	EC, 2005
Oncorhynchus mykiss		N	F	Merpan 80 WDG	79.4	rw	7.1-7.8	12.2-14.1	246-250	96 h	LC50	mortality	0.122	3	44,61	EC, 2005
Oncorhynchus mykiss		N	F	Merpan 80 WDG	79.4	rw	7.1-7.8	12.2-14.1	246-250	96 h	NOEC	tox. symptoms	0.0397	3	44,61	EC, 2005
Oncorhynchus mykiss		Y	F	83% WP	83	dtw	7.2-7.6	14.7-12.1	27.3-34.4	96 h	LC50	mortality	0.161	3	64	EC, 2005
Oncorhynchus mykiss		Y	F	83% WP	83	dtw	7.2-7.6	14.7-12.1	27.3-34.4	96 h	NOEC	tox. symptoms	0.085	3	64	EC, 2005
Oncorhynchus mykiss		Y	S	80% WG	76.5	nw	7.9-8.4		120-128	96 h	LC50	mortality	0.47	2	65	EC, 2005
Oncorhynchus mykiss		Y	S	80% WG	76.5	nw	7.9-8.4		120-128	96 h	NOEC	tox. symptoms	0.37	2	65	EC, 2005
Oncorhynchus mykiss	12.2 cm, age 375 d	N	S	Captan 50-W	50	nw	7.7	9.4		72 h	LC50	mortality	0.16	3	48	Holland et al., 1960
Oncorhynchus mykiss	7.0 cm, age 170 d	N	S	Captan 50-W	50	nw	7.8	13.1		72 h	LC61	mortality	0.28	3	48	Holland et al., 1960
Oncorhynchus mykiss	5 d old	N		W formulation	80		ca. 7.5	10		96 h	LC50	mortality	0.075	3		Kikuchi et al., 1996
Oncorhynchus mykiss	41-46 d old	N		W formulation	80		ca. 7.5	10-13		96 h	LC50	mortality	0.090	3		Kikuchi et al., 1996

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness $CaCO_3$ [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Oncorhynchus mykiss	83 d old	N		W formulation	80		ca. 7.5	10-13		96 h	LC50	mortality	0.075	3		Kikuchi et al., 1996
Oncorhynchus mykiss	5.3 cm, 1.9 g	Y	S	Captan	95.4	dtw		12-15	180	96 h	LC50	mortality	0.186	2	66	Addendum to EC, 2005
Oncorhynchus mykiss	5.3 cm, 1.9 g	Y	S	Captan	95.4	dtw		12-15	180	96 h	NOEC	mortality	0.118	2	66	Addendum to EC, 2005
Oncorhynchus mykiss	1.0 g	N	S	Captan	90		7.4		44	96 h	LC50	mortality	0.073	3		Mayer & Ellersieck, 1986
Oncorhynchus trutta	0.6 g	N	F	Captan	90		7.5		314	96 h	LC50	mortality	0.026	3		Mayer & Ellersieck, 1986
Oncorhynchus trutta	0.7g	N	S	Captan	90		7.5		44	96 h	LC50	mortality	0.080	3		Mayer & Ellersieck, 1986
Oncorhynchus tshawytscha	fingerlings	N	S	Captan	90		7.5		44	96 h	LC50	mortality	0.120	3		Mayer & Ellersieck, 1986
Oryzias latipes	2.54 cm, 0,16 g	N	S	Captan	tg			23.5±0.5		48 h	LC50	mortality	1.0	3	28	Nishiuchi and Hashimoto, 1969
Oryzias latipes										48 h	LC50	mortality	1.0	4	25,28	Hashimoto and Nishiuchi, 1981
Oryzias latipes	0.2 g, 2 cm	N		Captan	pa	nw		10		48 h	LC50	mortality	0.8	3		Tsuji et al., 1986
Oryzias latipes	0.2 g, 2 cm	N		Captan	pa	nw		20		48 h	LC50	mortality	0.61	3		Tsuji et al., 1986
Oryzias latipes	0.2 g, 2 cm	N		Captan	pa	nw		30		48 h	LC50	mortality	0.50	3		Tsuji et al., 1986
Perca flavescens	1.0 g	N	F	Captan	90		7.5		314	96 h	LC50	mortality	0.12	3		Mayer & Ellersieck, 1986
Pimephales promelas	3.5 months old	Y	F	Captan	88.4	nw	7.5		45	96 h	LC50	mortality	0.065	2	51	Hermanutz et al., 1973
Pimephales promelas	0.4 g	N	F	Captan	90		7.5		314	96 h	LC50	mortality	0.130	3		Mayer & Ellersieck, 1986
Pimephales promelas	0.3 g	N	S	Captan	90		7.5		44	96 h	LC50	mortality	0.20	3		Mayer & Ellersieck, 1986
Rasbora heteromorpha	1-3 cm	N	F	Captan	89	am	8.1		20	96 h	LC50	mortality	0.30	3		Tooby et al., 1975
Rutilus rutilus	1.1 g, 4.0 cm	N	S	Captan	95.2	dtw	7.9-8.6	12.9-13.9	172-184	96 h	LC50	mortality	0.154	3	44	EC, 2005
Rutilus rutilus	1.1 g, 4.0 cm	N	S	Captan	95.2	dtw	7.9-8.6	12.9-13.9	172-184	96 h	NOEC	tox. symptoms	0.0423	3	44	EC, 2005
Salmo trutta	3.16 g, 6.0 cm	N	S	Captan	95.2	dtw	7.8-8.5	13.1-14.4	176-182	96 h	LC50	mortality	0.098	3	44	EC, 2005
Salmo trutta	3.16 g, 6.0 cm	N	S	Captan	95.2	dtw	7.8-8.5	13.1-14.4	176-182	96 h	NOEC	tox. symptoms	<0.0137	3	44	EC, 2005
salmonoid fish										96 h	LC50	mortality	0.056	4	23	Delistraty, 1999
Salvelinus fontinalis	1.5 year old	Y	F	Captan	88.4	nw	7.5		45	96 h	LC50	mortality	0.034	2	51	Hermanutz et al., 1973
Salvelinus namaycush	0.42 g	N	S	Captan	90		7.5		44	96 h	LC50	mortality	0.049	3		Mayer & Ellersieck, 1986
Salvelinus namaycush	fingerlings	N	F	Captan	90		7.5		314	96 h	LC50	mortality	0.051	3		Mayer & Ellersieck, 1986
Salvelinus namaycush	2.3 g	N	S	Captan	90		7.4		162	96 h	LC50	mortality	0.063	3		Mayer & Ellersieck, 1986

