PHD

Understand the environmental fate, behaviour, effects and risks associated with contaminants of emerging concern (CECs) with the goal of protecting environmental and human health

Thomas, Kevin Victor

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Understand the environmental fate, behaviour, effects and risks associated with contaminants of emerging concern (CECs) with the goal of protecting environmental and human health

By

Kevin Victor Thomas

A thesis and collection of works submitted to the University of Plymouth in partial fulfilment for the degree of

DOCTOR OF SCIENCE

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"A Who's Who of pesticides is therefore of concern to us all. If we are going to live so intimately with these chemicals eating and drinking them, taking them into the very marrow of our bones - we had better know something about their nature and their power."

— Rachel Carson, *Silent Spring*

Author's Declaration

I declare that I am author of the works submitted and that I have carried out the work described herein.

At no time during the registration for the degree of Doctor of Science has the author been registered for any other University award without prior agreement of the Graduate Committee.

Work submitted for this research degree at the University of Plymouth has not formed part of any other degree, either at the University of Plymouth or at any other establishment.

Kevin V Thomas
Kolsås, Norway
20th November 2014

Acknowledgements

Over the past 20 years I have had the good fortune to have worked at two top-flight environmental research institutes; Cefas, UK and NIVA, Norway and collaborated with many others globally. I have been fortunate to be surrounded by very gifted environmental scientists with which to collaborate, develop ideas and hypotheses, share knowledge and learn a great deal. I owe a large debt of gratitude to all those scientists with whom I have worked with, who have helped me to conduct that which is presented in this collection of works.

Understand the environmental fate, behaviour, effects and risks associated with contaminants of emerging concern (CECs) with the goal of protecting environmental and human health

Kevin Victor Thomas B.Sc. (Hons), Ph.D. (Plym)

Nature and Significance of the Work Submitted

Each and every one of us is exposed to chemicals on a daily basis and contributes to the global issue of chemical pollution. Humankind has become heavily dependent on the use of man-made chemicals in order to sustain the increased quality of life that is generally seen globally. There is however a price to pay in that we generally live in a world that is polluted by anthropogenic chemicals. From the water we drink to the food we eat there will be some trace of chemical residues; you just need to look closely enough and/or know what you're looking for. With many hundreds of thousands of man-made chemicals approved within Europe for use in various ways, it is no surprise that we come into daily contact with them. What is also important to understand is that the presence of a man-made chemical is not enough to establish whether it poses a risk to environmental or human health; it needs to be present in sufficient amounts to elicit an effect. Over the past 20 years the focus of my research been on understanding which chemicals we should be concerned with, which pose the greatest risk and why do they pose such a risk. This work is of major societal and scientific significance as it protects the world we live in whilst teaching us about the better regulation of the chemicals we have become so dependent.

To understand the nature of my research it is important to understand that prior to the mid-nineteen nineties hazardous organic chemicals were typically restricted to lists comprising of a number of banned (and typically chlorinated) pesticides, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans and the antifouling biocide tributyltin (TBT). One of the major enigmas that faced environmental scientists at the time was that even though it was possible to quantify and monitor the presence of the above hazardous substances in the environment, they often didn´t explain the environmental quality measured though biological effects on organisms. Chemicals are globally regulated on an individual substance level and subsequently within the context of influencing these regulations, for the improved protection of environmental and human health, it is therefore essential to know which chemical contaminants are actually causing biological effects. It is also necessary to know the levels at which any organism will be exposed and what the consequences of these levels. My research subsequently became focused on two separate approaches; identifying which substances actually cause the biological effects unexplained by hazardous substances and evaluating the occurrence, environmental fate and ecotoxicity of those chemicals not routinely monitored or present on priority lists of hazardous substances; a group of chemical contaminants later termed contaminants of emerging concern (CECs).

An effect-directed non-target approach

A targeted approach to environmental analysis infers that we know exactly what we should be looking for. Whilst this is a suitable approach for chemicals that we suspect may be of concern, it

does not help us understand which other contaminants may be present in the environment and potentially causing harm. When embryos of oysters exposed to estuarine surface waters developed deformities and this could not be attributable to the levels of priority hazardous substances a bioassay-directed non-target approach to environmental analysis was developed to identify chlorinated and alkylphenols as responsible [5, 6]. This approach has subsequently evolved into the approach termed effect-directed analysis (EDA) and is widely used globally for the identification of CECs. My own research has successfully applied the approach to identify for the first time a number of important environmental contaminants; steroidal androgens [10, 13, 14] as environmental contaminants, the phthalate ester bis(2-ethylhexyl)phthalate [10], cinnarizine, cholesta-4,6.dien-3-one [19], C_1-C_5 and C_9 alkylphenols [21], petrogenic naphthenic acids [57] as environmental estrogen receptor agonists, C_1-C_5 and C_9 alkylphenols [21], PAHs and petrogenic naphthenic acids [57] as androgen receptor antagonists and unresolved polar aromatic compounds as important environmental genotoxins [15]. Another focus of my effects-directed research has been identifying environmental contaminants that exert the same effects as dibenzo-p-dioxins and polychlorinated dibenzofurans in that they are aryl hydrocarbon receptor (AhR) agonists. Dioxin-like chemicals are ubiquitous in the environment and in addition to those that are routinely monitored there are a large number of other compounds that exert dioxin-like effects [26, 28, 32, 33, 37, 52, 64, 82, 93, 98, 99]. Better understanding of AhR agonists will in the long run help protect the environment and humans from a particularly hazardous group of chemicals.

A targeted approach

The early- to mid-nineteen nineties saw the widespread introduction of liquid chromatography coupled to mass spectrometry (LC-MS) to the environmental analytical toolbox. Robust instruments typically using electrospray and atmospheric pressure chemical ionisation were well suited to the analysis of the more polar CECs, such as alternative antifouling biocides to TBT, pharmaceuticals, personal care products, veterinary medicines, illicit drugs and rodenticides. Robust analytical methodology is key to my research [2, 4, 18, 31, 34, 35, 42, 49, 66, 69, 72, 73, 86, 94, 102] as it allows the better understanding of how contaminants behave and interact with the environment. Development of robust, specific and sensitive methods for the analysis of alternative antifouling biocides [2, 4] allowed for the first time an evaluation of their life-cycle from release at the paint surface, and the factors that influence this [3], their occurrence in the environment [7, 8, 12, 29], fate and behaviour [12, 16] and subsequent effects [36, 41]. Assessment of the environmental risks based upon these data showed that both Irgarol 1051 and diuron were a threat to freshwater and marine algae. The significance of this research is that it subsequently led to restrictions being placed on the use of Irgarol 1051 and diuron in antifouling products in a number of European countries [58] and an awareness of the hazards associated with the deliberate release of biocidal products into the environment [86].

Observations of human pharmaceutical residues in the chromatograms of wastewater effluent samples being analysed by EDA and reports of their occurrence in German wastewaters motivated the development of LC- tandem MS methods for the quantification of pharmaceutical residues in waste- and surface waters [18]. Pharmaceuticals, we showed, occur in treated wastewater effluents and marine and freshwater recipients [24, 25, 30, 42, 43, 51, 66] and that, to no great surprise, the per capita pharmaceutical loads from hospitals were greater than the general population [43, 51]. Other highlights include understanding the processes that occur within sewer systems and what influences pharmaceutical occurrence in the final treated effluent [59, 60, 81, 85, 105], all of which allow for a better assessment of the overall risk posed to the environment. Even though several hundred papers

have been published on pharmaceuticals in the environment since my early work, this has almost exclusively been focused on the parent pharmaceutical ingredient in aqueous matrices from developed counties. To remedy this shortfall more recent work has focused on quantifying the proportion of pharmaceutical metabolites released as compared to the parent [66], pharmaceutical occurrence in sludges and sediments [69], as well as evaluating occurrence in less studied water cycles [101]. My studies have shown that the risks associated with pharmaceutical metabolites are largely neglected and poorly understood and while we understand the releases of pharmaceuticals in Asia, Europe and North America, emissions of pharmaceuticals (and illicit drugs) in newly industrialised regions are also of significance [101].

