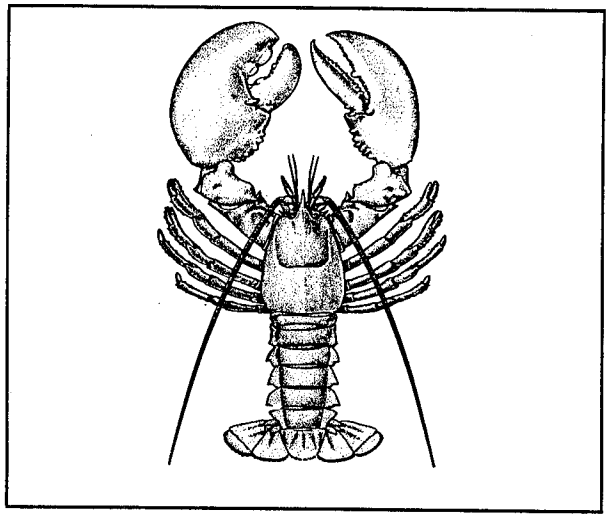
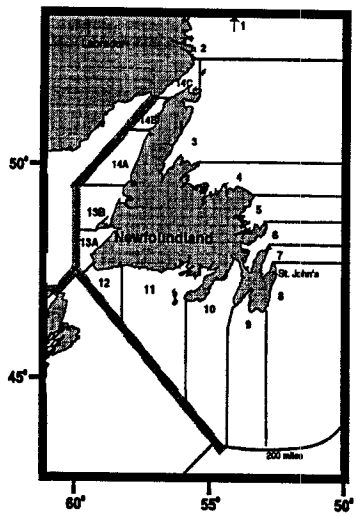




Newfoundland lobster fishing areas (LFA's).

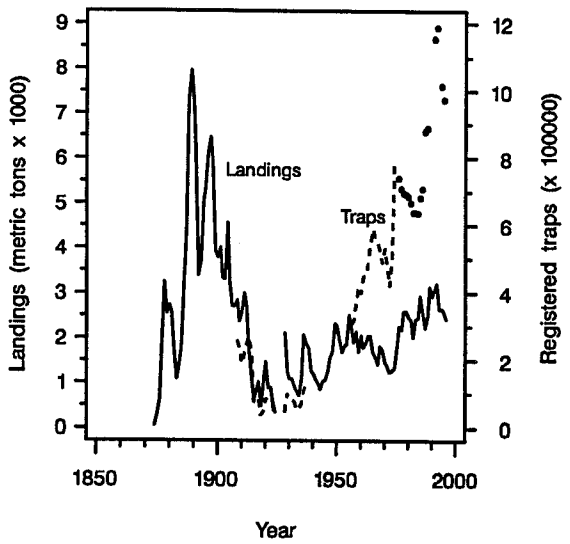
STOCK STATUS REPORT LOBSTER

Background

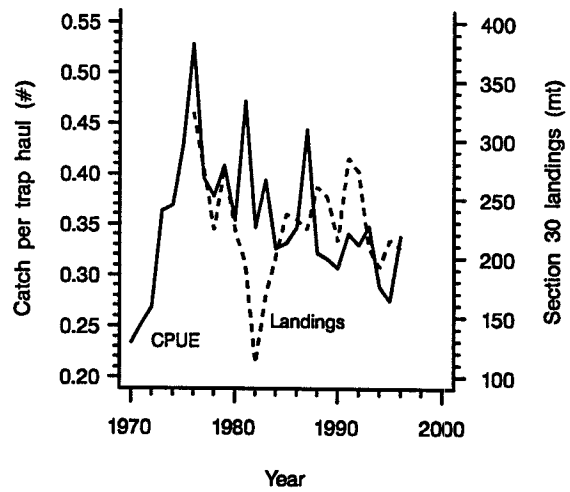
Lobsters are distributed nearshore around the island of Newfoundland and along the Strait of Belle Isle portion of the Labrador coast. Populations are localized. The major life history events occur during mid-July to mid-September following the spring fishing season. It takes 8-10 years from hatching to recruit to the fishery. At the minimum legal size of 81 mm carapace length (CL) about 50% of the non-ovigerous females will spawn during summer. At smaller sizes many of the ripe females molt and spawn in the same summer. Once spawning has occurred an alternate year molt/lay sequence (i.e. a 2-year reproductive cycle) is the norm. This means that the majority of females have to survive at least one season of very intensive fishing before they spawn. Spawny females are protected from exploitation. Eggs are brooded under the female's abdomen for about a year before hatching and larval release. During the 6-10 week planktonic phase there are three molts and during the last of these metamorphosis to a postlarval stage occurs. This stage is equipped with swimming and behavioural capabilities designed to locate suitable settling habitat. However, the extent to which postlarval settlement originates with eggs produced in the same area is unknown. Fishing is carried out from small open boats during an 8-10 week spring season. Traps are set close to shore in depths generally less than 15-20 m. Fishing effort is controlled through restrictive licencing and trap limits. The number of licences is currently around 3800 and trap limits vary between lobster fishing areas (LFA's) from 100 to 425. A downward trend starting in the mid 1950's saw landings drop to 1238 t in 1972. The trend reversed during the 1970's. Landings increased to 2592 t by 1979 and reached a long-term (since 1905) high of 3207 t in 1992. Landings have been declining in recent years (2413 t valued at $20.8 million in 1996), much more severely in some LFA's than in others. Declines have been widespread and substantial in some areas leading to concern with the possibility of a new long-term downward trend.