NOTES

1 Unclear whether a formulation or the active substance alone is tested.
2 Unclear whether a formulation or the active substance alone is tested.
3 L(E)C50 determined by graphical interpolation.
4 Unclear whether a formulation or the active substance alone is tested.
5 With aeration.
6 Corrected for purity.
7 Based on nominal test concentrations.
8 Based of measured concentration at the beginning, but after 48h exposition the concentration of captan was less than 0.002 for all test concentration
9 Too high concentration of solvent 1mL/L
10 Only two test concentrations.
11 Hardness recalculated form 14.5°dH.
12 Test concentration above water solubility (5.1mg/l - EPIWIN).
13 Above water solubility (5.1mg/l - EPIWIN).
14 1% concentration of solvents (DMSO or acetone) was used (no information about concentration in test solutions), no control with solvent.
15 Not continuous light, but photoperiod 16/8 light/dark.
16 Growth of the algae was measured in terms of g/10ml wet weight every second day.
17 Nitrate free medium (without KNO3, NaNO3).
18 Growth of the algae was determined using absorbance measurement and result were converted to percentage of control.
19 Value results are estimated from graph (no the other data in the text or table) and converted from mM concentration.
20 Not clear duration and condition of the test, not clear what compound was used pure or formulated.

21 Not clear, if corrected for purity.
22 1% stock solution based on active ingredient in water.
23 Article, where data were obtained from Hazardous Substance Data Bank (HSDB, 1998), no other data test substance and test condition.
24 Hardness calculated (composition of medium is reported).
25 Article is in Japanese, only abstract and tables available in English.
26 Abstract, no other data.
27 Test performed on microplates.
28 Values reported as a TLm.
29 Captan dissolved in acetone than add to 5ml of media, not written how much stock solution was added I estimate high concentration of solvents.
30 Total inhibition of biological activity (CO_2 released, denitrification) of cells, CO_2 concentrations were zero after 24,48,72 and 96 hours.
31 Only one test concentration.
32 Fishes were acclimatized in tap water (pH 7.3±0.2), not exactly reported if this are also test conditions.
33 Captan dissolved in acetone, not reported how much stock solution was added; control solvent included, but a control without solvent seems omitted.
34 Not clear if corrected for purity.
35 75% greater uptake compared to control but the differences are not statistically significant.
36 The roots in the bottom compartment were separated from shoots in the upper compartment using biocompartmental microcosms, with a leak proof silicone plug.
37 Repeated study according Jenkins 2002d, but with measured test concentration, results are based on mean measured initial concentration.
38 Repeated study according Jenkins 2002a, but with measured test concentration, results are based on mean measured initial concentration
39 Rimless test tube with suba seals.
40 1mL/L of acetone (0.1%).
41 Purity is not clear; it is also not clear if results are reported in mg/L formulation or mg/L active ingredient.
42 Stock dilution prepared in acetone, in test did not exceed 1%.
43 Purity of recrystallised captan not reported; 0.4% acetone used as co-solvent, which showed no effect on mortality in solvent control.
44 Because of the fast hydrolysis of captan the concentration was measured in the stock solution, but not in the test medium. Test result is expressed as nominal captan concentration; fish were not fed 19/21 d prior to and during exposure.
