

BIOASSAYS OF NORTH PORT ST. LUCIE SEWAGE TREATMENT PLANT (GENERAL DEVELOPMENT CORPORATION) PORT ST. LUCIE, ST. LUCIE COUNTY, FLORIDA

NPDES #FL0024945

Biological Section
Bureau of Water Analysis
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INTRODUCTION

The North Port St. Lucie Sewage Treatment Plant is a General Development Corporation facility located in St. Lucie County (Figure 1). It has a design capacity of 2.0 MGD but is currently operating at partial capacity serving a local residential community of approximately 5,000 people. Treatment of wastewater includes communition, extended aeration, final settling using clarifiers, chlorination and a polishing pond system. Sludge is anaerobically digested, dried, and disposed of on company owned land. The effluent is discharged via the polishing ponds to drainage ditches which flow into the Oceanbreeze Waterway, a portion of the St. Lucie River.

On 13 to 15 May, 1981, the Biological Section performed static toxicity bioassays on a sample of effluent from the North Port St. Lucie Sewage Treatment Plant to determine the existence and extent of toxicity to the biota of the receiving waters. The results of these tests are presented in this report.

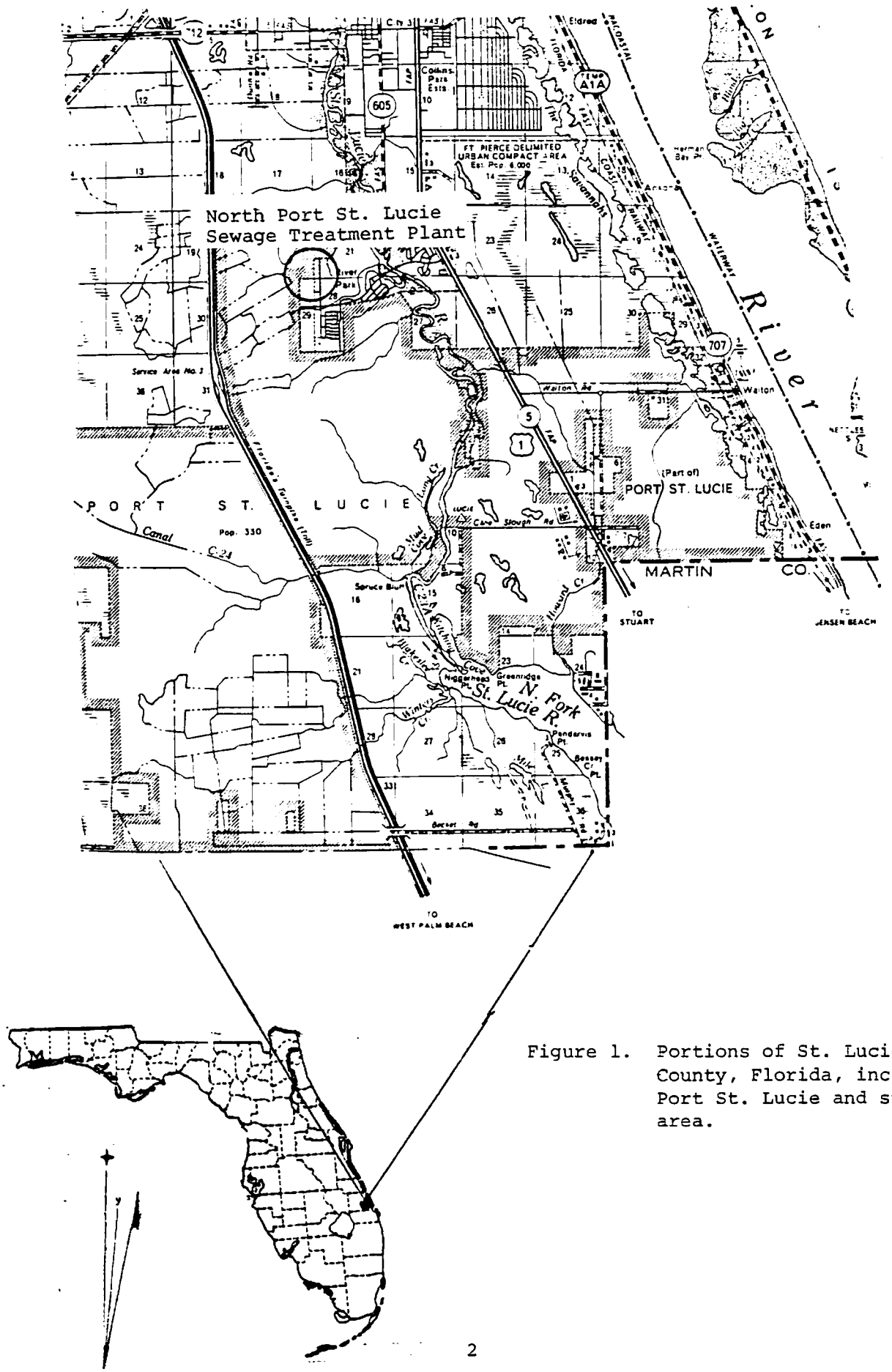


Figure 1. Portions of St. Lucie County, Florida, including Port St. Lucie and study area.

METHODS AND MATERIALS

Test methods used to conduct these static bioassays are extensively described by Peltier (1978). The organisms selected for this study include species recommended by Peltier (1978) and the U.S. EPA (1978). Additionally, the Biological Section maintains cultures of several species of organisms indigenous to the State of Florida. Life histories of these test organisms and maintenance procedures used to culture them are detailed below.

History and Maintenance of Bioassay Organisms

Daphnia pulex (water flea) - A breeding culture of Daphnia pulex was obtained from the EPA laboratory in Athens, Georgia in March, 1979. This culture has been maintained since its arrival, in 2½ gallon all glass aquaria filled with unchlorinated DER well water, using a 16:8 hour light-dark cycle. Organisms are fed a liquified blend of Purina Trout Chow® and Cerophyl® twice daily, and are kept at a constant temperature of 22° ± 1°C. The aquaria are cleaned weekly by siphoning off half the water along with the detritus and excess daphnids. They are then refilled with fresh aerated well water. Additional measures are taken and/or new cultures started in the event of abnormal circumstances such as: declining populations, ephippia formation, or excessive fungal or bacterial growth.