The Fishery

The recent history of the Newfoundland fishery is dominated by the sudden reversal of a downward landings trend that saw landings increase from 1238 t in 1972 to 2592 t in 1979. Landings continued to increase and reached a long-term (since 1905) high of 3207 t in 1992. The timing and extent varied between LFA's but this trend was part of a pattern that occurred more or less throughout the range of the species. Although the phenomenon is not well understood, its widespread nature indicates a period of strong recruitment during the 1970's associated with favourable environmental/ ecological factors. The extent to which the generally high level of recruitment since then has been maintained by continued favourable conditions or by increased egg production at the high level of abundance or by a combination of the two is unknown. Landings have generally been declining in recent years and were down to 2413 t in 1996. This decline is also part of a widespread pattern in Atlantic Canada.



Historical landings and effort for the Newfoundland lobster fishery.



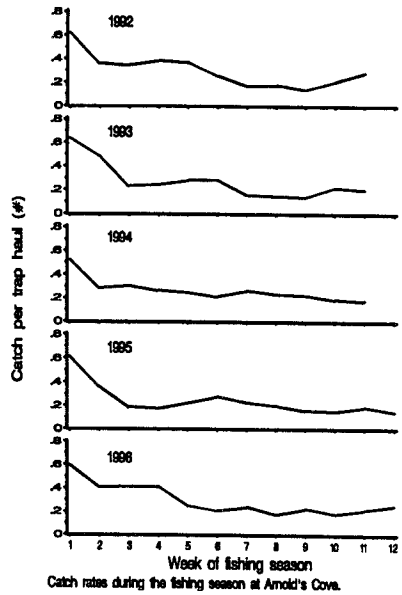
Average seasonal catch rates at Arnold's Cove with annual landings for the Statistical Section in which it is located.

Up until 1976, effort in the Newfoundland lobster fishery, in terms of both licences and the number of traps that could be fished per licence, was uncontrolled. A limited entry licencing policy was implemented in 1976. The number of licences issued dropped from 5992 to around 3800 in 1997 but the number of registered traps increased sharply with introduction of uniform trap limits for west coast LFA's in 1987 and for east and south coast LFA's in 1991. This number has been declining since 1992 due to trap limit reductions in some LFA's.

Resource Status

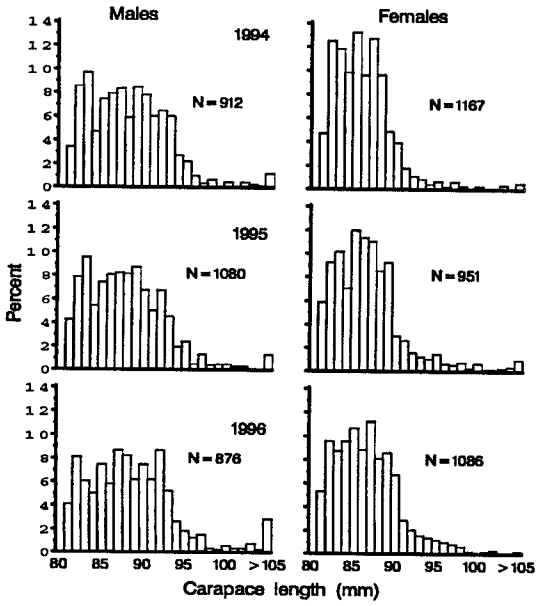
Monitoring has included a voluntary research logbook program and dockside (post cull) sampling of commercial catches throughout the fishing season at five localized fishing sites starting in the late 1960's - early 1970's. This was discontinued at two west coast sites in 1982. It was re-established on the west coast in 1994 with five sites selected for logbooks and at-sea sampling of commercial catches.