As with biocides we were eager to understand the risks associated with the pharmaceutical exposure levels we were determining, however only acute short-term toxicity data were available which limited the possibility of evaluating any chronic long-term risks. A situation that is sadly not much better today. Linking causality to occurrence becomes easier however when the there is knowledge about the levels that can inflict a particular response in an organism, particularly when that response is mortality. An awareness of the potential of certain chemicals and their use has more recently led to better successes in linking occurrence with a particular response [86, 102]. For example my research has shown that second generation anticoagulant rodenticides (SGARs) occur at levels above the potential lethal range in the livers of raptors found dead in Norway [86] and that chitin synthesis inhibitors used in controlling sea-lice in Norwegian fish farms pose a serious risk to any species that undergoes moulting during its lifecycle [102].

With so many pharmaceuticals in use, prioritising which pharmaceuticals to target posed a new challenge and one which led to the use of prescription data to predict influent loads [44]. These estimations proved to be effective and combined with reports of the occurrence of cocaine in Italian rivers and wastewaters stimulated an interest in illicit drugs and one of the earliest publications of a robust analytical method for the quantification of a number of commonly used drugs [42]. With a focus on generating quality data representative of that occurring within a specific community our initial focus was on understanding the temporal fluxes in drug loads and what influenced such changes [71, 72, 74, 85]. After being convinced that wastewater analyses offered an alternative to conventional epidemiological methods for generating population level data we proceeded to develop the first wastewater biomarker for alcohol consumption, based upon ethylsufate [73], include for the first time new psychoactive substances in our analyses and a strategy for their identification [94, 97] and proposed that wastewater-based epidemiology had the potential to tell more about a community than just their drug use, provided the first comparison with conventional epidemiological data [84] and for the first time presented the hypothesis that wastewater contained indigenous and exogenous biomarkers of human interactions with their environment and that quantitative measurements of these biomarkers could be used to relate to health, diet, lifestyle and environment [75]. Large spatial studies were necessary to demonstrate that wastewater-based epidemiology had a role to play in providing useful data to drug and crime monitoring agencies. In 2010, I initiated the first Europe-wide spatial study that has generated comparable drug use data for up to 50 European cities from 2011 and is ingoing [79, 100], and allowed for the first time an assessment of the uncertainties associated with a wastewater-based approach [95].

Integrated sampling for improved characterisation

Accurate characterisation of chemical contamination very much requires that the samples we analyse are representative of the environment. A complementary focus of my research has been the

application of passive sampling techniques [46, 47, 53, 55, 71, 88, 89]. Such techniques can provide time-integrated samples that better describe the environments that I am characterising. They are particularly suitable for monitoring in hostile and difficult environments, such as off-shore around oil platforms [46, 47, 53, 55], whilst providing an effective tool for the long term monitoring of CECs [71] and cleaner extracts for coupling with non-targted analytical approaches for identifying unknown contaminants that are potentially bioaccumulative [88, 89]. A particularly novel passive sampling tool that we have used is explanted silicone implants that have huge potential for biomonitoring and have also led to a potential tool for cleaning contaminated bodies of chemicals [133].

Summary

The presented body of work represents 20 years research to better understand the influence of chemicals on environmental and human health. My research has resulted in the improved understanding of which chemicals affect the environment and pose the greatest risk. As described above, I was one of the first researchers to report the environmental risks posed by certain CECs that provoked the major research effort that we see today. This includes some of the earliest works on the presence of specific environmental endocrine disrupters, in particular androgen receptor agonists and antagonists, pharmaceuticals and personal care products, and engineered nanoparticles that has lead to the implementation of improved wastewater treatment and better societal awareness of chemicals in consumer goods. Direct impacts of this work have been restrictions in the use of Irgarol 1051 and diuron in most European countries following my seminal work on antifouling paint biocides and their inclusion in the Water Framework Directive´s list of priority substances, banning the use of second generation anticoagulant rodenticides (SGARs) for amateur use in Norway and brought focus on the dependence of the Norwegian fish farming industry on veterinary medicines. My influential work with using sewage to estimate illicit drug use has lead to a new paradigm as to how this is performed in Europe and afield and reported to the European Monitoring Centre for Drugs and Drug Addiciton and the United Nations Office on Drugs and Crime. At the time of writing these papers have been cited over 5,600 times.

Personal Contribution to the Work Submitted

The work submitted herein as supporting material for the award of a Doctor of Science (D.Sc.) was performed during my employment at the UK Centre for Environment, Fisheries and Aquaculture Science (Cefas) and the Norwegian Institute for Water Research (NIVA). By means of this statement I confirm that for each of the peer-reviewed articles submitted herein that I have made a substantial contribution to the conception or design of the work, or the acquisition, analysis, or interpretation of data for the work, and have drafted the work or revised it critically for intellectual content and am accountable for all aspects of the work. I am first or final author on 75% of the publications listed, which is to say that I am main owner of the research presented in these papers. In the remaining 25% of the publications listed are the results of where I personally have collaborated with other researchers and made a substantial contribution meriting co-authorship.

From within this body of work, the following ten articles have been selected to collectively support this submission, with my particular contribution to the research highlighted below each.

1. Thomas, K.V. 1998. **Determination of selected antifouling paint booster biocides by high performance liquid chromatography-atmospheric pressure chemical ionisation mass spectrometry.** *Journal of Chromatography A* 825, 29-35.

This early paper on the determination of antifouling paint biocides by LC-MS demonstrates the application of what at the time was a relativley new technology for the quantitiative analysis of polar organic contaminants that could not be easily determined by more commonly available GC-MS techniques. This was the first reported multi-residue method for the analysis of the new antifouling paint biocides introduced onto the market following restrictions in the use of TBT. This analytical method allowed not only the occurrence of these biocides to be determined in the environment [7, 8, 12, 29] but also allow their environmental fate and effects to be determined [12, 16, 41]. Data that were subsequently used by myself and others to evaluate the environmental risks posed by antfouling paint biocides [8] and eventually has led to restrictions in their use in many European states.

Ownership of the research reported within this paper lies solely with K.V. Thomas.

2. Thomas, K.V., Hurst, M.R., Smith, A., McHugh, M, Matthiessen, P. and Waldock, M.J. 2002. **An assessment of in vitro androgenic activity and identification of environmental androgens in United Kingdom estuaries.** *Environmental Toxicology & Chemistry* 21(7), 1456-1461.

This paper for the first time reports the occurrence of androgens as a new class of endocrine disrupters in the aquatic environment. Until this point endocrine disruption in the aquatic environment had exclusively focused on estrogens and their feminizing effects. The paper built on my earlier work on identifying environmental estrogens and toxins in surface waters [5,6,9,10] through using *in vitro* reporter gene assays to direct the isolation of the active components within the complex environmental extract prior to non-target analysis; a technique that is today referred to as effect-directed analysis (EDA). This paper is one of the most effective reports of EDA ever reported in the peer-reviewed literature as 99% of the unknown androgens were successfully identified. EDA has become widely used for identifying unknown causes of biological effects in the environment and increasingly applied to the identification of CECs [10, 13, 14, 21, 26, 28, 32, 33, 37, 52, 57, 64, 82, 93, 98, 99].

Ownership of the research reported within this paper lies primarily (>60%) with K.V. Thomas.

3. Ashton, D, Hilton, M. and Thomas, K.V. 2004. **Investigating the potential risk to the environment from human pharmaceuticals**. *Science of the Total Environment* 333 (1-3), 167-184.

This highly cited paper for the first time reports the occurrence of selected human pharmaceuticals in the UK environment. Building upon the earlier development of sensitive and specific multi-residue LC-MSMS methods for the analysis of human pharmaceuticals [18] this paper reported their occurrence in treated wastewater effluent and receiving rivers as well as evaluated the acute

environmental risks posed based upon the levels of exposure determined and published ecotoxicology data.