Heterandria formosa (least killifish) - Approximately 100 adult killifish were obtained from a wild population in the St. Marks Wildlife Refuge (Wakulla County, Florida) during August, 1980. The fish have been maintained in 2½ to 5 gallon all glass aquaria under brackish conditions. Each aquarium is equipped with undergravel filters. Water for this system is unchlorinated and is pumped from a deep well near the DER laboratory. This water is adjusted to 5 ppt salinity by adding an appropriate amount of Turkey Point seawater. The fish have been reared at 22° ± 2°C under a 16:8 hour light-dark cycle and are fed freshly hatched Artemia (brine shrimp) twice daily. New born fish are initially maintained in the adult tanks, but are removed at weekly intervals, thereby segregating fish into even age groups. The fish used in this test were 1 to 4 weeks old.

Mysidopsis bahia (mysid shrimp) - In September, 1978, approximately 300 adult mysid shrimp were obtained from the Gulf Breeze EPA Laboratory in Pensacola, Florida. The mysids have been cultured under continuous lighting in 10 and 15 gallon all glass aquaria equipped with undergravel filtration and aeration. The mysid shrimp are cultured over a wide range of salinities (10-30 ppt) to minimize acclimation periods to low or high salinity effluents. Seawater is obtained from the FSU Marine Laboratory located at Turkey Point, Florida (salinity range 17-31 ppt) and partial water changes are performed weekly. Freshwater, for dilution of the seawater as necessary, is obtained from a deep well near the DER laboratory. The mysids are fed twice daily with freshly hatched Artemia (brine shrimp) and are kept at a constant temperature of 22° ± 1°C.

To ensure the uniform sensitivity of these test organisms to toxic substances, the Biological Section conducts monthly Standard Reference Toxicant Bioassays using sodium lauryl sulfate as the reference toxicant.

Test Methods

Three separate 48 hour static bioassays were conducted from 1030 hours on 13 May, 1981 to 1100 hours on 15 May, 1981, on a grab sample of effluent from Outfall #001. The sample was collected by Mr. Greg Graves from DER's Port St. Lucie Office using standard wastewater sampling procedures at 1130 hours on 12 May, 1981. The sample was iced and transported to the DER laboratory in Tallahassee within 24 hours of collection.

Since effluent from this facility is freshwater and it flows through brackish drainage ditches to a saltwater river, we elected to use three different organisms to test for toxicity to biota of the respective aquatic systems. The water flea, Daphnia pulex, was used for the freshwater test; the least killifish, Heterandria formosa was used for the brackish water test; and the mysid shrimp, Mysidopsis bahia, was used for the saltwater test. Methods used for these tests are as follows.