Average seasonal catch rates have ranged widely over the time series and vary considerably from year to year. Variability tends to coincide with landings. Catch rates are usually highest early in the season, even though bottom temperature and lobster catchability are low, and decline rapidly as the season progresses. Departures from this general pattern are common and are caused by anomalously low temperature, weather and ice conditions, and changing fishing patterns.

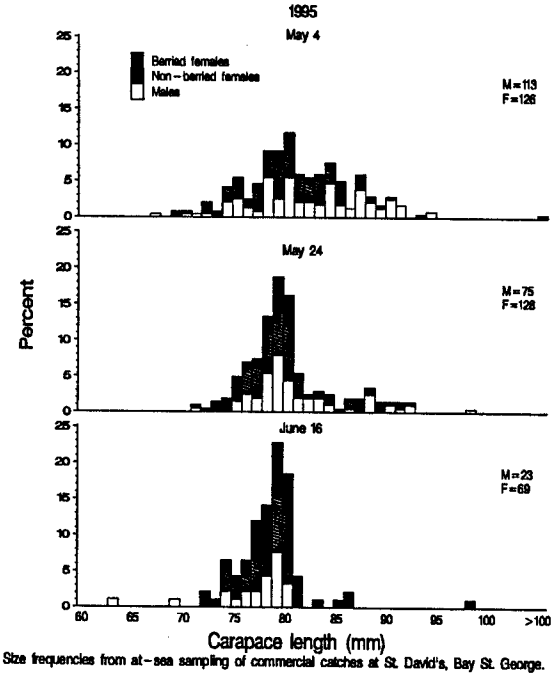


Catch rates during the fishing season at Arnold's Cove.

Size frequencies from dockside commercial catch sampling show that most of the landings are in the recruit size range (81-93 mm for males, 81-90 mm for females). Size frequencies from at-sea sampling illustrate the almost complete removal of commercial lobsters from local populations over the course of the fishing season.



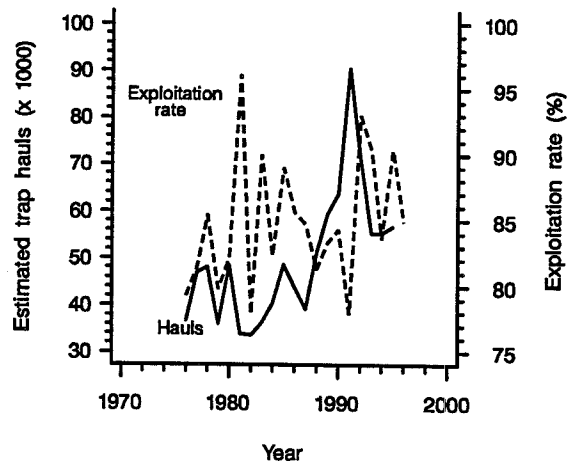
Size frequencies from commercial catch sampling at Arnold's Cove.



Size frequencies from at-sea sampling of commercial catches at St. David's, Bay St. George.

Detailed analyses of various components of long-term fishery and population monitoring at the Arnold's Cove, Placentia Bay study site provide results that are considered generally representative of Newfoundland lobster populations.