Ownership of the research reported within this paper lies primarily (>70%) with K.V. Thomas.

4. Thomas, K.V., Langford, K., Pedersen, K., Smith, A. J., Tollefsen, K.E. 2009. **Effect-directed identification of naphthenic acids as important in vitro xeno-estrogens and anti-androgens in North Sea offshore produced water discharges.** *Environmental Science & Technology* 43, 8066–8071.

This paper for the first time identified petrogenic naphthenic acids as important in vtro xeno-estrogens and anti-androgens in offshore produced water discharges. The significance of this EDA study was such that previous to my work the environmental risk attributable to xeno-estrogens in produced water discharges was solely based upon the occurrence of short chain C_1-C_5 alkylphenols as identified in my previous work [21] and typically only representative of 30% of the total activity.

Ownership of the research reported within this paper lies primarily (>60 %) with K.V. Thomas.

5. Harman, C., Reid, M., and Thomas, K.V. 2011. **In situ calibration of a passive sampling device for selected illicit drugs and their metabolites in wastewater, and subsequent year-long assessment of community drug usage.** *Environmental Science & Technology* 45, 5676–5682.

Bringing together my earlier work on passive sampling technology (with PhD student C. Harman [ ]) and the robust quantitative analytical methodology developed for illicit drugs (with PhD student M. Reid [], this was the first paper to report the use of the technology for wastewater based epidemiology and the first to temporally monitor drug use trends over 1 year. From a technological perspective the paper presented an approach for the in situ calibration of the POCIS sampler and the measurement of uptake kinetics that are representative of the sampling environment. The work showed for the first time the high levels of temporal variability in illicit drug use and identified specific peaks in drug use. For example cocaine loads peaks in the holiday periods over summer and Christmas, while the peak ecstasy load corresponded with high-school students celebrating the end of their studies. This well cited paper provided a new tool for long-term wastewater based epidemiology studies. This work has continued with data soon available for 4-years revealing illicit drug use over an extended period and has helped establish the long-term wastewater based monitoring of drug use in a number of Norwegian cities that is supported by the Norwegian Institute for Alcohol and Drug Research and will be reported annually to the EMCDDA. Subsequent development of the technology has also led to a design registration being granted [132].

Ownership of the research reported within this paper lies primarily (>60%) with K.V.Thomas.

6. Farkas, J., Peter, H., Christian, P., Gallego Urrea, J.A., Hassellöv, M., Tuoriniemi, J., Gustafsson, S., Olsson, E., Hylland, K., and Thomas, K.V. 2011. **Characterization of the effluent from a nanosilver producing washing machine.** *Environment International* 37, 1057–1062.

Describing the complex process of unequivocally characterizing wash-water from a nanoparticlate silver producing washing machine for the presence of silver nanoparticles, this paper is one of the first to demonstrate the release of nanoparticles from a consumer product directly into the urban sewer network. The motivation behind the paper was to establish protocols for PhD student J. Farkas to be able to effectively characterize her exposure solutions for the presence of silver nanoparticles when testing their toxicity and fate [61, 63, 65, 77], with the end result being a highly topical application of a number of new analytical techniques (e.g. single ion ICP-MS) in the quest for unequivocal characterization.

Ownership of the research reported within this paper lies primarily (>50%) with K.V.Thomas.

7. Thomas, K.V., Bijlsma, L., Castiglioni, S., Covaci, A., Emke, E., Grabic, R., Hernández, F., Karolak, S., Kasprzyk-Hordern, B., and Lindberg, R.H. 2012. **Comparing illicit drug use in 19 European cities through sewage analysis**. *Science of the Total Environment* 432, 432-439.

Having published one of the first methodological papers on the quantification of illicit drugs in wastewater [42] and performed temporal trend studies at various scales in Norway [69, 72, 73, 74] I identified a need to develop a Europe-wide network for performing spatial multi-city studies. This highly cited paper allowed for the first time a comparison of illicit drug use in 19 European cities in 2011. Using a consensus-based best practice approach to sample collection, and the first interlaboratory comparison study of the quantitiative analysis of illicit drugs in wastewater, comparable data were generated and served as a demonstration to international drug related agencies (EMCDDA and UNODC) that wastewater based epidemiology had a role to play in establishing the scale of the illicit drug problem internationally. This collaboration has evolved into a major European network (www.score-cost.eu) and allowed the uncertainties associated with such an approach to be estimated [87] as well as further international temporal and spatial epidemiology studies [100] that have received global media attention.

Ownership of the research reported within this paper lies primarily (>50%) with K.V. Thomas.

8. Allan, I.J., Bæk, K., Kringstad, A., Roald, H.E., Thomas, K.V. 2013. **Should silicone prostheses be considered for specimen banking? A pilot study into their use for human biomonitoring**. *Environment International* 59, 462-468.

This highly innovative paper evolved from my work on passive sampling and discussions with co-author and colleague I. Allan. Together we hypothesized that silicone prostheses placed within the human body would equilibrate with the pollution in the body and provide an excellent matrix for biomonitoring. For the first time we demonstrated that explanted silicone prostheses do indeed contain organic contaminants and that the relative levels are in agreements with those typical of those from breast-milk or serum and that they provide a promising matrix for the biomonitoring of non-polar and non-ionic pollutants in humans. Finally we suggested that since silicone prostheses are widely accessible and representative of the overall body burden that they should be seriously considered for specimen banking. In addition the work described in the paper also led to a patent

application for the "detoxification or measurement of at least one compound or at least one fluid in a host body" [133].

Ownership of the research reported within this paper lies primarily (> 40%) with K.V. Thomas.

9. Langford, K.H., Reid, M., and Thomas, K.V. 2013. **The occurrence of second-generation anticoagulant rodenticides in non-target raptor species in Norway**. *Science of the Total Environment* 450, 205–208.

This paper directly led to a ban in Norway on the use of second-generation anticoagulant rodenticides (SGARs) by non-professionals. The paper reports the occurrence of SGARs in the iconic birds of prey species, golden eagles and eagle owls, and showed that at least 30% of the birds analysed may have been lethally poisoned by SGARs. The paper is included since it demonstrates the importance of integrating analytical exposure data in combination with effects data to establish, not only the occurrence of chemicals in the environment but also what the consequences of its presence in the environment are.

Ownership of the research reported within this paper lies primarily (> 40%) with K.V. Thomas.

10. Langford, K., Øxnevad, S., Schøyen, M., Thomas, K.V. 2014. **Do anti-parasitic medicines used in aquaculture pose a risk to the Norwegian aquatic environment?** *Environmental Science & Technology* 48, 7774-7780.

Following publication of this work the Norwegian government set up a working-group to specifically evaluate the use of anti-parasitic medicines and in particular chitin synthesis inhibiting compounds and the use of said chemicals dropped dramatically within the fish farming industry due to an increased awareness of the direct effects of these chemicals on the environments surrounding fish farms. The paper showed that levels of selected chitin synthesis inhibitors, sufficiently high to affect commercial shrimp and crab populations, could be detected up to 5 km from treated fish farms.

Ownership of the research reported within this paper lies primarily (> 50%) with K.V. Thomas.