Freshwater Test

Freshwater for dilution of the effluent sample was obtained from the same DER deep well that is used to culture the test organisms. The concentration series selected for this study (Table 1) is that recommended by APHA (1976). Two replicates, each with six concentrations and a control, were used to test with Daphnia pulex. Flint glass jars of 250 ml capacity were used as test chambers, and 200 ml of the appropriate test concentration was placed in each chamber. Daphnia were transferred into a large culture dish through a stainless steel screen to isolate the proper size and age organisms (neonates). These neonates were then transferred individually by glass pipette and were loaded 10 per chamber, resulting in 20 per test concentration.

Dissolved oxygen, pH, temperature and the number of live organisms were recorded for each test chamber at 0 hours, 24 hours and 48 hours. Total alkalinity and total hardness were recorded at the beginning and end of the test for the controls and the 100% effluent concentration. Specific conductivities were recorded for each test concentration at the beginning and end of the test. Additionally, ammonia concentrations, including total and unionized fractions[1], were recorded for a control and the 100% effluent at the beginning of the test.

Brackish Water Test

For the Brackish Water Test using Heterandria formosa, a portion of the effluent was salinity adjusted to 4.4 ppt using artificial sea salts (Ocean 50 ®). Also, the diluent used for this test (Turkey Point seawater, salinity = 31 ppt) was diluted with DER well water until a salinity of approximately 4 ppt was

[1] Total ammonia concentrations are expressed as mg/l as N and unionized ammonia concentrations are expressed as mg/l as NH_3.

achieved. This procedure resulted in a final salinity of approximately 4 ppt in each test concentration, the salinity at which the Heterandria were cultured. Two control groups were then used to ensure that any mortality in the test organisms was not the result of toxic properties associated with the artificial sea salts or to the diluted seawater. These included: artificial sea salt (Ocean 50®) adjusted well water (4.3 ppt salinity), and a diluent control (4.0 ppt salinity).

Two replicates, of six concentrations and the two controls, were used for this bioassay. The fish were transferred individually or by twos, by net, into wide mouth quart jars containing 500 ml each of the appropriate test concentration. Heterandria were loaded 5 per chamber resulting in 10 per concentration. The concentration series selected for this study (Table 1) is that recommended by APHA (1976).

Dissolved oxygen, pH, temperature, and the number of live organisms were recorded for each test chamber at 0 hours, 24 hours and 48 hours. These values were recorded on the bioassay data forms and are presented in Table 3. Organisms were not fed during this test.

Saltwater Test

For the Saltwater Test using Mysidopsis bahia, a portion of the effluent was salinity adjusted to 7.0 ppt using artificial sea salts (Ocean 50®). The diluent used for this test (Turkey Point seawater, salinity = 31 ppt) was diluted with well water until a salinity of approximately 7.0 ppt was again achieved. This procedure resulted in a final salinity of approximately 7.0 ppt in each test concentration, the lower limit of mysid shrimp tolerance. Two control groups were then used to ensure that any mortality in the test organisms was not the result of toxic properties associated with the artificial sea salts or to the diluted seawater. These included: artificial sea salt (Ocean 50®) adjusted well water to 6.8 ppt salinity, and a diluent control at 7.0 ppt salinity.

Two replicates of each test concentration and the controls were used in this static test. Immediately prior to the bioassays, a suitable number of mysids were transferred by net from the 10 ppt salinity aquarium to a culture dish for observation and selection of individuals for the tests. Individual 10 to 15 day old (three-quarter adult size) mysid shrimp were siphoned via glass tube, carefully examined for injury and transferred to wide mouth quart jars, each containing 500 ml of the appropriate concentration. For each concentration the mysid shrimp were pre-acclimated to within 3 ppt salinity. The concentration series selected for this study (Table 1) are those recommended by the APHA (1976).

Five organisms were loaded per test chamber, giving ten per concentration. Temperature, pH, dissolved oxygen, and the number of live organisms were recorded at 0, 24 and 48 hours for each test chamber (Table 4). According to EPA (1978), "Although it is generally undesirable to feed most fish and macroinvertebrates during static toxicity tests, an exception is necessary for M. bahia". Therefore, the mysids were fed bring shrimp (Artemia) nauplii at the rate of approximately 10 to 20 per mysid shrimp to minimize cannibalism.