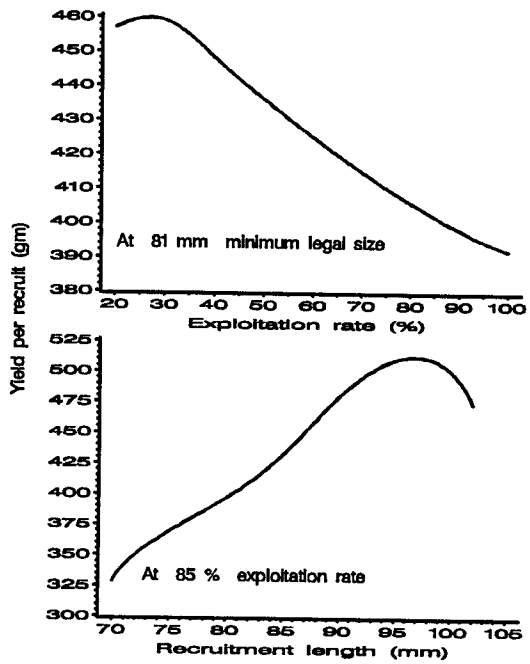
Estimated trap hauls for the season and tag-recapture estimates of exploitation rate show considerable inter-annual variation but no consistent pattern between the two is evident. Exploitation rates in excess of 85-90% have occurred regularly over the past 15-20 years.



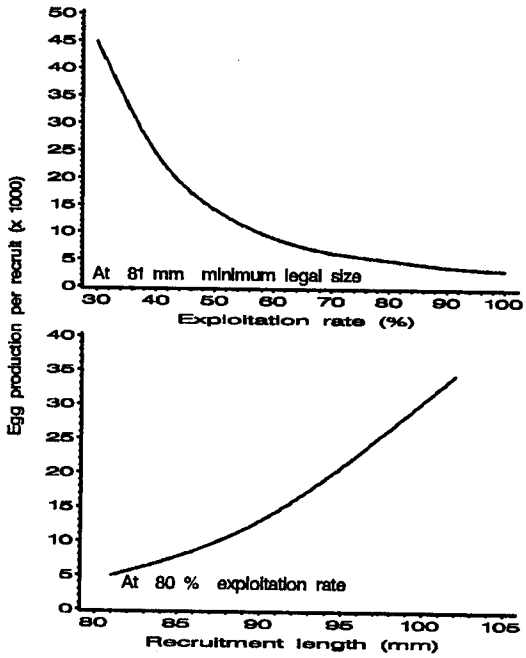
Estimated trap hauls for the season and exploitation rates at Arnold's Cove.

Lobster fisheries are characterized by high exploitation rates and size limits that are small in relation to growth rate and size at maturity. Yield per recruit analyses demonstrate growth overfishing in Newfoundland populations. Results for Arnold's Cove indicate that yield per recruit could be increased by as much as 27%, however, the increase in size limit and/or reduction in exploitation rate required would mean a substantial reduction in catch in the year a change is implemented with benefits realized in subsequent years. Egg per recruit analyses for this population show that egg production is severely constrained

towards the low end of the potential range. Egg production per female recruit could be more than doubled with much more moderate shifts in the management regime than would be required to maximize yield per recruit.

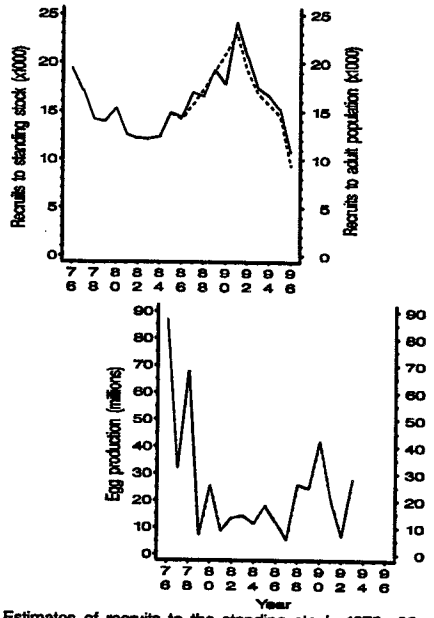


Yield per recruit analyses for the Arnold's Cove lobster population.

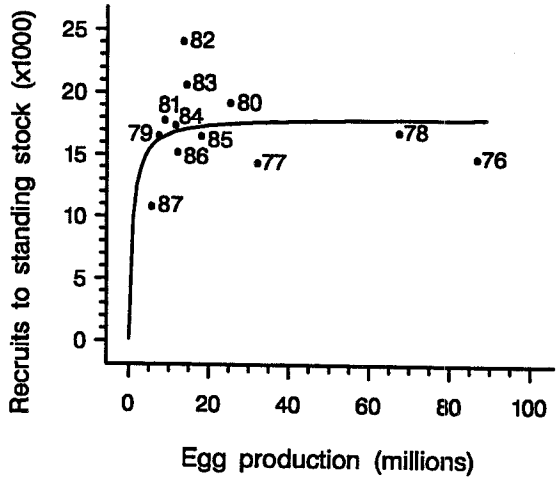


Egg per recruit analyses for the Arnold's Cove lobster population.