Contents

Peer Reviewed Journal Articles

No.	Article type	Authors	Title	Pages	Volume	Year	*Journal*
1.	Research Note	Thomas, K.V., Donkin, P., Rowland, S.J.	Toxicity Enhancement of an Aliphatic Petrogenic Unresolved Complex Mixture (UCM) by Chemical Oxidation	379-382	29	1995	*Water Research*
2.	Paper	Thomas, K.V.	Determination of selected antifouling paint booster biocides by high performance liquid chromatography-atmospheric pressure chemical ionisation mass spectrometry	29-35	825	1998	*Journal of Chromatography A*
3.	Paper	Thomas, K.V., Chadwick, J., Raymond, K., Waldock, M.	The effects of short-term changes in environmental parameters on the release of biocides from antifouling coatings: Cuprous Oxide and tributyltin.	1-8.	13	1999	*Applied Organometalic Chemistry*
4.	Paper	Thomas, K.V.	Determination of the antifouling agent zinc pyrithione in water samples by copper chelate formation and high performance liquid chromatography-atmospheric pressure chemical ionisation mass spectrometry.	105-109.	833	1999	*Journal of Chromatography A*
5.	Paper	Thomas, K.V., Benstead, R., Thain, J.E., Waldock, M.J.	Toxicity characterisation of organic contaminants in UK estuaries and coastal waters	925-932	38	1999	*Marine Pollution Bulletin*
6.	Paper	Thomas, K.V., Thain , J.E. Waldock, M.J.	Identification of toxic substances in UK estuaries	401-411	18	1999	*Environmental Toxicology and Chemistry*
7.	Paper	Thomas, K.V., Blake, S. Waldock, M.	Antifouling paint booster biocide contamination in UK marine sediments.	739-745	40	2000	*Marine Pollution Bulletin*
8.	Paper	Thomas, K.V., Fileman, T.W., Readman, J.,	Antifouling paint booster biocides in the UK coastal	677-688	42	2001	*Marine Pollution Bulletin*

		Waldock, M.	environment and potential risks of biological effects.				
9.	Paper	Thomas, K.V., Hurst, M.R., Matthiessen, P., Sheahan, D., Williams, R.	Toxicity characterisation of organic contaminants in stormwaters from an agricultural headwater stream in South East England.	2411-2416	35	2001	*Water Research*
10.	Paper	Thomas, K.V., Hurst, M.R., Matthiessen, P., Waldock, M.J.	Identification of oestrogenic compounds in surface and sediment pore water samples collected from industrialised UK estuaries.	2165-2170.	20	2001	*Environmental Toxicology and Chemistry.*
11.	Critical review	Thomas, K.V.	The environmental fate and behaviour of antifouling paint booster biocides: A review.	73-86	17	2001	*Biofouling.*
12.	Paper	Thomas, K.V., McHugh, M., Waldock, M.J.	Antifouling paint booster biocides in UK coastal waters: Inputs, occurrence and environmental fate.	117-127	293	2002	*The Science of the Total Environment.*
13.	Paper	Thomas, K.V., Hurst, M.R., Smith, A., McHugh, M, Matthiessen, P., Waldock, M.J.	An assessment of *in vitro* androgenic activity and identification of environmental androgens in United Kingdom estuaries.	1456-1461	21	2002	*Environmental Toxicology and Chemistry*
14.	Paper	Matthiessen, P., Allen, Y., Bamber, S., Craft, J., Hurst, M., Hutchinson, T., Feist, S., Katsiadaki, I., Kirby, M., Robinson, C., Scott, S., Thain, J., Thomas, K.V.	The Impact Of Oestrogenic and Androgenic Contamination pn Marine Organisms in the United Kingdom – Summary Of The EDMAR Programme.	645-649	54	2002	*Marine Environmental Research.*
15.	Paper	Thomas, K.V., Balaam, J., Lavender, J., Jones, C.	Characterisation of genotoxic compounds in sediments collected from United Kingdom estuaries.	247-258	49	2002	*Chemosphere*
16.	Paper	Thomas, K.V.,	Increased persistence	153-161	123	2003	*Environmental*

		McHugh, M., Hilton, M., Waldock, M.J.	of antifouling paint booster biocides when associated with paint particles.				*Pollution.*
17.	Paper	Thomas, K.V., Barnard, N., Collins, K.	Toxicity characterisation of sediment pore waters collected from UK estuaries using a *Tisbe battagliai* bioassay.	1105-1111.	53	2003	*Chemosphere*
18.	Paper	Hilton, M., Thomas, K.V.	Determination of selected pharmaceutical compounds in surface water samples by liquid chromatography-electrospray tandem mass spectrometry.	129-141	1015	2003	*Journal of Chromatography A*
19.	Paper	Thomas, K.V., Balaam J., Hurst M.R., Nedyalkova, Z., Mekenyan, O.	The *in vitro* potency and characterisation of oestrogen receptor (ER) agonists in UK marine sediments.	471–479.	23(2)	2004	*Environmental Toxicology and Chemistry*
20.	Paper	Kirby, M.F., Allen, Y.T., Dyer, R.A., Feist, S.W., Katsiadaki, I., Matthiessen, P., Scott, A.P., Smith, A., Stentiford, G.D., Thain, J.E., Thomas, K.V., Tolhurst, L., Waldock, M.J.	Surveys of plasma vittelogenin and intersex in male flounder (Platichthys flesus) as measures of endocrine disruption by estrogenic contamination in UK esturies: Temporal trends 1988-2002.	748–758	23(3)	2004	*Environmental Toxicology and Chemistry*
21.	Paper	Thomas, K.V., Balaam, J., Hurst, M.R. Thain, J.E.	Identification of *in vitro* oestrogen and androgen receptor agonists in offshore produced water discharges.	1156-1163	23(5)	2004	*Environmental Toxicology and Chemistry*
22.	Paper	Thomas, K.V., Balaam, J., Hurst, M.R. Thain, J.E.	Bio-analytical and Chemical Characterisation of Offshore Produced Water Effluents for Estrogen Receptor (ER) Agonists.	593-598	6	2004	*Journal of Environmental Monitoring*
23.	Critical Review	Eggleton, J., Thomas K.V.	Factors affecting the release and bioavailability of contaminants during sediment disturbance events.	973-980.	30(7)	2004	*Environment International*

24.	Paper	Thomas, K.V., Hilton, M.	The Occurrence of Selected Human Pharmaceutical Compounds in UK estuaries.	436-444	49	2004	*Marine Pollution Bulletin*
25.	Paper	Ashton, D, Hilton, M., Thomas, K.V.	Investigating the potential risk to the environment from human pharmaceuticals.	167-184	333	2004	*Science of the Total Environment*
26.	Paper	Hurst, M., Balaam, J., Chan-Man, Y., Thain, J.E., Thomas, K.V.	Determination of dioxin and dioxin-like compounds in sediments from UK estuaries using a bio-analytical approach: chemical-activated luciferase expression (CALUX) assay	648-658	49	2004	*Marine Pollution*
27.	Paper	Brack, W., Bakker, J., de Deckere, E., Deerenberg, C., van Gils, J., Hein, M., Jurajda, P., Kooijman, B., Lamoree, M., Lek, S., López de Alda, M.J., Marcomini, A., Muñoz, I., Rattei, S., Segner, H., Thomas, K.V., von der Ohe, - P.C. Westrich, B., de Zwart., D., Schmitt-Jansen, M.	MODELKEY. Models for assessing and forecasting the impact of environmental key pollutants on freshwater and marine ecosystems and biodiversity.	252-256	12	2005	*Environmental Science and Pollution Research*
28.	Paper	Hurst, M.R., Chan-Man, Y., Balaam, J.L., Thain, J.E., Thomas, K.V.	The stable aryl hydrocarbon receptor agonists potency of United Kingdom Continental Shelf (UKCS) offshore produced water effluents.	1694-1698	50	2005	*Marine Pollution Bulletin*
29.	Paper	Lambert, S, Thomas, K.V., Davey, A.	An assessment of the risk posed by the antifouling paint booster biocides Irgarol 1051 and diuron in the freshwaters of East Anglia, UK.	734-743	63	2006	*Chemosphere.*
30.	Paper	Roberts, P.,	The occurrence of	143-153	356	2006	*Science of the Total*

