COMITÉ NATIONAL DE LA CONCHYLICULTURE

ACTALIA

LCPME
Laboratoire de Chimie Physique et Microbiologie pour les Matériaux et l'Environnement

UMT VIROCONTROL

OXYVIR national observatory

Monitoring viral contamination (norovirus) in shellfish harvesting areas using the "infectious F-specific RNA bacteriophages" indicatorurveillance

WG2 – CCA, 10 june 2026

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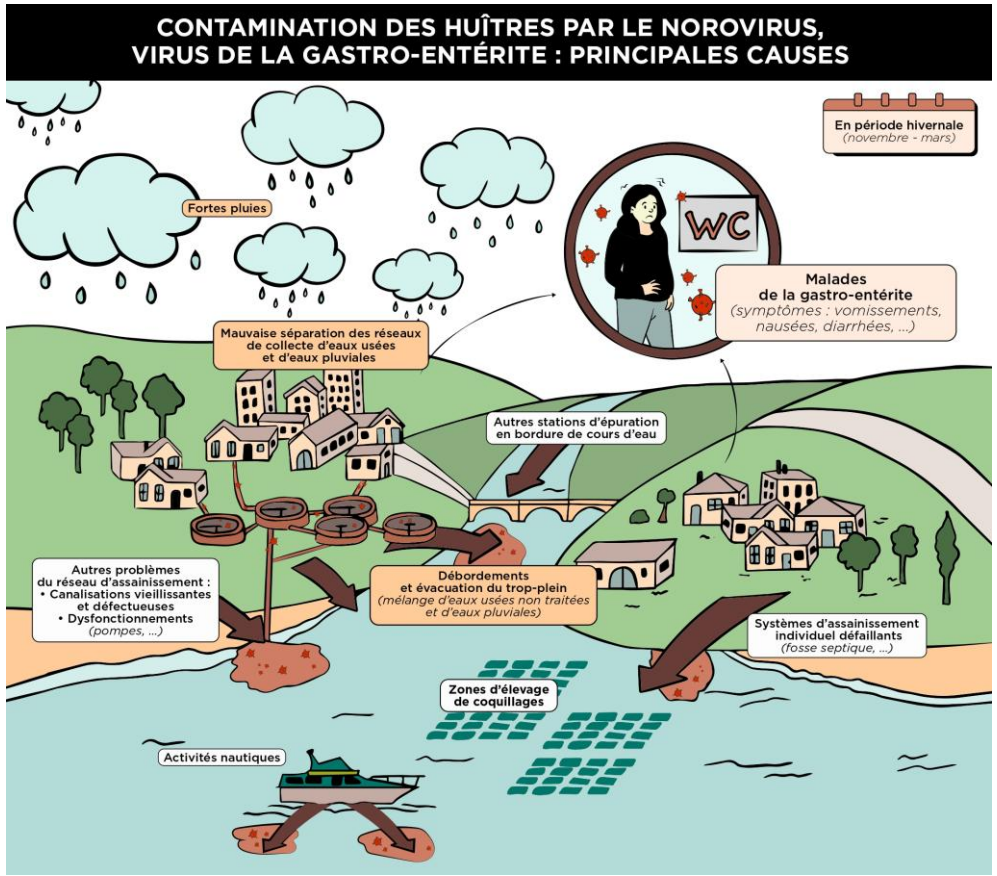
OXYVIR

Shellfish contamination by norovirus

Norovirus

The main virus responsible for acute winter **gastroenteritis** in humans

Direct fecal–oral transmission (person-to-person) or **indirect** transmission (through consumption of water or food)



Consequences for the shellfish industry

- Closure of production areas, suspension of marketing, product withdrawals and recalls, resulting in economic losses during a critical period (year-end holiday season)
- Intense media coverage: impact on the industry's image among consumers

Shellfish producers are affected by the deterioration of coastal water quality and viral contamination

Infectious F-specific RNA bacteriophages as indicators

Observation

Current bacterial indicators (E. coli) only partially reflect the viral risk

Detection of the norovirus genome by RT-PCR provides no information about its infectivity !