Using a 9-year lag between egg production and subsequent recruitment to the fishery, the estimates for Arnold's Cove indicate an asymptotic stock-recruitment relationship with a very steep ascending limb near the origin. This suggests a high degree of resilience to fishing.



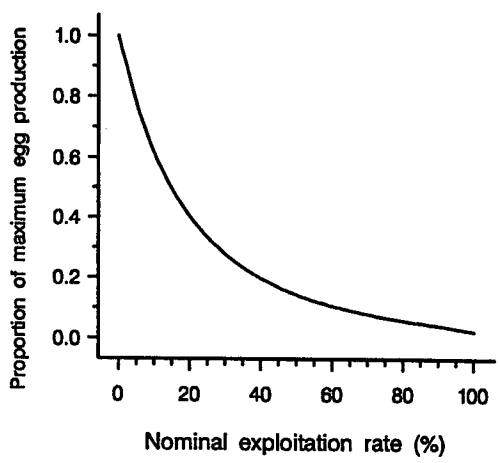
Estimates of recruits to the standing stock, 1976–96 and recruits to the adult population 1985–96 (top), and egg production, 1976–93 offset 9 years to right (bottom), in the Arnold's Cove lobster population.



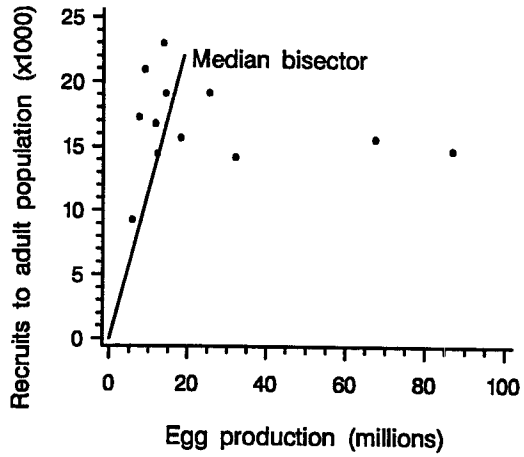
Estimates of egg production for 1976 to 1987 and recruits to the standing stock 9 years later for the Arnold's Cove lobster population fitted to the Beverton and Holt stock–recruitment model. Numbers adjacent to the data points indicate the yearclass.

Arnold's Cove population estimates have been used to define the limiting level of exploitation beyond which the risk of recruitment overfishing is high. The approach is based on the concept that the recruits of one generation must, on average, produce enough eggs to replace their parental generation. The threshold for replacement is identified by the median survival ratio (recruits per unit egg production) derived from egg production (i.e. stock) - subsequent recruitment (to the adult population) data. The number from an egg per recruit (E/R) analysis whose reciprocal (i.e. 1 divided by the egg per recruit number to convert it to recruits per egg) corresponds to the median survival ratio from the egg production-recruitment (E-R) data identifies the limiting level of exploitation.

The analysis of Arnold's Cove data indicates that the threshold for replacement corresponds to an egg per recruit level of 2.5% that of an unfished population which would occur at an exploitation rate on commercially legal lobsters in excess of 95%. This suggests that the population can sustain exploitation rates exceeding 95% without risk of recruitment overfishing.



The relationship between egg production per recruit (E/R) expressed as a proportion of the maximum and nominal exploitation rate for the Arnold's Cove lobster population. Assuming a 1:1 sex ratio, the E/R value was halved.



Estimates of egg production (E) for 1976–87 and recruitment (R) to the adult population 9 years later for the Arnold's Cove lobster population. The line through the origin of the scatterplot with slope equal to the median survival ratio is shown.