45 Values corrected for the purity of captan.
46 Biomass (Area Under Growth Curve) is not considered to be a reliable endpoint.
47 Extrapolated value. The value is > solubility.
48 Insufficient reporting of test conditions.
49 Experiment performed outdoors in 18 cm deep pots with sediment.
50 LC50 based on most sensitive life stage. Surfactant (Triton X-100) added at 6.7×10^{-6} % vol/vol.
51 Surfactant (Triton X-100) added at 6.7×10^{-6} % vol/vol; combined effects of captan and surfactant cannot be excluded. Concentrations measured daily; test result based on mean measured concentrations.
52 Concentrations measured only prior to the test; result based on nominal concentration; EC50 is approx. 2 times the aqueous solubility.
53 Concentrations measured only prior to the test; result based on nominal concentration; EC50 is approx. the aqueous solubility.
54 Measured concentrations 74-85% at start and < LOQ at end of test; result expressed as a.s., based on nominal concentrations.
55 Test result is approx. 10x water solubility.
56 Concentrations dropped to < LOQ at 48 h; result based on measured initial concentrations.
57 Measured concentrations 61-73% of nominal; result based on measured initial concentrations.
58 Mean measured concentrations 80% at start, 0-4% at t= 24 h; result expressed as nominal captan concentration.
59 Concentrations were 12 to 39% at the start of the test, below LOQ at end of test; result expressed as nominal captan concentration.
60 Test result is expressed as nominal captan concentration; fish were not fed 19 d prior to and during exposure.
61 Test result is expressed as nominal captan concentration.
62 Test result based on mean measured initial concentrations; concentrations were non detectable at t= 48 h.
63 Concentrations measured daily; test result based on mean measured concentrations.
64 Concentrations in stock solutions 47-65% of nominal; in three lowest treaments captan could not be measured; in highest treatment 260% (at day 0); in other treatments 11-25%; test result is expressed as nominal captan concentration.
65 Concentrations at start of test 98-111% of nominal, and < LOQ at t = 48 and 96 h; test result based on nominal captan concentrations.
66 Concentrations at start of test 79-91% of nominal, and < LOQ at t = 48; test result based on initial measured captan concentrations.

Table A2.2. Acute toxicity of captan to marine organisms.

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Algae/Chlorophyta																
Dunaliella tertiolecta		N	S	Captan	99				30	48 h	EC50		2.3	3	2	Mayer, 1986
Algae/Chrysophyta																
Isochrysis galbana		N	S	Captan	99				30	48 h	EC50		0.21	3	2	Mayer, 1986
Pavlova gyrans		N	S	Captan	99				30	48 h	EC50		0.76	3	2	Mayer, 1986
Pavlova tutheri		N	S	Captan	99				30	48 h	EC50		0.55	3	2	Mayer, 1986
Algae/Diatomea																
Skeletonema costatum		N	S	Captan	99				30	48 h	EC50		0.16	3	2	Mayer, 1986
Crustacea																
Cancer magister	eggs	N	S	Captan	92.8	nw		12-13	30	24h	EC50	hatching	>10	3	1,2	Caldwell et al., 1978
Cancer magister	eggs	N	S	Captan	92.8	nw		12-13	30	24h	EC50	development	>10	3	1,2	Caldwell et al., 1978
Cancer magister	1st zoael stage	N	S	Captan	92.8	nw		12-13	30	24h	EC50	immobility	1.7	3	1,2	Caldwell et al., 1978

1 Hatching in controls and solvent controls was too low: 39 an 36%, respectively (hatching in all other captan treatments was 76%); acetone used as solvent at 0.01%, solvent and control solvent included.
2 Concentrations were not measured.