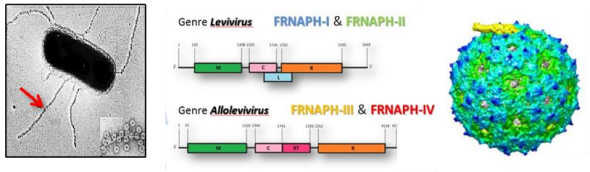
- **Persistence of the norovirus genome** in water and shellfish
- **More rapid loss of viral infectivity** in water and shellfish

Use of **infectious F-specific RNA bacteriophages (FRNAPH)** as an indirect tool to **discriminate** between **infectious and non-infectious noroviruses in oysters**

→ OXYVIR programme

A few words about the OXYVIR programme (EMFF, 2017–2024)

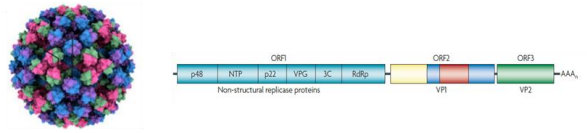
For more than 10 years, almost absolute **scientific demonstration** of the usefulness of a viral indicator (**infectious F-specific RNA bacteriophages** (FRNAPH)) for estimating the presence of **infectious noroviruses** in oysters.



Structure des bactériophages ARN F-spécifiques

~ 3,5 à 4,2 kb
~ 30 nm
90 dimères + protéine A2

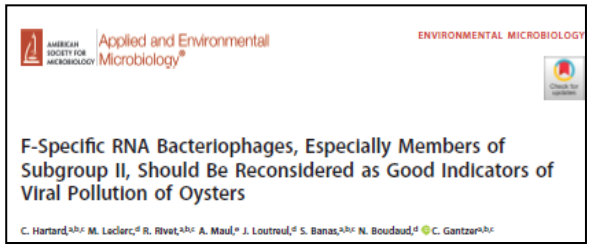
Génome ARN à polarité +
Virus nus
capside icosaédrique



Structure des NoV

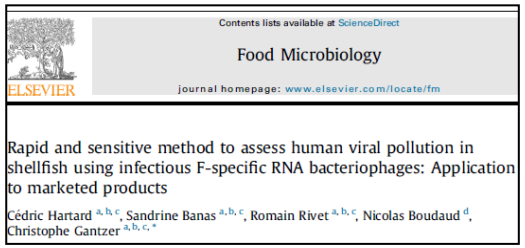
~ 7,5 kb
~ 40 nm
90 dimères VP1 + quelques copies VP2

4 of 7 major scientific references of the concept:


Applied and Environmental Microbiology
ENVIRONMENTAL MICROBIOLOGY

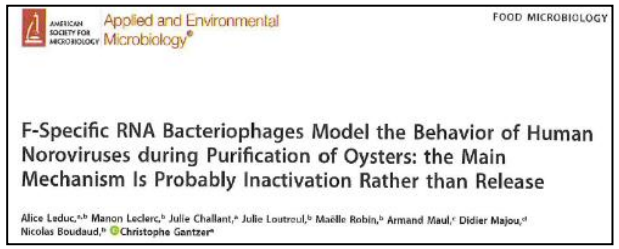
F-Specific RNA Bacteriophages, Especially Members of Subgroup II, Should Be Reconsidered as Good Indicators of Viral Pollution of Oysters

C. Hartard, M. Leclerc, R. Rivet, A. Maul, J. Loutreul, S. Banas, N. Boudaud, C. Gantzer


Contents lists available at ScienceDirect
Food Microbiology
journal homepage: www.elsevier.com/locate/fm

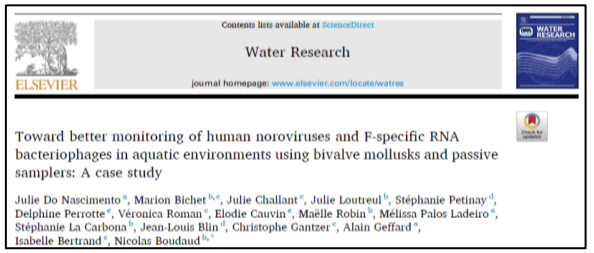
Rapid and sensitive method to assess human viral pollution in shellfish using infectious F-specific RNA bacteriophages: Application to marketed products