While lobster populations must be highly resilient to fishing, there are a number of factors/considerations indicating that a more cautious interpretation of this result is warranted. The relationship between egg production in a given year and recruitment to the adult population 9 years later is tenuous because recruitment of a particular yearclass will undoubtedly be spread over several years. Processes and mechanisms which determine where larvae that originate in an area eventually settle are not completely understood and the extent to which recruitment to a localized population (i.e. postlarval settlement) originates with egg production within that population is not known. In addition any overestimation of recruitment or underestimation of egg production will result in a high-biased estimate of the median survival ratio. Further, the approach is most appropriately applied to stock-recruitment data with no compensation involved and collected during a period when environmental conditions affecting survival are average. The high resilience of lobster populations suggests a strongly compensatory mechanism in the life cycle. The Arnold's Cove E-R data were obtained during a period of strong

recruitment that was at least partly associated with better than average environmental/ecological conditions. The Arnold's Cove E-R data probably provide a survival ratio that is higher than normal. The higher the estimated survival ratio the greater the degree of resilience to fishing that is indicated and the less likely that recruitment overfishing will be detected in the kind of analysis described above.

A large portion of the egg production in the Arnold's Cove population is by undersized (prerecruit) females carrying eggs for the first time. Egg viability, fertilization success, egg adhesion and hatchability may be lower for smaller lobsters. Large female lobsters tend to produce larger eggs with higher energy content than small females which probably represents a survival advantage for the larvae they produce. Also, large females both extrude and hatch their eggs earlier in summer and there appears to be a survival advantage associated with hatching when temperature is increasing rapidly. Effectively then E/R numbers could be considered much lower than the model outputs. The lower the E/R number the higher the survival ratio estimated from its reciprocal and the more likely the risk of recruitment overfishing will be indicated when compared with the survival ratio from the E-R data. Nevertheless, egg production by sublegal females represents a buffer against exploitation that may help to prevent exploitation rates from exceeding limiting levels.

In evaluating various options for increasing egg production, model outputs indicate that the most effective management measures would be any providing long-term protection from exploitation to even small numbers of females. A factor not considered in the E/R analysis is the occurrence in some areas of small isolated pockets of mostly large lobsters. In Newfoundland waters lobsters tend to be restricted to a narrow band of rocky-bottom habitat along the shore. Areas adjacent to exposed headlands are lightly exploited because of rough seas during much of the fishing season. Such areas yield relatively small numbers of mostly large lobsters that are rarely seen in heavily exploited areas within the bays. Small pockets of large lobsters may originate because of light exploitation in limited areas or possibly because some individuals have low vulnerability to capture in baited traps and avoid capture long enough to reach sizes at which entry is restricted in standard traps. Relatively small numbers of large lobsters may represent refugia that produce enough high-quality eggs to provide some of the resilience to fishing that this species exhibits. Such refugia would contribute to an overestimation of the survival ratio from E-R data and reduce the likelihood of recruitment overfishing being detected.

A cautionary interpretation of the foregoing consideration of recruitment overfishing based on estimates for the Arnold's Cove population is that recruitment failure is likely to occur during periods that environmental/ecological conditions affecting survival to recruitment are less than favourable.

Outlook

In Newfoundland as elsewhere, lobsters are very heavily exploited and the bulk of annual landings is made up of animals that recruited since the previous year. Annual recruitment fluctuates with changes in environmental/ecological conditions; landings, therefore, will be determined largely by the vagaries of nature. However, over the long term, landings can be expected

to be lower, less stable, and to decline to lower levels than under a more moderate level of exploitation.

Over the past 45-50 years, major long-term trends in Newfoundland lobster landings have been part of widespread phenomena evident throughout the range of the species. Landings have been declining in recent years in many areas, for longer and to much lower levels in some than in others. Whether this represents the early stage of a widespread downward trend is not yet clear.

Yield per recruit analyses show that growth overfishing is occurring under the current management regime. Egg per recruit analyses show that the relative level of egg production is very low. While recruitment overfishing has not been demonstrated conclusively, there clearly is a high risk of recruitment failure, especially during periods when factors that influence survival to recruitment are unfavourable.

New management initiatives aimed at increasing the level of egg production will have to achieve a much more moderate level of exploitation before future landings are dictated to a lesser extent by the vagaries of nature.

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References

Research Document:

Ennis, G. P. et al. Review of the Newfoundland lobster fishery. DFO Atl. Fish. Res. Doc. 97/126.

This report is available:

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