Table A2.3. Chronic toxicity of captan to freshwater organisms.

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness CaCO3 [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Cyanobacteria																
Anabaena azollae		N	S	Captan		am	7.5	room		32 d	LOEC	growth	≤ 0.01	3	5,21,25	Bharati and Angadi, 1981
Anabaena cycadeae		N	S	Captan		am	7.5	room		32 d	LOEC	growth	≤ 0.01	3	5,21,25	Bharati and Angadi, 1981
Aulosira fertilissima		N	S	Hexacap		am		25±3		30 d	NOEC	growth	500	3	6,15,16,22	Gangawane and Saler, 1979
Calothrix sp.		N	S	Hexacap		am		25±3		30 d	NOEC	growth	500	3	6,15,16,22	Gangawane and Saler, 1979
Nostoc sp.		N	S	Hexacap		am		25±3		30 d	NOEC	growth	500	3	6,15,16,22	Gangawane and Saler, 1979
Tolypothrix tenuis		N	S	Hexacap		am		25±3		30 d	NOEC	growth	500	3	6,15,16,22	Gangawane and Saler, 1979
Westiellopsis prolifica		N	S	Hexacap		am		25±3		30 d	NOEC	growth	500	3	6,15,16,22	Gangawane and Saler, 1979
Algae																
Chlorella pyrenoidosa	10^6 cells/mL	N	S	Captan	60.2	am	near 8	20±1		96 h	NOEC	biomass	6.02	3	2,8,9	Antón et al., 1993
Chlorella pyrenoidosa	10^6 cells/mL	N	S	Captan	60.1	am	near 9	20±1		96 h	EC10	biomass	5.63	3	2,8,9,10	Antón et al., 1993
Hapalosiphon welwitschii		N	S			am	7.5	room		32 d	LOEC	growth	≤ 0.01	3	5,21	Bharati and Angadi, 1981
Pseudokirchneriella subcapitata	104 cells/mL	Y	Sc	Captan	90	am	7.4	24		96 h	NOEC	area under the curve (biomass)	0.2	2	7	EC, 2005
Pseudokirchneriella subcapitata	104 cells/mL	Y	Sc	Captan	90	am	7.4	24		96 h	NOEC	growth rate	0.72	2	7,2	EC, 2005
Pseudokirchneriella subcapitata	104 cells/mL	Y	Sc	Malvin WG	84.62	am	7.3	24		72 h	NOEC	area under the curve (biomass)	0.34	2	2,7	EC, 2005
Pseudokirchneriella subcapitata	10^4 cells/mL	Y	Sc	Malvin WG	84.62	am	7.3	24		72 h	NOEC	growth rate	0.34	2	2,7	EC, 2005
Scenedesmus subspicatus		Y	Sc	Merpan 80WDG	79.6	am	7.2-8.91	23±2		72 h	NOEC	area under the curve(biomass)	7.96	3	2,6,7	EC, 2005
Scenedesmus subspicatus		Y	Sc	Merpan 80WDG	79.6	am	7.2-8.91	23±2		72 h	NOEC	growth rate	15.1	3	2,6,7	EC, 2005
Crustacea																
Daphnia magna	<24hr old, first instar	Y	R	Captan	90	rw	8.0-8.4	20	173	21 d	NOEC	mortality	0.50	3	1,24	EC, 2005
Daphnia magna	<24hr old, first instar	Y	R	Captan	90	rw	8.0-8.4	20	173	21 d	EC50	reproduction	> 0.9	3	1,24	EC, 2005
Pisces																
Clarias batrachus	adult, 70-75 g, 18-19 cm	N	R	Captan 75%WP	76	tw	7.3±0.2	room		40 d	LC50	mortality	0.5473	3	18,19,20	Tripathi, 1992
Oncorhynchus mykiss		N	F	Captan	90	dtw	7.3-8.1	15	34-47	21 d	LC50	mortality	0.068	3	1	EC, 2005
Oncorhynchus mykiss		N	F	Captan	90	dtw	7.3-8.1	15	34-47	21 d	NOEC	mortality	0.056	3	1	EC, 2005
Oncorhynchus mykiss		Y	R	Merpan 83WP	81.7	rw	7.05-8.5	12.2-13.7	244-270	28 d	LC50	mortality	>0.1992	2	2	EC, 2005
Oncorhynchus mykiss		Y	R	Merpan 83WP	81.7	rw	7.05-8.5	12.2-13.7	244-270	28 d	NOEC	mortality	≥0.1992	2	2	EC, 2005
Pimephales promelas	9 d old	Y	F	Captan	88.4	nw	7.5		45	45 w	NOEC	mortality	0.040	2	26,30	Hermanutz et al., 1973
Pimephales promelas	9 d old	Y	F	Captan	88.4	nw	7.5		45	45 w	NOEC	growth	0.017	2	26,30	Hermanutz et al., 1973
Pimephales promelas	1 d old, ELS	Y	F	Captan	88.4	nw	7.5		45	30 d	NOEC	mortality	0.017	2	26,30	Hermanutz et al., 1973
Pimephales promelas	1 d old, ELS	Y	F	Captan	88.4	nw	7.5		45	30 d	NOEC	growth	0.017	2	26,30	Hermanutz et al., 1973
Pimephales promelas	adult	Y	F	Captan	88.4	nw	7.5		45	30 d	EC10	egg spawning	0.0011	4	26,27,29,31	Hermanutz et al., 1973