Cédric Hartard, Sandrine Banas, Romain Rivet, Nicolas Boudaud, Christophe Gantzer


Applied and Environmental Microbiology
FOOD MICROBIOLOGY

F-Specific RNA Bacteriophages Model the Behavior of Human Noroviruses during Purification of Oysters: the Main Mechanism Is Probably Inactivation Rather than Release

Alice Leduc, Manon Leclerc, Julie Challant, Julie Loutreul, Maëlle Robin, Armand Maul, Didier Majou, Nicolas Boudaud, Christophe Gantzer


Contents lists available at ScienceDirect
Water Research
journal homepage: www.elsevier.com/locate/watres

Toward better monitoring of human noroviruses and F-specific RNA bacteriophages in aquatic environments using bivalve mollusks and passive samplers: A case study

Julie Do Nascimento, Marion Bichet, Julie Challant, Julie Loutreul, Stéphanie Petinay, Delphine Perrotte, Véronica Roman, Elodie Cauvin, Maëlle Robin, Mélissa Palos Ladeiro, Stéphanie La Carbona, Jean-Louis Blin, Christophe Gantzer, Alain Geffard, Isabelle Bertrand, Nicolas Boudaud

Consortium et financement

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European Maritime and Fisheries Fund (EMFF)
eau seine NORMANDIE Agence de l'eau
MINISTÈRE DE L'AGRICULTURE ET DE LA SOUVERAINETÉ ALIMENTAIRE
RÉGION NORMANDIE
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OXYVIR national observatory, dual objective

OXYVIR concept

- Simultaneous detection of norovirus genomes and infectious FRNAPH in oysters = high probability of the presence of infectious noroviruses (**recent viral contamination**)
- Detection of norovirus genomes and absence of infectious FRNAPH in oysters = low probability of the presence of infectious noroviruses (**older viral contamination**)

OXYVIR national observatory

Scientific and operational objectives

1. Validate the reliability of the OXYVIR indicator under field conditions
2. Implement appropriate control measures for each production area (depuration, relaying)
3. Publish the results and promote recognition of the value of infectious FRNAPH in France and across Europe