		Thomas, K.V.	selected pharmaceuticals in wastewater effluent and surface waters of the Tyne Estuary, UK and its tributaries.				*Environment*
31.	Paper	Bones, J., Nestrenko, P, Thomas, K.V. Paull, B.	Dual gradient LC method for the determination of pharmaceutical residues in environmental samples using a monolithic silica reversed phase column.	487-	86	2006	*International Journal of Environmental Analytical Chemistry*
32.	Paper	Thomas, K.V., Roberts, P.H., Balaam, J.L.	DR-CALUX Screening of stranded cetacean blubber.	185-188	86	2006	*Organohalogen compounds*
33.	Paper	Thain, J.E., Hurst, M.R., Thomas, K.V.	Determination of dioxin-like activity in sediments from the East Shetland basin.	*1855-1857.*	86	2006	*Organohalogen compounds*
34.	Paper	Bones, J., Nestrenko, P, Thomas, K.V., Paull, B.	On-line preconcentration of pharmaceutical residues from large volume water samples using short reversed-phase monolithic cartridges coupled to LC-UV-ESI-MS.	*1117-1128*	*70*	2006	*Talanta*
35.	Paper	Bones J., Thomas K.V., Paull, B.	Improved method for the determination of Zinc Pyrithione in environmental water samples incorporating on-line extraction and preconcentration coupled with liquid chromatography atmospheric pressure chemical ionisation mass spectrometry.	157-164	113	2006	*Journal of Chromatography A*
36.	Paper	Dyer, R., Tolhurst, L., Hilton, M., Thomas, K.V.	Bio-concentration of the antifouling paint biocide Irgarol 1051 by the green alga *Tetraselmis suecica.*	524-532	77	2006	*Bulletin of Environmental Contamination and Toxicology*
37.	Paper	Balaam, J.L., Thomas, K.V.	Bioanalytical characterisation of estrogen and arylhydrocarbon	419-424	9	2007	*Journal of Environmental Monitoring*

			receptor agonists in transplanted blue mussels (Mytilus edulis): Proof of concept.				
38.	Paper	Tollefsen, K.E., Harman, C., Smith, A., Thomas, K.V.	Estrogen receptor (ER) agonists and androgen receptor (AR) antagonists in effluents from oil production platforms and North Sea surface waters.	277-283	54	2007	*Marine Pollution Bulletin*
39.	Paper	Grung, M., Lichtenthaler, R., Ahel, M., Tollefsen, K.E, Thomas, K.V.	Toxicity characterization of organic contaminants in effluents from the city of Zagreb.	108-120	68	2007	*Chemosphere*
40.	Paper	Brooks, S., Bolam, T., Tolhurst, L., Bassett, J., La Roche, J., Waldock M Thomas, K.V.	The effects of dissolved organic carbon on the toxicity of copper to the developing embryos of the Pacific oyster, Crassostrea gigas.	1756-1763.	26(8)	2007	*Environmental Chemistry and Ecotoxicology*
41.	Paper	Tolhurst, L. Barry, J., Dyer, R., Thomas, K.V.	The effect of resuspending sediment contaminated with antifouling paint particles containing Irgarol 1051 on the marine macrophyte Ulva intestinalis.	1519-1524	68(8)	2007	*Chemosphere*
42.	Paper	Bones J.J, Thomas K.V., Paull, B.	Using environmental analytical data to estimate levels of community consumption of illicit drugs and abused pharmaceuticals	701-707	97(7)	2007	*Journal of Environmental Monitoring*
43.	Paper	Thomas, K.V., Dye, C., Schlabach, M., Langford, K.H.	Source to sink tracking of selected human pharmaceuticals from two Oslo city hospitals and a wastewater treatment works.	1410-1418	9(12)	2007	*Journal of Environmental Monitoring*
44.	Paper	Grung, M., Kallqvist, T., Sakshaug, S., Skurtveit, S., Thomas, K.V.	Environmental assessment of Norwegian priority pharmaceuticals based on the EMEA guideline.	328-340	71	2008	*Ecotoxicology and Environmental Safety*

45.	Paper	Kallqvist, T. Milacic, R., Smital, T., Thomas, K.V., Vranes, S., Tollefsen, K.E.	Chronic toxicity of the Sava River (SE Europe) sediments and river water to the algae *Pseudokirchneriella subcapitata*.	2146-2156	42	2008	*Water Research*
46.	Paper	Harman, C., Tollefsen, K-E., Bøyum O., Thomas, K.V., Grung, M.	Uptake rates of alkylphenols, PAHs and carbazoles in semipermeable membrane devices (SPMDs) and polar organic chemical integrative samplers (POCIS)	1510-1516	72(10)	2008	*Chemosphere*
47.	Paper	Harman, C., Bøyum, O, Tollefsen, K-E, Thomas, K.V., Grung, M.	Uptake of some selected aquatic pollutants in semipermeable membrane devices (SPMDs) and the polar organic chemical integrative sampler (POCIS)	239-247	10	2008	*Journal of Environmental Monitoring*
48.	Paper	Brooks, S., Bolam, T., Tolhurst, L., Bassett, J., La Roche, J., Waldock M., Thomas, K.V.	Dissolved organic carbon reduces the toxicity of copper to germlings of the macroalgae, *Fucus vesiculosus*	88-98	70(1)	2008	*Ecotoxicology and Environmental Safety*.
49.	Paper	Langford, K.H., Thomas, K.V.	Inputs of chemicals from recreational activities into the Norwegian coastal zone.	894-898	10	2008	*Journal of Environmental Monitoring*
50.	Paper	Okamura, H., Kitano, S., Toyota, S., Harino, H., and Thomas, K.V.	Ecotoxicity of the degradation products of triphenylborane pyridine (TPBP) antifouling agent.	1275-1278	74	2009	*Chemosphere*
51.	Paper	Langford, K.H., Thomas, K.V.	Determination of pharmaceutical compounds in hospital effluents and their contribution to wastewater treatment works.	766-770	35	2009	*Environment International*
52.	Paper	Balaam, J.L., Chan-Man, Y., Roberts, P.H., Thomas, K.V.	Identification of non-regulated pollutants in North Sea produced water discharges.	1158-1169	28(6)	2009	*Environmental Toxicology and Chemistry*
53.	Paper	Harman, C., Holth, T.F., Hylland, K.,	Relationship Between Polycyclic Aromatic	234-243	72(3)	2009	*Journal of Toxicology and Environmental Health, Part A*

		Thomas, K.V., Grung, M.	Hydrocarbon (PAH) Accumulation in Semipermeable Membrane Devices and PAH Bile Metabolite Levels in Atlantic Cod (*Gadus morhua*)				
54.	Paper	Weiss, J.M., Thomas, K.V., Hamers, T., van der Linden, S., Leonards, P.E.G., Lamoree. M.H.	Masking effect of anti-androgens on androgenic activity in European river sediment unveiled by Effect Directed Analysis.	1385–1397	394	2009	*Ananlytical & Bioanalytical Chemistry*
55.	Paper	Harman, C., Bøyum, O., Thomas, K.V., Grung, M.	Small but different effect of fouling on the uptake rates of SPMDs and POCIS.	2324-2332	28(11)	2009	*Environmental Toxicology and Chemistry*
56.	Paper	Harman, C., Thomas, K.V., Tollefsen, K.E., Meier, S., Bøyum, O., Grung, M.	Monitoring the freely dissolved concentrations of polycyclic aromatic hydrocarbons (PAH) and alkylphenols (AP) around a Norwegian oil platform by holistic passive sampling.	1671–1679	58	2009	*Marine Pollution Bulletin*
57.	Paper	Thomas, K.V., Langford, K., Nilsen, A. J. Smith, A., Tollefsen, K.E.	Effect-directed identification of naphthenic acids as important in vitro xeno-estrogens and anti-androgens in North Sea offshore produced water discharges.	8066–8071	43	2009	*Environmental Science and Technology*
58.	Critical review	Thomas, K.V., Brooks, S.	A mini review of the environmental fate and effects of antifouling paint biocides.	73-88	26(1)	2010	*Biofouling*
59.	Paper	Plosz, B., Leknes, H., Thomas, K.V.	Impacts of Competitive Inhibition, Parent Compound Formation and Partitioning Behavior on the Removal of Antibiotics in Municipal Wastewater Treatment.	734-742	44	2010	*Environmental Science and Technology*
60.	Paper	Plosz, B., Leknes, H., Liltved, H., Thomas, K.V.	Diurnal variations in the occurrence and the fate of hormones and antibiotics in	1915-1924	408	2010	*Science of the Total Environment*