Table 1. Concentration Series and Volumes Used for These Static Bioassays

Water flea (Daphnia pulex)

Concentration	Dilution Water	Effluent	Total Vol.
Control	200 ml	---	200 ml
5.6%	188.8 ml	11.2 ml	200 ml
10.0%	180 ml	20 ml	200 ml
18.0%	164 ml	36 ml	200 ml
32.0%	136 ml	64 ml	200 ml
56.0%	88 ml	112 ml	200 ml
100%	----	200 ml	200 ml

Killifish (Heterandria formosa) and Mysid shrimp (Mysidopsis bahia)

Concentration	Dilution Water	Effluent	Total Vol.
Control	500 ml	---	500 ml
5.6%	472 ml	28 ml	500 ml
10.0%	450 ml	50 ml	500 ml
18.0%	410 ml	90 ml	500 ml
32.0%	340 ml	160 ml	500 ml
56.0%	220 ml	280 ml	500 ml
100%	---	500 ml	500 ml

Table 2. Data recorded during 48 hour, Daphnia pulex, static acute toxicity bioassay of North Port St. Lucie Sewage Treatment Plant, St. Lucie County, Florida, NPDES #FL0024945, Outfall #001 on 13 to 15 May, 1981.

Freshwater Test.

Conc. or %	Number of Live Organisms			Dissolved Oxygen (mg/ℓ)			pH			Total Alkalinity (mg/ℓ as $CaCO_3$)		Total Hardness (mg/ℓ as $CaCO_3$)		Temperature (°C)			NH_3/NH_3+NH_4 (mg/ℓ)		Conductivity (μmhos)	
	0	24	48	0	24	48	0	24	48	0	48	0	48	0	24	48	0	48	0	48
Control	10	10	10	8.7	8.8	8.9	7.7	8.1	8.1	118	120	120	114	21.4	20.7	20.2	0/.05	-		
Control	10	10	10	8.7	8.9	9.0	7.7	8.1	8.1										210	235
5.6%	10	10	10	8.8	8.9	9.0	7.8	8.1	8.1					21.3	20.5	20.2				
5.6%	10	10	10	8.8	9.0	9.0	7.8	8.1	8.1										238	240
10.0%	10	10	9	8.8	9.0	9.0	7.8	8.0	8.1					21.3	20.4	20.4				
10.0%	10	10	10	8.8	9.0	9.0	7.8	8.1	8.1										260	260
18.0%	10	10	10	8.8	9.0	8.9	7.9	8.0	8.1					21.5	20.4	20.2				
18.0%	10	10	10	8.8	9.0	8.9	7.9	8.1	8.1										298	295
32.0%	10	10	10	8.8	9.0	8.9	7.9	8.1	8.1					21.6	20.4	20.1				
32.0%	10	10	10	8.8	9.0	8.9	7.9	8.1	8.1										359	350
56.0%	10	10	10	8.8	9.0	9.0	8.0	8.1	8.1					22.0	20.4	20.1				
56.0%	10	10	10	8.8	9.0	9.0	8.0	8.1	8.1										478	500
100%	10	10	10	8.7	9.0	9.1	8.3	8.0	8.1	100	148	100	109	22.6	20.8	20.3	.01/.11	-		
100$	10	10	10	8.7	9.0	9.1	8.3	8.0	8.1										720	690

Remarks: Total Chlorine Residual = Not Detected (HACH DPD)

Table 3. Data recorded during 48 hour, Heterandria formosa, static acute toxicity bioassay or North Port St. Lucie Sewage Treatment Plant, St. Lucie County, Florida, NPDES #FL0024945, Outfall #001 on 13 to 15 May, 1981.

Brackish Water Test.