Winter season 2024-2025

68 shellfish harvesting areas monitored

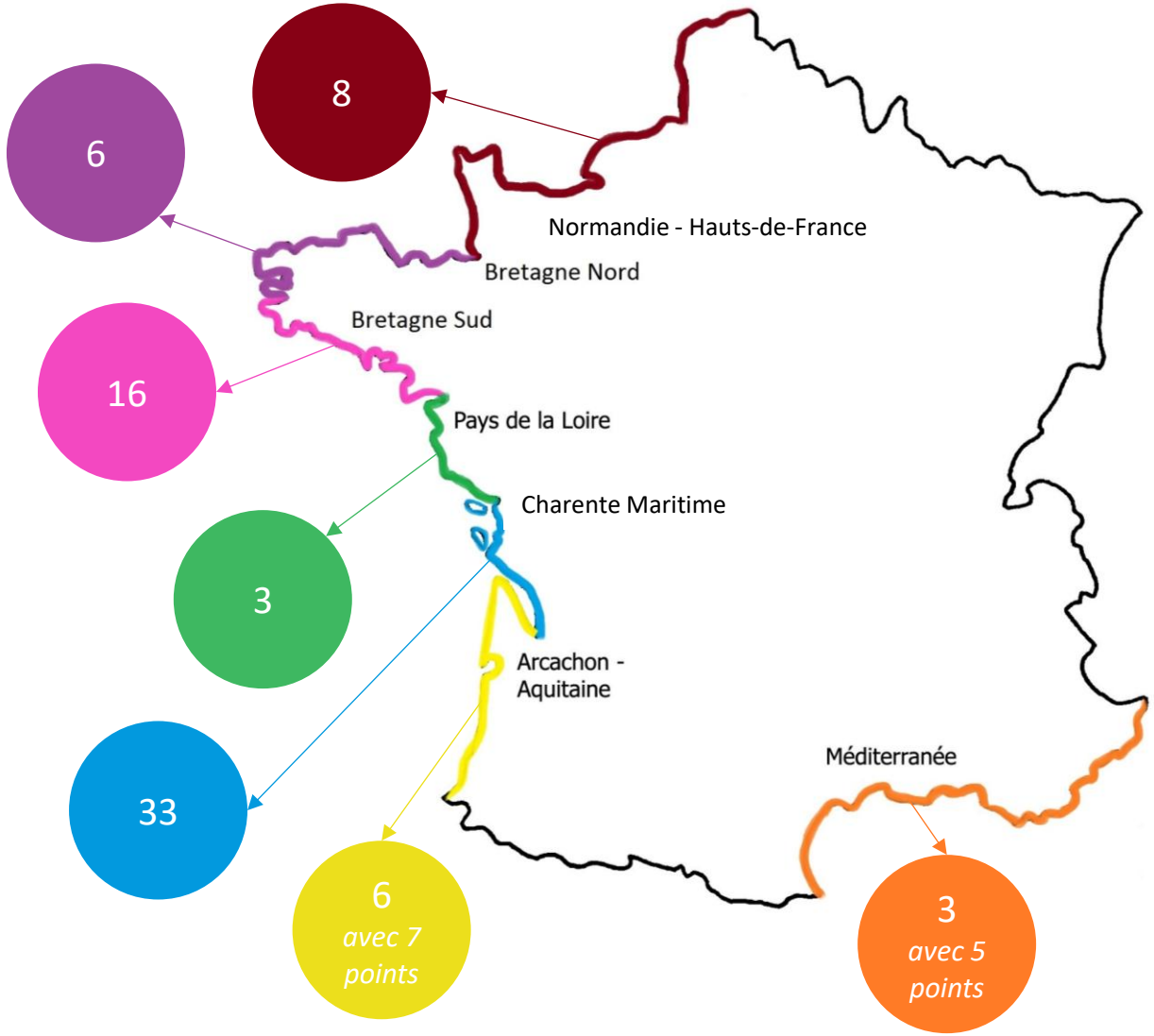
697 batches analysed

Winter season 2025-2026

75 shellfish harvesting areas monitored

795 *batches analysed*

Deployement



Sources of funding

+ self-funding

General methodology

Day 0: samples sent

Sampling points

Shipped cold within 24 hours

Traceability sheet

D+1: receipt of samples

5 laboratories involved

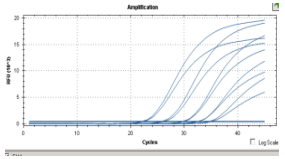
D+1 - D+4: analyses

E. coli *(ISO 16649-3, NF V08-106)*

Total infectious FRNAPH
(Hartard and al., 2018)

GI and GII norovirus genome
(ISO 15216-1, 2017)

FRNAPH-II genome
(Wolf and al., 2010)



D+4 - D+5: dissemination of results

CRC: consolidated data via Noroscope platform

Professionnels: information by e-mail and/or SMS

Saison 2 overwiew, Oct. 2025 – Apr. 2026

- **Norovirus GI and GII genomes in oysters**: identification of three distinct periods across the 75 monitored areas

Norovirus	Nov. - Dec. 2025	Jan. - Feb. 2026	Mar. - Apr. 2026	Total
Batches analysed	264	307	223	794
detected	73	266	150	489
Prevalence (%)	**28%**	**87%**	**67%**	**62%**

- **Saison 1** results (winter 2024-2025):

Norovirus	Nov. - Déc. 2024	Jan. - Fév. 2025	Mars - Avr. 2025	Total
lots analysés	196	278	223	697
détecté	28	173	107	308
Prévalence (%)	**14%**	**62%**	**48%**	**44%**

Summary:

- A pattern similar to winter 2024–2025, with a **higher prevalence** of norovirus genomes
- Combined effect of “acute gastroenteritis + rainfall” from **early January 2026** onwards (late December 2025 in some regions)