			activated sludge wastewater treatment in Oslo, Norway.				
61.	Paper	Farkas, J., Christian, P., Gallego Urrea, J., Roos, N., Hassellöv, M., Tollefsen, K.E., Thomas, K.V.	Effects of Silver and Gold Nanoparticles on Rainbow Trout (*Oncorhynchus mykiss*) Hepatocytes.	46-52	96	2010	*Aquatic Toxicology*
62.	Paper	Ellesat, K.S., Tollefsen, K.-E., Åsberg, A., Thomas, K.V., Hylland, K.	Cytotoxicity of atorvastatin and simvastatin on primary rainbow trout (Oncorhynchus mykiss) hepatocytes.	1610-1618	24	2010	*Toxicology in Vitro*
63.	Paper	Farkas, J., Christian, P., Gallego Urrea, J., Roos, N., Hassellöv, M., Tollefsen, K.E., Thomas, K.V.	Uptake and effects of manufactured silver nanoparticles in rainbow trout (*Oncorhynchus mykiss*) gill cells.	117-125	101	2011	*Aquatic Toxicology*
64.	Paper	Grung, M., Næs, K., Fogelberg, O., Nilsen, A.J., Brack, W., Lübcke-von Vare, U., Thomas, K.V.	Effects directed analysis of sediments from polluted marine sites in Norway.	439-454	74	2011	*Journal of Toxicology and Environmental Health*
65.	Paper	Thomas, K.V., Farkas, J., Gregersen, I.K., Farmen, E., Christian, P., Langford, K., Wu, Q., Tollefsen, K.E.	Effects of dispersed aggregates of carbon and titanium dioxide engineered nanoparticles on rainbow trout hepatocytes.	466-477	74	2011	*Journal of Toxicology and Environmental Health*
66.	Paper	Langford, K.H.,Thomas, K.V.	Input of selected human pharmaceutical metabolites into the Norwegian aquatic environment.	416-211	13	2011	*Journal of Environmental Monitoring*
67.	Paper	Smital, T., Terzic, S., Zaja, R., Senta, I., Pivcevic, B., Popovic, M., Mikac, I., Tollefsen, K.E., Thomas, K.V., Ahel, M.	Assessment of toxicological profiles of the municipal wastewater effluents using chemical analyses and bioassays.	844-851	74	2011	*Ecotoxicology and Environmental Safety*
68.	Paper	Farkas, J., Peter, H.,	Characterization of the effluent from a	1057-1062	37	2011	*Environment International*

		Christian, P., Gallego Urrea, J.A:, Hassellöv, M., Tuoriniemi, I., Gustafsson, S., Olsson, E., Hylland, K., Thomas, K.V.	nanosilver producing washing machine.				
69.	Paper	Langford, K., Reid, M., Thomas, K.V.	Multi-residue screening of prioritised human pharmaceuticals, illicit drugs and bactericides in sediments and sludge.	2284 - 2291.	13(8)	2011	*Journal of Environmental Monitoring*
70.	Paper	Paterson, G., Macken A., Thomas, K.V.	The environmental analysis of engineered nanoparticles: small pollutants and big challenges.	1461-1467	3	2011	*Analytical Methods*
71.	Paper	Harman, C., Reid, M., Thomas, K.V.	Long-term measurement of population drug use – An approach using passive samplers in wastewater.	5676–5682.	45(13)	2011	*Environmental Science and Technology*
72	Paper	Reid, M.J., Langford, K.H., Mørland, J., Thomas, K.V.	Quantitative assessment of time dependent drug-use trends by the analysis of drugs and related metabolites in raw sewage	179-186	119	2011	*Drug and Alcohol Dependence*
73.	Paper	Reid, M.J., Langford, K.H., Mørland, J., Thomas, K.V.	Analysis and Interpretation of Specific Ethanol Metabolites, Ethyl Sulfate and Ethyl Glucuronide, in Sewage Effluent for the Quantitative Measurement of Regional Alcohol Consumption.	1593–1599.	35(9)	2011	*Alcoholism: Clinical and Experimental Research*
74.	Paper	Reid, M.J., Harman, C., Grung, M., Thomas, K.V.	The current status of community drug testing via the analysis of drugs and drug metabolites in sewage.	15-23	21(1)	2011	*Norwegian Journal of Epidemiology*
75.	Viewpoint	Thomas, K.V., Reid M.	What else can the analysis of sewage for urinary biomarkers reveal?	7611–7612.	45(18)	2011	*Environmental Science and Technology*
76.	Paper	Gade, A.L.,	REACH exposure	332-339	61(3)	2011	*Regulatory Toxicology*

		Heiaas, H., Thomas, K.V., Hylland, K.	assessment of anticorrosive paint products – Determination of exposure from application and service life to the aquatic environment.				*and Pharmacology*
77.	Paper	Farkas, J., Nizzetto, L., Thomas, K.V.	The Binding of Phenanthrene to Engineered Silver and Gold Nanoparticles.	283-288	425	2012	*Science of the Total Environment*
78.	Paper	Macken, A.L. Byrne, H.J. Thomas, K.V.	Effects of varying salinity on the toxicity of ionic silver and Ag-PVP nanoparticles to *Tisbe battagliai* and *Ceramium tenuicorne.*	101-110	86	2012	*Ecotoxicology & Environmental Safety*
79.	Paper	Thomas, K.V., Bijlsma, L., Castiglioni, S., Covaci, A., Emke, E., Grabic, R., Hernández, F., Karolak, S., Kasprzyk-Hordern, B., Lindberg, R.H., de Alba, M.L., Meierjohann, A., Ort, C., Pico, Y., Quintana, J.B., Reid, M., Rieckermann, J., Terzic, S., van Nuijs, A.L.N., de Voogt, P.	Comparing illicit drug use in 19 European cities through sewage analysis.	*432-439*	432	2012	*Science of the Total Environment*
80.	Paper	Radović, J.R., Rial, D., Lyons, B., Harman, C., Viñas, L., Beiras, R., Readman, J.W., Thomas, K.V., Bayona, J.M.	Post incident monitoring to evaluate environmental damage from shipping incidents: Chemical and biological assessments.	136-153	109	2012	*Journal of Environmental Management*
81.	Paper	Plósz, B.G., Langford, K.H., Thomas, K.V.	An activated sludge modelling framework for xenobiotic micro-pollutants (ASM-X): Assessment of diclofenac and carbamazepine.	2757-2769	109	2012	*Biotechnology and Bioengineering*
82.	Paper	Muusse, M.,	Characterization of	1-10	6	2012	*Analytical and*

		Langford, K.H., Tollefsen, K.E., Cornelissen, G., Haglund, P., Hylland, K., Thomas , K.V.	AhR agonist compounds in road-side snow.				*Bioanalytical Chemistry*
83.	Paper	Grung, M., Langford, K.H., Thomas, K.V.	Pharmaceuticals as pollution (In Norwegian)	1249-51	132(19)	2012	*Tidskrift for den Norske Laegeforening*
84.	Paper	Reid, M.J., Langford, K.H., Grung, M., Hallvard, G., Amundsen, E.J., Morland, J., Thomas, K.V.	Estimation of cocaine consumption in the community: a critical comparison of the results from three complimentary techniques	2012;2:e001637	6(2)	2012	*BMJ Open*
85.	Paper	Plósz, B., Reid, M.J., Borup, M., Langford, K.H., Thomas, K.V.	Biotransformation kinetics of cocaine and its metabolites and the factors influencing their fate in wastewater.	2129-2140	47	2013	*Water Research*
86.	Paper	Langford, K.H., Reid, M., Thomas, K.V.	The occurrence of second generation anticoagulant rodenticides in non-target raptor species in Norway.	205-208	450	2013	*Science of the Total Environment*
87.	Paper	Castiglioni, S., Bijlsma, L., Covaci, A., Emke, E., Hernández, F., Reid, M., Ort, C., Thomas, K.V., van Nuijs, A.L., de Voogt, P.	Evaluation of uncertainties associated with the determination of community drug use through the measurement of sewage drug biomarkers	1452-1460.	47	2013	*Environmental Science & Technology*
88.	Paper	Allan, I.J., Harman, C., Ranneklev, S.B., Thomas, K.V., Grung, M.	Passive sampling for target and nontarget analyses of moderately polar and nonpolar substances in water.	1718-1726	32	2013	*Environmental Toxicology and Chemistry*
89.	Paper	Allan, I.J., Bæk, K., Kringstad, A., Roald, H.E., Thomas, K.V.	Should silicone prostheses be considered for specimen banking? A pilot study into their use for human biomonitoring.	462-468	59	2013	*Environment International*
90.	Paper	Rial, D., Radovic, J.R., Bayona, J.M.,	Effects of simulated weathering on the toxicity of selected	67-73	260	2013	*Journal of Hazardous Materials*