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Hardness CaCO3 [mg/L]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Pimephales promelas	adult	Y	F	Captan	88.4	nw	7.5		45	30 d	EC10	egg spawning	0.00059	4	26,27,29,32	Hermanutz et al., 1973

NOTES

1 Measured were only stock solution (between 80-100%), value based of nominal test concentration.
2 Corrected for purity (in the study).
3 Using 0.4% acetone - no mortality in solvent control.
4 Recrystallised captan.
5 Growth of the algae was measured in terms of g/10ml wet weight every eight day.
6 Far above water solubility limit (5.1mg/l - EPIWIN).
7 Based of nominal test concentration.
8 Number of inoculated cells too high to sustain exponential growth, which shows in the control; EC50 at mean aqueous solubility; 1% concentration of solvents (DMSO or acetone) were used (no information about concentration in test solutions), no control with solvent.
9 Photoperiod 16/8 light/dark.
10 Value estimated from graph (using TECHDIG) and then calculated with software TOXEDO.
11 Nitrate free medium (without KNO3, NaNO3).
12 Growth of the algae was determined using absorbance measurement and result were converted to percentage of control.
13 Value results are estimated from graph (no the other data in the text or table) and converted from mM concentration.
14 No clear duration and condition of the test, not clear what compound was used pure or formulated and if corrected.
15 Fogg´s nitrogen free medium.
16 Incubation for 8 hours at light intensity 1500lux at 25±3 and than allowed to grow for 30 days.
17 Test in petri dishes moist chamber, seeds were irrigated with 10 ml of pesticide suspension, no other data available about test conditions, only one test concentration.
18 Fishes were acclimatized in tap water (pH 7.3±0.2), not exactly reported if this are also test conditions.
19 Captan dissolved in acetone, not written how much stock solution was added, appropriate amount of solvent also in control.
20 Not clear if corrected for purity.
21 Purity is not clear; it is also not clear if results are reported in mg/L formulation or mg/L active ingredient.
22 Results expressed as active ingredient..
23 Calculated from fig 2 (using TECHDIG)
24 Author of DAR summary reports: it was not possible to analyse captan in the test media due to rapid hydrolysis.
25 Unclear whether a formulation or the active substance alone is tested.
26 Surfactant (Triton X-100) added at 6.7x10-6% vol/vol.
27 EC10 below lowest effect concentration.
28 EC10 calculated by fitting log-logistic dose-effect relationship; EC10 estimate with high uncertainty (95% CI = 0.023-54 µg/L) due to high variation in first two treatments.
29 EC10 calculated by fitting log-logistic dose-effect relationship; EC10 estimate with high uncertainty (95% CI = 0.0045-78 µg/L) due to high variation in first two treatments.
30 Concentrations measured daily; test result based on mean measured concentrations.
31 Concentrations measured daily; test result based on mean measured concentrations; EC10 calculated by fitting log-logistic dose-effect relationship; EC10 estimate with high uncertainty (0.023-54 µg/L) due to high variation in first two treatments.
32 Concentrations measured daily; test result based on mean measured concentrations; EC10 calculated by fitting log-logistic dose-effect relationship; EC10 estimate with high uncertainty (0.0045-78 µg/L) due to high variation in first two treatments.

Table A2.4. Chronic toxicity of captan to marine organisms.