Saison 2 overwiew, Oct. 2025 – Apr. 2026

- **Infections FRNAPH in oysters:** identification of three distinct periods across the 75 monitored areas

FRNAPH	Nov. - Dec. 2025	Jan. - Feb. 2026	Mar. - Apr. 2026	Total
Batches analysed	264	308	223	795
> 5 PFU/g	106	181	66	353
Prevalence (%)	**40%**	**59%**	**30%**	**44%**

- **Saison 1** results (winter 2024-2025):

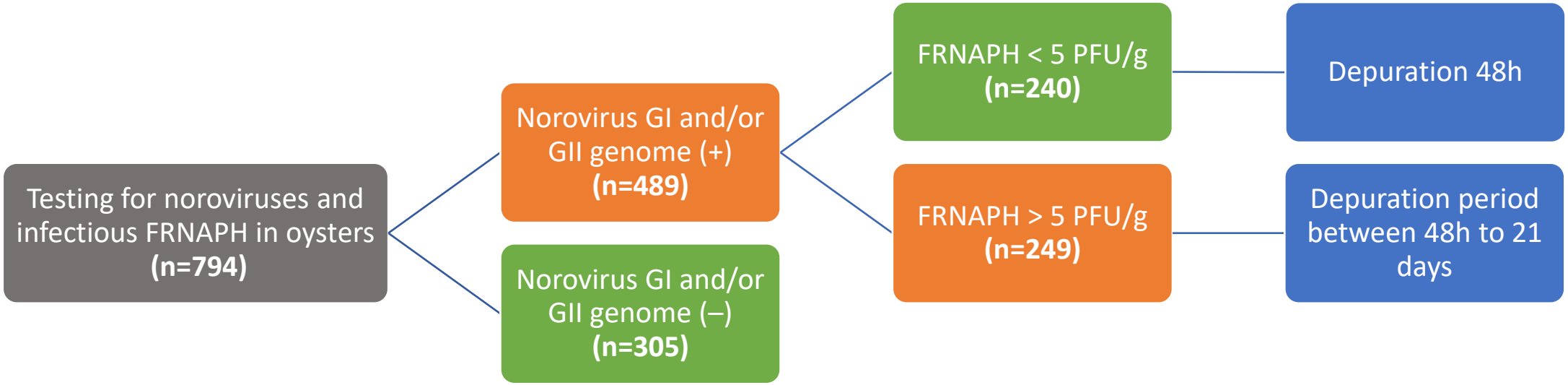
FRNAPH	Nov. - Déc. 2024	Jan. - Fév. 2025	Mars - Avr. 2025	Total
lots analysés	195	277	223	695
> 5 UFP/g	105	161	65	331
Prévalence (%)	**54%**	**58%**	**29%**	**48%**

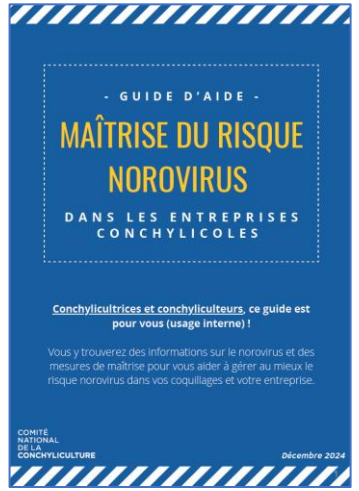
Summary:

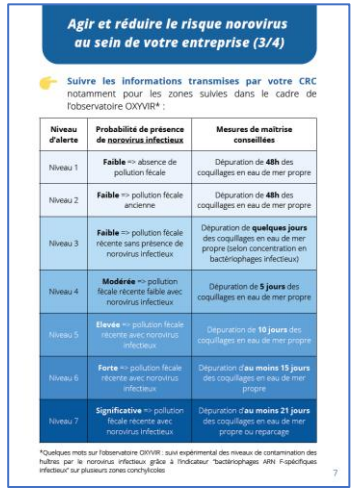
- More pronounced **recent** viral contamination from **January 2026** onwards (late December 2025 in some regions), with a higher probability of the presence of infectious noroviruses