		Macrae, K., Thomas, K.V., Beiras, R.	crude oils and their components to sea urchin embryos.				
91.	Paper	Smital, T., Terzic, S., Zaja, R., Senta, I., Pivcevic, B., Popovic, M., Mikac, I., Tollefsen, K.E., Thomas, K.V., Ahel, M	Prioritisation of organic contaminants in a river basin using chemical analyses and bioassays	1-12	20(3)	2013	*Environmental Science and Pollution Research*
92.	Communication	Brack, W., Govender, S., Schulze, M., Krauss, M., Hu, M., Hollender, Schirmer, K., Schollee, J., Hidasi, A., Slobodnik, J., Rabova, S., Ait-Aissa, S., Sonavane, M., Carere, M., Lamoree, M., Leonards, P., Tufi, S., Ouyang, X., Schriks, M., Thomas, K.V., de Almeida, A.C., Froment, J., Hammers-Wirtz, M., Ahel, M., Soprivica, S., Hollert., H., Seiler., T.B., Di Paolo, C., Tindall, A., Spirhanzlova, P.	EDA-EMERGE: an FP7 initial training network to equip the next generation of young scientists with the skills to address the complexity of environmental contamination with emerging pollutants	1-7	25	2013	*Environmental Science Europe*
93.	Paper	Schipper, C.A., Leonards, P.E.G., Klamer, H.J.C., Thomas, K.V., Vethaak, A.D.	Protocol for measuring dioxin-like activity in environmental samples using *in vitro* reporter gene DR-Luc assays	1-21	55	2013	*ICES Techniques in Marine Environmental Sciences*
94.	Paper	Reid, M.J., Derry, L., Thomas, K.V.	Analysis of new classes of recreational drugs in sewage: Synthetic cannabinoids and amphetamine-like	72-79	6	2014	*Drug Testing and Analysis*

			substances.				
95.	Preface	Castiglioni, S., Griffiths, P. Kasprzyk-Hordern, B., Me, A., Thomas, K.V.,	Testing the waters: A selection of papers from the first international multidisciplinary conference on detecting illicit drugs in wastewater.	611-612	487	2014	*Science of the Total Environment*
96.	Paper	Castiglioni, S., Thomas, K.V., Kasprzyk-Hordern, B., Vandam, L., Griffiths, P.	Testing wastewater to detect illicit drugs: State of the art, potential and research needs.	613-620	487	2014	*Science of the Total Environment.*
97.	Paper	Reid, M.J., Baz-Lomba, J.A., Ryu, Y., Thomas, K.V.	Using biomarkers in wastewater to monitor community drug use: A conceptual approach for dealing with new psychoactive substances	651-658	487	2014	*Science of the Total Environment*
98.	Paper	Radovic, J.R., Thomas, K.V., Parastar, H., Díez, S., Tauler, R., Bayona, J.M.	Chemometrics-Assisted Effect-Directed Analysis of Crude and Refined Oil Using Comprehensive Two-Dimensional Gas Chromatography–Time-of-Flight Mass Spectrometry.	3074-3083	48	2014	*Environmental Science and Technology*
99.	Paper	Muusse, M., Christensen, G., Langford, K., Tollefsen, K.E., Thomas, K.V.	Aryl Hydrocarbon Receptor Agonists in European Herring Gull (Larus argentatus) Eggs From Norway.	550-556	77	2014	*Journal of Toxicology and Environmental Health, Part A*
100.	Paper	Ort, C., Nuijs, A.L.N., Berset, J-D., Bijlsma, L., Castiglioni, S., Covaci, A., de Voogt, P., Emke, E., Fatta-Kassinos, D., Griffiths, P., Hernández, F., González-Mariño, I., Grabic, R., Kasprzyk-Hordern, B., Mastroianni, N., Meierjohann, A., Nefau, T.,	Spatial differences and temporal changes in illicit drug use in Europe quantified by wastewater analysis	1338-1352	109	2014	*Addiction*

		Östman, M., Pico, Y., Racamonde, I., Reid, M., Slobodnik, J., Terzic, S., Thomaidis, N., Thomas, K.V.					
101.	Paper	Thomas, K.V., Araújo da Silva, F.M., Langford, K.H., D Leão Souza, A., Nizzeto, L., Waichman, A.V.	Screening for Selected Human Pharmaceuticals and Cocaine in the Urban Streams of Manaus, Amazonas, Brazil.	3012-308	2	2014	*Journal of the American Water Resources Association*
102.	Paper	Langford, K., Øxnevad, S., Schøyen, M., Thomas, K.V.	Do anti-parasitic medicines used in aquaculture pose a risk to the Norwegian aquatic environment?	7774-7780	48	2014	*Environmental Science & Technology*
103.	Paper	Oliveira, I.B., Beiras, R., Thomas, K.V., Suter, M.J.F. Barroso, C.M.	Acute toxicity of trlopyril, capsaicin and triphenylborane pyridine to marine invertibrates.	1336-1344	23	2014	*Ecotoxicology*
104.	Critical Review	Gaw, S., Thomas, K.V., Hutchinson, T.H.	Sources, impacts and trends of pharmaceuticals in the marine and coastal environment	1471-2970	369	2014	*Philosophical Transactions of the Royal Society B (Biology)*
105.	Paper	Polesel, F., Lehnberg, K., Dott, W., Trapp, S., Thomas, K.V., Plósz, B.G.	Factors influencing sorption of ciprofloxacin onto activated sludge: Experimental assessment and modelling implications.	105-111	119	2015	*Chemosphere*

Peer Reviewed Conference Proceedings (not submitted herein)

No.	Article type	Authors	Title	Pages	Volume	Year	Journal	Publisher
106.	Conference proceeding	Thomas, K.V., Chadwick, J., Raymond, K., Waldock, M.	The effects of changes in environmental parameters on the release of organic booster biocides from antifouling coatings.	157-170.	2	2001	2nd Volume of the Proceedings of the 10th ICMCF,	DSTO-GD-0287, Melbourne,
107.	Conference proceeding	Thomas, K.V.	The environmental fate and behaviour of antifouling paint booster biocides: A review			2000		Ensus 2000
108.	Conference proceeding	Thomas, K.V., Aldridge, J., Dyer, R., Hilton, M., McHugh, M., Reed,	The occurence, fate and effects of selected antifouling paint booster biocides in	177-195		2004	Proceedings of the international symposium on antifouling paint	

		J., Reynolds, W.J., Tolhurst, L.	UK docks, harbours and marinas			and the marine environment. (Pro. InSAfE)	
109.	Conference proceeding	Thomas, K.V., McHugh, M. Waldock, M.J.	Antifouling paint booster biocides: The current status of inputs and impacts in the UK coastal environment.		2001	Proceedings of OCEANOLOGY 2001, International Pollution Prevention Symposium from Ships and Shipyards, April 4-5 2001, Miami, FL, USA.	Office of Naval Research
110.	Conference proceeding	RA Dyer, JL Balaam, KV Thomas	The development of an autonomous solid phase extraction (SPE) system for environmental monitoring	35	2006	Environmental Research, Engineering & Management	

Non-peer reviewed Journal articles (not submitted herein)