Conc. or %	Number of Live Organisms			Dissolved Oxygen (mg/l)			pH			Total Alkalinity (mg/l as $CaCO_3$)		Total Hardness (mg/l as $CaCO_3$)		Temperature (°C)			NH_3/NH_3+NH_4 (mg/l)		Salinity (ppt)
	0	24	48	0	24	48	0	24	48	0	48	0	48	0	24	48	0	48	0
Sea salt Control	5	5	5	8.7	7.2	7.3	8.3	7.8	7.7					21.7	20.4	20.1			4.3
Sea salt Control	5	5	5	8.8	7.5	7.6	8.3	7.9	7.7										
Seawater Control	5	5	5	8.8	7.6	7.6	7.8	7.8	7.7					21.3	20.6	20.4			4.0
Seawater Control	5	5	5	8.8	7.6	7.5	7.8	7.8	7.7										
5.6%	5	5	5	8.9	7.6	7.6	7.8	7.8	7.6					21.2	20.3	20.0			4.0
5.6%	4[a]	4	4	8.8	7.5	7.3	7.8	7.8	7.6										
10.0%	5	5	5	8.9	7.7	7.6	7.9	7.8	7.7					21.2	20.2	20.0			4.0
10.0%	1[b]	1	1	8.9	8.3	8.4	7.9	7.9	7.8										
18.0%	5	5	5	8.9	8.1	7.9	7.9	7.9	7.8					21.2	20.1	20.2			4.0
18.0%	5	5	5	8.9	8.0	8.0	7.9	7.9	7.8										
32.0%	5	5	5	8.9	7.5	7.8	8.1	7.9	7.7					21.3	20.0	20.2			4.2
32.0%	5	5	5	8.9	7.6	7.8	8.1	7.9	7.7										
56.0%	5	5	5	8.9	7.6	7.8	8.3	7.9	7.7					21.7	20.1	20.2			4.3
56.0%	5	5	5	8.9	7.9	8.2	8.3	7.9	7.8										
100%	5	5	5	8.8	7.4	8.1	8.6	8.0	7.9					22.6	20.5	20.4			4.4
100%	5	5	5	8.8	7.8	8.4	8.6	8.0	7.8										

Remarks: a. Only four organisms were loaded in this container.
b. Only one organism was loaded in this container.

Average weight of fish = .032 g each.

Table 4. Data recorded during 48 hour, Mysidopsis bahia, static acute toxicity bioassay of North Port St. Lucie Sewage Treatment Plant, St. Lucie County, Florida, NPDES FL0024945, Outfall #001 on 13 to 15 May, 1981.

Saltwater Test.

Concentration or	Number of Live Organisms			Dissolved Oxygen (mg/ℓ)			pH			Temperature (°C)			NH_3/NH_3+NH_4 (mg/ℓ)		Salinity (o/oo)
	0	24	48	0	24	48	0	24	48	0	24	48	0	48	0
Sea salt Control	5	5	5	8.9	7.3	6.1	8.7	8.1	7.7	21.7	20.6	20.5			6.8
Sea salt Control	5	4	4	8.9	6.7	5.6	8.7	8.1	7.8						
Seawater Control	5	5	4(5)[a]	8.9	6.8	6.0	8.0	7.9	7.7	21.4	20.7	20.8			7.0
Seawater Control	5	5	5	8.9	6.6	5.9	8.0	7.8	7.8						
5.6%	5	5	5	8.9	7.0	5.4	8.0	7.8	7.5	21.1	20.4	20.2			7.0
5.6%	5	5	5	8.9	6.8	5.4	8.0	7.8	7.5						
10.0%	5	5	5	8.9	6.7	5.0	8.0	7.8	7.5	21.1	20.2	20.2			7.0
10.0%	5	5	5	8.9	6.8	5.3	8.0	7.8	7.5						
18.0%	5	4	4	8.9	6.9	5.5	8.1	7.8	7.5	21.2	20.3	20.4			7.0
18.0%	5	5	5	8.9	6.7	5.0	8.1	7.8	7.5						
32.0%	5	5	5	8.9	6.9	5.3	8.3	7.8	7.5	21.4	20.3	20.2			7.0
32.0%	5	5	5	8.9	6.6	5.2	8.3	7.9	7.5						
56.0%	5	5	5	8.9	6.0	5.2	8.5	7.9	7.6	21.9	20.4	20.2			7.0
56.0%	5	5	5	8.9	6.0	5.3	8.5	7.9	7.6						
100%	5	4	4	8.8	6.3	6.1	8.9	8.2	7.7	22.5	20.7	20.6			7.0
100%	5	5	5	8.8	6.3	6.2	8.9	8.2	7.7						

Remarks: a. Number in parentheses used in calculations since one organism jumped out of the test container.

RESULTS AND DISCUSSION

This particular sample of effluent from the North Port St. Lucie Sewage Treatment Plant was essentially non-toxic. Only one Daphnia pulex (Freshwater Test, Table 2) and two Mysidopsis bahia (Saltwater Test, Table 4) had died by the end of the test. No Heterandria formosa (Brackish Water Test, Table 3) died during the test.

LITERATURE CITED

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