Saison 2 overwiew, Oct. 2025 – Apr. 2026

- **Management of the risk associated with infectious noroviruses**: control measures in accordance with the CNC guidelines







👉 **31% of batches** subject to a control measure between November 2025 and April 2026 (compared with 25% during Season 1)

👉 Vulnerability profiles: a **greater number of areas affected** than during Season 1

Niveau d'alerte	Probabilité de présence de norovirus infectieux	Mesures de maîtrise conseillées	Winter 2024-2025 (n=697)	Winter 2025-2026 (n=795)
Niveau 1	**Faible** => absence de pollution fécale	Dépuration de **48h** des coquillages en eau de mer propre	35%	25%
Niveau 2	**Faible** => pollution fécale ancienne	Dépuration de **48h** des coquillages en eau de mer propre	20%	30%
Niveau 3	**Faible** => pollution fécale récente sans présence de norovirus infectieux	Dépuration de **quelques jours** des coquillages en eau de mer propre (selon concentration en bactériophages infectieux)	21%	13%
Niveau 4	**Modérée** => pollution fécale récente faible avec norovirus infectieux	Dépuration de **5 jours** des coquillages en eau de mer propre	6%	7%
Niveau 5	**Elevée** => pollution fécale récente avec norovirus infectieux	Dépuration de **10 jours** des coquillages en eau de mer propre	14%	15%
Niveau 6	**Forte** => pollution fécale récente avec norovirus infectieux	Dépuration d'**au moins 15 jours** des coquillages en eau de mer propre	2%	6%
Niveau 7	**Significative** => pollution fécale récente avec norovirus infectieux	Dépuration d'**au moins 21 jours** des coquillages en eau de mer propre ou reparcage	2%	4%

Conclusions

- **Control measures:**
  - Alert levels communicated on average **within 2–3 working days** after receipt of the samples
  - Adaptation of farming practices, with most producers extending depuration periods
- **A scenario broadly similar** to that observed during Season 1, although with higher levels of norovirus contamination

- **9 production area closures between Dec. 2025 - March 2026, including 5 areas covered by the OXYVIR observatory**

Closed area	Date of product non-compliance	Sampling date	Norovirus GI genome (copies/g)	Norovirus GII genome (copies/g)	FRNAPH-II genome (copies/g)	Infectious FRNAPH (PFU/g)	*E. coli* (/100 g FIF)
1	19/12/2025	24/12/2025	581	12 462	1 920	**261**	NR
2	06/01/2026	-	*Monitoring started on 04/02/2025 (1,584 cg/g for norovirus; 145 PFU/g for infectious F-RNA bacteriophages)*				
3	17/01/2026	19/01/2026	< LDQ	3 447	*in progress*	**19**	NR
4	03/02/2026	02/02/2026	< LDQ	501	*in progress*	**15**	110
5	24/02/2026	17/02/2026	NR	NR	*NR*	**151**	NR

LDQ : 200 copies/g

Perspectives

- Scientific publication of results from the OXYVIR observatory (seasons 1 and 2)
- Referral to ANSES for an expert assessment of the OXYVIR observatory and indicator
- Long-term continuation of the OXYVIR observatory in France, along with the integration of wastewater-based epidemiology (WBE) to monitor the epidemic circulation of noroviruses in wastewater treatment plants (WWTPs) located in coastal areas representative of the monitored regions → funding search
- **Scaling up of the OXYVIR observatory at European level by 2027 to facilitate its adoption within the EU; interested countries identified → search for the most suitable funding call (upcoming meeting within AEPM)**

Winter season	Number of closed areas	Cumulative number of closure days (from the dates of non-compliance of products)	Affected areas
2019 - 2020	37 zones	1 344 days	9 areas
2020 - 2021	16 zones	492 days	4 areas
2021 – 2022 (Covid-19)	4 zones	124 days	2 areas
2022 - 2023	19 zones	611 days	6 areas
2023 - 2024	25 zones	682 days	9 areas
2024 - 2025	5 zones	72 days	3 areas
2025 - 2026	12 zones	567 days (several areas within the same territory)	5 areas

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UMT VIROCONTROL

Thank you for your attention, any question?

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OXYVIR