No.	Article type	Authors	Title	Pages	Volume	Year	Journal
111.	Paper	Matthiessen, P., Allen, Y.T., Allchin, C.R., Feist, S.W., Kirby, M.F., Law, R.J., Scott, A.P., Thain, J.E., Thomas, K.V.	Oestrogenic endocrine disruption in flounder (*Platichthys flesus L.*) from UK estuarine and marine waters.		107	1998	CEFAS Technical Report
112.	Paper	Thomas, K.V., Hurst, M.R., Lavender, J., Matthiessen, P., Thain, J.E., Waldock, M.J.	Characterising hazardous substances in the UK marine environment		S:11	2000	*International Council for the Exploration of the Sea, Annual Science Conference (ICES ASC CM)*
113.	Paper	Hylland, K., Becker, G., Klungsøyr, J., Lang, T., McIntosh, A., Serigstad, B, Thain, J.E., Thomas, K.V., Utvick, T.I.R, Vethaack, D., Wosniok, W.	An ICES workshop on biological effects in pelagic ecosystems (BECPELAG): overview of the programme.		X:02	2002	ICES ASC CM
114.	Paper	Serigstad, B, Hylland, K., Becker, G., Klungsøyr, J., Lang, T., McIntosh, A., Thain, J.E., Thomas, K.V., Utvick, T.I.R, Vethaack, D., Wosniok, W.	The use of *in-situ* deployment of live organisms and passive samplers to monitor contaminants in pelagic ecosystems.		X:06	2002	ICES ASC CM.
115.	Paper	Hylland, K., Becker, G., Klungsøyr, J., Lang, T., McIntosh, A., Serigstad, B, Thain, J.E., Thomas, K.V., Utvick, T.I.R,	An ICES workshop on biological effects in pelagic ecosystems (BECPELAG): Summary of results and recommendations.		X:13	2002	ICES ASC CM.

		Vethaack, D., Wosniok, W.					
116.	Paper	Thomas, K.V., Hurst, M.R., Reynolds, W., Klungsøyr, J., Meier, S., J.E.Thain	*In vitro* ecotoxicological assessment of pelagic ecosystems.		X:07	2002	ICES ASC CM
117.	Paper	Thomas, K.V., Balaam, J., Chan-Man, Y., Hurst, M.R., Thain, J.E.	The use of in vitro bioassays and bioassay-directed analysis/TIE in Marine Ecosystem Management.		Z:01	2004	ICES ASC CM
118.	Correspondence	Harman, C., Reid, M., Thomas, K.V.	Concering the viewpoint "An anti-doping sampling strategy utilizing the sewerage systems of sport villages"	4191-4191	45(10)	2011	Environmental Science & Technology

Book Chapters (not submitted herein)

No.	Article type	Authors	Title	Pages	Year	Book	Editor	Publisher/ISBN
119.	Book Chapter	Thomas, K.V., Thain, J., Hurst, M.R., Sheahan, D., Matthiessen, P. and Waldock, M.	Toxicity Identification Evaluation (TIE) of Kennet and Avon Canal (UK) Water Following a Major Fish Kill	350-355	2005	Toxicity Reduction and Toxicity Identifcation Evaluations for effluents, ambient waters, and other aqeous media	Norberg-King, T.	SETAC Press/ 1-880611-64-3
120.	Book Chapter	Thomas, K.V., Thain, J., Hutchings, M., Gurling, A. and Johnson, I.	The Use of Toxicity Identification Evaluation as part of the UK Direct Toxicity Assessment (DTA) Demonstration Project.	344-349	2005	Toxicity Reduction and Toxicity Identifcation Evaluations for effluents, ambient waters, and other aqeous media	Norberg-King, T.	SETAC Press/ 1-880611-64-3
121.	Book Chapter	Thomas, K.V., Hurst, M.R., Matthissen, P. and Waldock, M.	Identification of Estrogen and Androgen Receptor Agonists in Sewage Effluent.	356-364	2005	Toxicity Reduction and Toxicity Identifcation Evaluations for effluents, ambient waters, and other aqeous media	Norberg-King, T.	SETAC Press/ 1-880611-64-3
122.	Book Chapter	Thomas, K.V., Hurst, M.R., Reynolds, W. and Thain, J.E.	*In vitro* Bioassay testing and bioassay-directed analysis of produced and surface water extracts		2006	Biological effects of contaminants in marine pelagic ecosystems	Hylland,K.; Lang, T.; Vethaak, D.	SETAC Press, Brussels
123.	Book Chapter	Hylland, K., Becker, G., Lang, T., McIntosh, A.D., Thain, J.E., Thomas, K.V., Utvik, T.I., Vethaak, A.D., Wosniok, W.	Biological effects of contaminants in pelagic ecosystems- the BECPELAG workshop	3-8	2006	Biological effects of contaminants in marine pelagic ecosystems	Hylland,K.; Lang, T.; Vethaak, D.	SETAC Press, Brussels
124.	Book Chapter	Bakker, J.F., Belzunce-Segarra, M.J., Castro, R., Van De Heuvel-Greve, M.,	Chapter 5. Effect directed analysis and toxicity identification evaluation Sediment Quality and Impact Assessment of Pollutants	163-214	2007	Sediment quality and impact assessment of pollutants. Sustainable Management of Sediment Resources	Barcelo, D. and Petrovic, M.	Elsevier, Brussels

		Klamer, H.J.C., Brack, W., Altenburger, R., Poulsen, V., Thomas, K.V., Leonards, P.E.G.						
125.	Book Chapter	Thomas, K.V. Langford, K.H.	Occurrence of pharmaceuticals in the aqueous environment.	337-359	2007	Comprehensive Analytical Chemistry. Analysis, fate and removal of pharmaceuticals in the water cycle, volume 50	Barcelo, D. and Petrovic, M.	Elsevier, Brussels/ 9780444530523
126.	Book Chapter	Thomas, K.V. Langford, K.H.	The Analysis of Antifouling Paint Biocides in Water, Sediment and Biota. In the Ecotoxicology of Antifouling biocides	311-327	2009	Ecotoxicology of Antifouling biocides	Takaomi Arai, Hiroya Harino, Madoka Ohji and William John Langston.	Springer, Tokyo/
127.	Book Chapter	Thomas, K.V. Langford, K.H.	Monitoring of Alternative Biocides: Europe and USA	331-344	2009	Ecotoxicology of Antifouling biocides	Takaomi Arai, Hiroya Harino, Madoka Ohji and William John Langston.	Springer, Tokyo/
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129.	Book Chapter	Houtman, C.J., Legler, J., Thomas, K.V.	Effect-Directed Analysis of Endocrine Disruptors in Aquatic Ecosystems	237-265	2011	Effect-Directed Analysis of Complex Environmental Contamination The Handbook of Environmental Chemistry	Brack, W.	Springer, Berlin/ 978-3-642-18384-3
130.	Book Chapter	Grung, M., Thomas, K.V.	Environmental effects of pharmaceuticals (in Norwegian)	G23	2012	Norsk legemiddelhåndbok	Fjeldstad, T.	Foreningen for utgivelse av Norsk legemiddelhåndbok
131.	Book Chapter	Harman, C., Allan, I., Thomas, K.V.	Passive sampling of organic contaminants in waters	265-280	2012	Comprehensive Sampling and Sample Preparation. Volume 1: Sampling Theory and Methodology	Pawliszyn, J.	Elsevier, Amsterdam/ 978-0-12-381374-9

Patent applications and other intellectual property rights (Not submitted herein)

No.	Article type	Authors	Title	Registration No.	Date	Status
132.	Design Registration	Harman, C., Reid, M., Thomas, K.V.	PATCH™-Passive sampling device	083428	2012	Granted
133.	Patent application	Allan, I., Langford, K.H., Thomas, K.V.	Method for detoxification or measurement of at least one compound or at least one fluid in a host body	20120485	26.04.2012	Pending

Dedication

This collection of works is dedicated to my collaborator in life, Langford, K.H.

Papers 1-105 have been removed due to copyright restrictions.