Species	Species properties	A	Test type	Test compound	Purity [%]	Test water	pH	T [°C]	Salinity [‰]	Exp. time	Criterion	Test endpoint	Value [mg/L]	Ri	Notes	Reference
Crustacea																
Artemia salina	eggs	N	S	captan	ag		7-8	27	20	48 h	NOEC	hatching	≥ 10	3	4,10	Kuwabara et al., 1980
Cancer magister	1st stage zoae	N	R	Orthocide - 50W	50	nw	7.6-7.9	13	25	96 h	EC50	cessation of swimming	0.36	2	1	Armstrong et al., 1976
Cancer magister	1st stage zoae	N	R	Orthocide - 50W	50	nw	7.6-7.9	13	25	96 h	LC50	mortality	8.0	3	1,4	Armstrong et al., 1976
Cancer magister	1st stage zoae	Y	F	captan	92.8	nw	8.1	12.3±0.5	28.8±1.4	9 d	LC50	mortality	0.45	1	2,3	Caldwell et al., 1978
Cancer magister	1st stage zoae	Y	F	captan	92.8	nw	8.1	12.3±0.5	28.8±1.4	21 d	LC100	mortality	0.45	1	2,3	Caldwell et al., 1978
Cancer magister	1st stage zoae	Y	F	captan	92.8	nw	8.1	12.3±0.5	28.8±1.4	69 d	NOEC	molting	0.0031	1	2,3	Caldwell et al., 1978
Cancer magister	juv; 1st instar	Y	F	captan	92.8	nw	7.2-8.2	13±2	31-34	36 d	NOEC	mortality	≥ 0.51	1	2,6,9,3	Caldwell et al., 1978
Cancer magister	juv; 3rd instar	Y	F	captan	92.8	nw	7.3-8.1	13±1	32-34.5	80 d	NOEC	mortality	≥ 0.29	1	2,7,8,9,3	Caldwell et al., 1978
Cancer magister	ad	Y	F	captan	92.8	nw	7.0-8.3	11-15	32.4	75 d	NOEC	mortality	≥ 0.34	1	2,9,8,3	Caldwell et al., 1978

NOTES

1 Test concentrations were adjusted for the percentage of active ingredients.
2 Acetone used as solvent at 0.01%, solvent and control solvent included.
3 Result expressed as mean measured captan concentration.
4 Above water solubility limits (5.1mg/l - EPIWIN).
5 Results are based on the nominal test concentration.
6 Four concentrations tested; in the test aquarium on the bottom a 1 cm layer of sand.
7 In the test aquarium on the bottom a 2 cm layer of sand.
8 Only two test concentrations.
9 Results are expressed in terms of the measured captan test concentration at the beginning, after 24 hours the concentrations of captan remaining in seawater were 48-74% - half life estimate from these data 23 to 54 hours.
10 Solvents acetone or DMSO used at 2%.

Appendix 3. Detailed bird and mammal toxicity data

Species	Species properties	Test compound	Purity [%]	Application route	Vehicle	Test duration	Exposure time	Criterion	Test endpoint	Value [mg/kg$_{bw}$.d]	Value [mg/kg$_{diet}$]	Ri	Notes	Reference
Birds														
Colinus virginianus	11 d old	Captan	90	Diet		5 d	8 d	LC50	Mortality		> 4680	2	1	EC, 2005
Colinus virginianus	11 d old	Captan	90	Diet		5 d	8 d	NOEC	Body weight		1170	2	1	EC, 2005
Colinus virginianus	5 months old	Captan	91	Diet	Corn oil	20 w	18 w	NOEC	Reproduction		≥ 910	2	1	EC, 2005
Anas platyrhynchos	8 d old	Captan	90	Diet		5 d	8 d	LC50	Mortality		> 4680	2	1	EC, 2005
Anas platyrhynchos	8 d old	Captan	90			5 d	8 d	NOEC	Body weight		1170	2	1	EC, 2005
Anas platyrhynchos	6 months old	Captan	91	Diet	Corn oil	21 w	19 w	NOEC	Body weight		≥ 910	2	1	EC, 2005
Mammals														
Rat	CD strain, male and female	Captan	89	Diet			2 year	NOAEL	Body weight	22.3	446	2	1	EC, 2005
Dog	Beagle, male and female	Captan	90.4	Diet			1 year	NOAEL	General toxicology	≥ 271		2	1	EC, 2005
Rat	COBS CD, male and female	Captan	89	Diet			3 gen (> 100 d)	NOAEL	Pup body weight	< 22.25		2	1	EC, 2005
Rat	COBS CD, male and female	Captan	tg	Diet			102 d	NOAEL	Pup body weight	12.5	250	2		EC, 2005

1 Values were corrected for the purity of captan.

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